

The Engineering Advisory Committee – One Solution Closing the Gap in the Iron Range’s Engineering Education: K-14

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Abstract: The Iron Range will never be the same. A powerful and influential group from communities surrounding Hibbing Minnesota has aligned to ensure area students have every opportunity to discover engineering as their lifelong passion. “Powerful” is not based on any organizational chart but rather an attitude of “we-will-make-it-happen.” The group started as the *Hibbing High School Engineering Advisory Committee*. Creating an ad-hoc partnership with local businesses, industry, higher education and regional development, this committee has sponsored activities such as: Curriculum development in the High School, Mentoring with young practicing engineers (representing multiple organizations from diverse backgrounds), job-shadowing with engineers to discover the nuts and bolts of a day in the life of an engineer, a business / engineering Pro-E computer lab at the High School, and a Junior Engineers’ Club among other things. The committee is comprised of instructors from Hibbing High School, Hibbing Community College and the University of Minnesota-Duluth; industry leaders from Cliffs Natural Resources, Jasper Engineering, BARR Engineering and NORAMCO; and leaders from regional support agencies such as the Hibbing Chamber of Commerce, Iron Mining Association, Applied Learning Institute, Engineers’ Club of Northern Minnesota and Iron Range Resource and Rehabilitation Board. This paper seeks to address the need for locally grown engineers on the Iron Range, the formation, challenges and successes of this committee, the committee-sponsored events, and the review of the spectrum of Engineering Exposure to students in the region. Further, the paper will describe how this committee works to identify and close any gaps in curriculum opportunities in order to create a continuum for multiple age/education levels, how Team-teaching accentuates the pre-engineering educational process and how the committee works to convert the perception of “can’t-be-done” and into ways that can be. We will discuss the necessity of championing a vision through to completion not only individual projects but also the Engineering Education concept itself.

The need for locally grown engineers

As a matter of statistical interest, Northeastern Minnesota is on the verge of a deficit in the engineering profession, with an even greater decline in trained engineers on the horizon as more senior engineers retire. According to the Minnesota Department of Employment and Economic Development (DEED), the demand for engineering and architecture occupations in Northeastern Minnesota alone is expected to increase by 9.9% in the decade of 2009-2019.¹ Nationally, it is expected that the overall growth in engineering fields will be 11% in the 2008-2018 decade, and

for mining and geological engineers topping 15%.² Further, the U.S. as a whole has only 4.5% of its undergraduates completing engineering degrees compared to Asia and the European Union at 21.1% and 12.6% respectively.³

Central to the Iron Range, Hibbing is a hub for the engineering industry in Northeastern Minnesota, with a demand for engineers at the local mining companies and engineering consultant firms. Local leaders, including Mr. Robert Bolf, principal recruiting executive of Cliffs Natural Resources, consistently report the need for engineers at area production facilities such as Hibbing Taconite Company and United Taconite Company. As Mr. Bolf travels the nation courting engineering graduates, he mentions that the area's recreational opportunities are a real selling point for potential employees, but finds that many leave the area after a few years of employment, seeking careers in other industries and regions of the state and country. It is generally true that Iron Range born and raised high school and even college graduates who have come back and have entered the mining companies are more likely to stay in the region for the long term. The next logical question to ask therefore is "how do we interest young Iron Range students to pursue engineering in order to keep engineers in the region for the long term?" Local graduates are very familiar with the area, have family and friends that keep the graduate interested in the area and those have a vested interest in improving their local communities and therefore have a vested interest in supporting their principal employer. But, according to Rich Rojeski of Hibbing Taconite Company, it can be a tough sell, even for his own two children. "They both say they won't come back to the range...My son said he would never come back. He just doesn't think there is anything up here for him."⁴ The challenge for local business, industry and educators, is therefore to provide the scaffold by which students can achieve their educational goals while remaining in their home communities. More importantly, for educators, the problem is how to attract students to this often poorly understood profession *early in their schooling*. The Engineering Advisory Committee has attempted to provide an answer to this difficult challenge. And now, the area is offering a smorgasbord of hands on opportunities with students saying: "I didn't even realize I liked doing this kind of stuff or even that I could!"

While attracting local graduates to the industry may be difficult, the opportunities for local students to pursue engineering careers has never been better, a fact that we believe can be beneficial in encouraging our students to consider pursuing engineering. Our two-year institutions, Hibbing Community College, Itasca Community College (ICC) and Mesabi Range Community and Technical College (MRCTC), all have 2-year pre-engineering degree programs leading to the level of Associate in Science. Recently, Iron Range Engineering (IRE), a program hosted at MRCTC and delivered by Minnesota State University-Mankato (MSUM) in conjunction with ICC has added a 4-year baccalaureate in Engineering. Our local graduates may now enter the IRE program with an AAS or AS and complete their engineering training on the Range with integrated experience through project work at local industries. As well, the University of Minnesota Duluth has added a Graduate Engineering degree program based at the

MRCTC campus and accessible at HCC and ICC - allowing regional engineers the option to either seamlessly transition from secondary school through graduate education without leaving the region.

However, the engineering profession remains rather misunderstood by the general public, not to mention the average career-seeking student. One interpretation is simply that “*They Don’t Know.*” School counselors, teachers and even parents are limited on their exposure to the intricacies of each engineering discipline or what it takes to become an engineer. Some extremely talented students may never reach their full potential because they are unaware of the possibilities or how to get there. Non-engineering parents typically will not steer their child in this direction. Even parents who are engineers may not know enough about other disciplines to be able to help create a burning desire in their daughters and sons. Indeed, student perception of engineering may be a significant limiting factor in the enrollment of future engineering students, especially high school students who might feel that they “...are not intelligent enough to become engineers.”⁵ As an example, a 2009 survey (Figure 1) of Hibbing High School graduates, courses and concepts perceived to be “difficult” and the perceived inability to pursue engineering comprised more than a third of the deficit in student engineering enrollment.

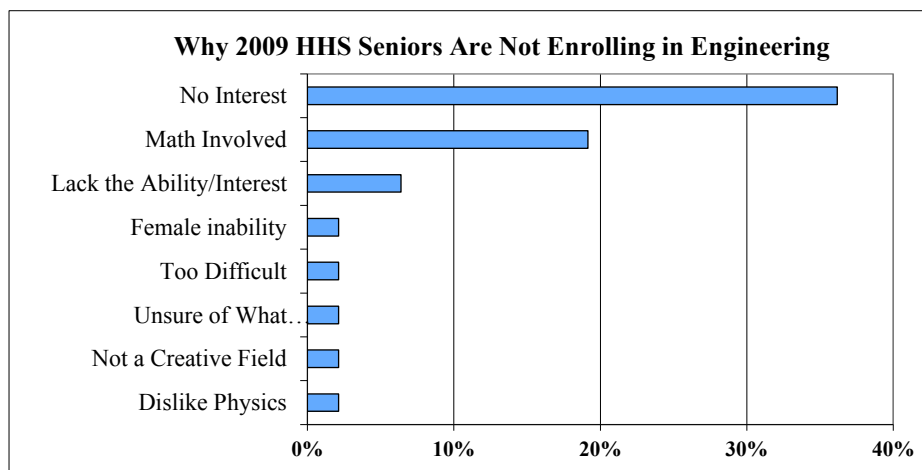


Figure 1. Hibbing High School Seniors 2009 Survey of Engineering Interest

From the same graduating class, data was collected regarding collegiate enrollment plans for the following fall of the same year. The results are summarized in Figure 2.

Interestingly, Engineering placed 2nd only to Health Sciences (physicians, nursing, dentists and dental hygienists). Similar data from 2008 showed only 9% of graduates selecting engineering. We believe that overall, our coursework has had some positive correlation in career selection of our graduating seniors.

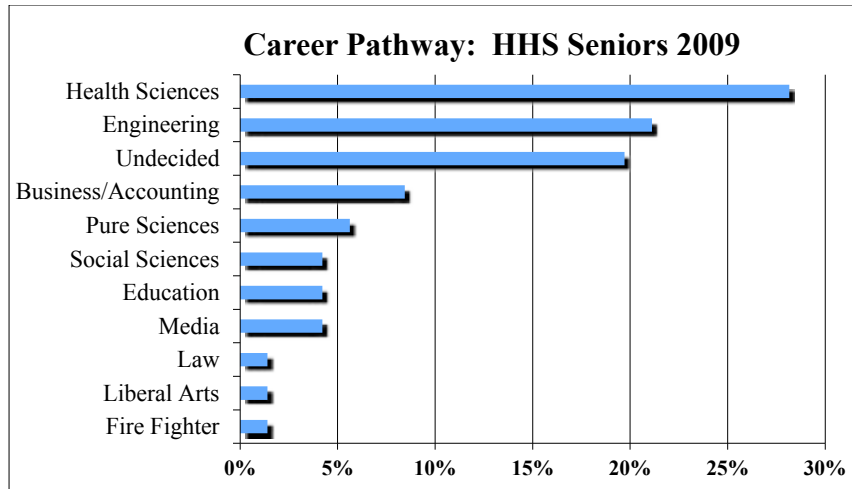


Figure 2. Hibbing High School Seniors 2009 Career Pathway

The advisory committee

The advisory committee is made up of professionals who serve no term, who have not been elected, but volunteer with energy and capability to support the students of the Iron Range and are in their way working to ensure a solid future for the Iron Range rife with innovation and opportunity. This powerful and influential committee comes from communities surrounding Hibbing Minnesota and has aligned itself to ensure area students have every opportunity to discover engineering as their lifelong passion (or not!). “Powerful” is not based on any organizational chart but rather an attitude of “we-will-make-it-happen.” The group started as an ad-hoc partnership with local industry, higher education and regional development in order to complete one project: a computer lab for Hibbing High School which turned into the Business and Engineering Computational Center for the school. In undertaking this project, Tom Jamar, president of Jasper Engineering and others provided financial and design support. From that effort, it became apparent to Mr. Jamar that this was the tip of the iceberg – that so much more could be done. There was a lot of interest and energy but there was no vehicle to harness it. The students were interested, but the schools needed the guidance and external funding. Jamar began reaching out to other organizations (letter 9/1/06 to Robert Belluzzo, Superintendent Hibbing Public Schools). Soon after, the Hibbing Chamber of Commerce, Iron Range Resources and Iron Mining Association joined in and Jamar et al became the Engineering Advisory Committee. These same organizations still play an active roll.

Five years later, the committee is now comprised of other organizations as well: instructors from Hibbing High School, Hibbing Community College and the University of Minnesota-Duluth; industry leaders from Cliffs Natural Resources, Jasper Engineering, BARR Engineering and NORAMCO; and leaders from regional support agencies such as the Hibbing Chamber of Commerce, Iron Mining Association, Applied Learning Institute (ALI), Engineers’ Club of

Northern Minnesota, Society for Mining Metallurgy and Exploration, and Iron Range Resource and Rehabilitation Board. The people are in place – now the infrastructure.

Mechanics

So, how does this all work? Monthly, the committee meets at a central location and is facilitated by Tom Jamar. The high school teachers talk about what they've been doing and what they need. The committee looks to each other to support the 'what' that is needed and to offer ideas for improving the curriculum. Additionally, the committee discusses and directly sponsors activities strongly in the upper grades (seven of which are described below) and is working to develop ways in which to reach the rest of the K-14 spectrum.

First (11th – 12th grade): Perhaps the crowning jewel of the advisory committee has been the \$100,000 Business and Engineering Laboratory that was completed during the summer of 2007. This facility resides in the old study hall on the second floor of Hibbing High School and houses 30 Dell Precision 390 workstations, a central server, printers and full network access. With support from the HHS Administration and Building and Grounds, this facility has been central to course content delivery. Recent additions through the Applied Learning Institute and Carl Perkins funding including upgraded memory for the computers and a new Dimension series prototyper for generating plastic 3D models from student CAD creations.

Second (9th – 14th): An annual engineering mentoring session is held in November at BARR Engineering in Hibbing. Local mining and engineering firms call for volunteer engineers to meet with students over hors d'oeuvres to discuss the future employment outlook, engineering careers, engineering colleges and offer a general question-answer session for students to learn exactly what engineers do in the region. In addition, it provides an opportunity for the students to meet one on one with practicing engineers discussing job details, college experiences and opportunities. Parents have also used this session to learn more about what engineers do on a daily basis and to obtain advice for preparing their children for college.

Third (11th – 12th): Through the inspiration of Robert Bolf from Cliffs Natural Resources, each spring the mining and engineering firms offer job-shadowing opportunities for students interested in capturing a "day-in-the-life" of an engineer. Roughly 12 students each year spend a half-day one-on-one with an engineer in the field from local mines, engineering consultant groups, the city, and other area manufactures. This is clearly one of the most popular events for our students, who return glowing with enthusiasm.

Fourth (6th): Each Fall, members of the local engineering community volunteer to teach a unit in an after-school series entitled "Engineering Cool," in which the 6th grade students learn about engineering careers through activities in science and engineering. This program was the result of

collaboration between the Hibbing Chamber of Commerce, the Hibbing School District and two highly engaging engineers; Julie Elkington and Christy Kearney. This Fall (2011) marks the second year of this series and the students and parents have shown excitement for continued involvement. 25 students registered for the first year, and early applications for the second year exceeded 40! Due to the short duration since inception and the current gulf between middle school and high school enrollments, the data suggest no conclusion as to its effect, but it is expected to have a large influence on initial student enrollment in pre-engineering courses at the high school level.

Fifth (9th – 14th): Jason Janisch of Jasper Engineering, J. Moe Benda from the University of Minnesota Duluth, Bob Zbikowski from HCC, Jason Slattery from MRCTC and Carl Sandness from HHS have started a Junior Engineer's Club of Northern Minnesota, based at HCC with groups in Hibbing and Virginia. This newly founded club is directly sponsored by the Engineer's Club of Northern Minnesota and the Society for Mining, Metallurgy and Exploration and meets in the evening bi-monthly to showcase a particular engineering discipline. Members are students from the areas respective schools (HHS and HCC in the central area of the Range and Virginia area high schools and MRCTC in the east). During the 2010-2011 school year, representatives from chemical, mechanical, civil, biomedical and renewable energy engineering presented a snap-shot of their respective discipline as well as providing an activity relevant to the discipline at hand. The club attendance for the past year averaged eight per night, with four returning this year. It is our hope to incorporate a regional challenge between the groups and perhaps add a third group on the western range.

Sixth (7th - 8th): The committee supports the Lego League competition coordinated by Shanna Eskeli, a junior high school science teacher. In 2010, they had two teams compete in local competition. To prepare, each team delivered an oral presentation to the Engineering Advisory Committee who provided industry feedback. As well, the committee also provided financial support.

Seventh (11th - 12th): As part of the FIDEARS (Fundamentals of Industrial Design, Engineering Applications, Robotics and Sustainability Studies) class, the students compete in Lake Superior College's Battlebots competition which is also supported by the engineering advisory committee, ALI and the American Manufacturers and Fabricators Association (AMFA).

With all of these efforts, the committee is working to provide students opportunities to see engineering for themselves and experience engineering first hand to be better able to make informed career life decisions. Some find a particular engineering discipline suits them more, or some see that Engineering is not for them at all. The cost of this decision increases exponentially with each post high school year that passes. Better to decide now when it's free, than \$159,000 of tuition later.

The curriculum development

Bob Zbikowski of Hibbing Community College (HCC) and Carl Sandness of Hibbing High School (HHS), had been discussing how engineering education is necessary prior to leaving high school since the early 2000s.

In July of 2006, they met with Tom Jamar of Jasper Engineering to discuss their cooperative strategy for bringing a team-taught, co-enrollment, *Introduction to Engineering* course to students of Hibbing High School. Met with a healthy enthusiasm, Jamar began to contact local business, industry and engineering leaders together in a meeting with educational leaders of ISD 701 (district) and Hibbing Community College (HCC) to discuss the need for the start to an engineering education curriculum. Zbikowski had a course in place at HCC that would serve as a platform to bring fundamental data analysis skills, group projects, career mentorship and college preparatory skills to students interested in pursuing engineering as a college major. Sandness attended training for Parametric Technology Corporation's Pro/Engineer Wildfire 3.0 (Pro/E) software at St. Cloud State University, granting a site license for the installation of parametric modeling software to institutional computers. Parametric modeling became the secondary tool-set for student study in the proposed course. Further consultation with the advisory committee led to the incorporation of the aforementioned mentoring sessions, job-shadowing activities, and site visits.

The *Introduction to Engineering* course has been a successful venture and has had five successful sections complete this course (106 students), of which we estimate 27 have continued their collegiate study in engineering. Student evaluations of this class has been favorable and consist of a series of statements to which students submit a rating of 1 to 5, where 5 represents "strongly agree" and 1 represents "strongly disagree." Of 20 evaluation categories, the overall rating for the course from 2007 to 2010 is 4, which we interpret as "good." Of those components for which the advisory committee offers support, site visits scored 4.4, guest speakers 4.2, and mentorship programming 4.1. Of those students surveyed, when asked if they would enroll in a second pre-engineering course, the average rating is 3.9. And of particular interest is a question pertaining to whether or not the responding student would recommend the course to another student interested in engineering, for which the average response is 4.5. The success of Intro to Engineering was further recognized with a 2009 University of Minnesota Humphrey Institute Local Government Innovation award.

After the success with *Intro to Engineering*, they continued their discussions of adding conceptual core engineering units in statics, dynamics, fluids and thermodynamics to coursework. Since Intro to Engineering was a semester-based course, there was financially no funding for an additional course to be added to the existing schedule. The advisory committee

again came through, and with logistical and financial support, the yearlong FIDEARSS course was first offered during the 2009-2010 school year. The brainchild of Frank Pengal, former president of NORAMCO Engineering (now senior consulting mechanical engineer at BARR Engineering and current advisory committee member), the FIDEARSS course is in its third year. In an advisory committee meeting in 2008, Pengal, an alumnus of HHS, commented on a missing facet to our programming, that being the proverbial “elbow grease” of industrial technology courses – the welding, fabrication, machining and electronics skills that many graduates from high school are lacking, and that these deficiencies can sometimes inhibit engineering undergraduates in their coursework projects. These same sentiments have been points of discussion for the student panelists at the 2009 and 2011 Engineering Education conferences held at the University of St. Thomas and the University of Minnesota. With its conceptual, project-based assessment model, the FIDEARSS course complements well the *Introduction to Engineering* course in providing the additional skills necessary for future student success. Of the 31 graduates of this course in the last two years, 10 had also taken the *Introduction to Engineering* course, giving these graduates nearly two years of pre-engineering education prior to entering college. In June of 2011, the Minnesota Association of Secondary School Principals (MASSP) honored the FIDEARSS course with a “Star of Innovation Award” to recognize its mission in improving student success in the technical and engineering career pathways at Hibbing High School. Without the consult, mentoring and support of the Engineering Advisory Committee, this would not have been possible.

The Teaching Team

With the myriad of skills taught came the need for a better way to teach them. Team teaching spontaneously developed and as such, it offers students many advantages⁶ over the traditional instruction:

1. Improvement in quality of scholarship through multidisciplinary approach by complementing one another’s expertise.
2. New perspectives and insights from watching each other teach.
3. Stimulation and challenge prevents mental fatigue and burnout.
4. Increased planning clarifies goals, how and why they teach and how to do it better.
5. Applied to education what is valued in industry: shared responsibility, creativity and community

Working together, the Team has determined that their level of satisfaction of content delivery has improved because they are able to rely on each other’s content knowledge to provide quality instruction for their students. Not only content knowledge is improved, but also the ascertainment of student content mastery has become better defined because while one is

teaching the concept, the other is observing the student behaviors, taking note of the level of attentiveness each student displays. Post-class discussions between instructors have revealed key areas for delivery and curricular improvements. They have also determined that the generation of novel projects has been greatly accentuated due to their different backgrounds enabling the synergistic incorporation of specific components that make each new project engaging.

For the FIDEARSS course, it has been even more important that Russell McConkey and Terry Vesel of the Industrial Technology department have joined the team-teaching effort. With over 50 years of combined automotive, electronics, machining and welding experience between them, Russ and Terry have complemented the team teaching effort seamlessly. Now students benefit from a much greater level of expertise, especially when all four are teaching at the same time. Student projects now have supervision and guidance for project development and execution on multiple levels simultaneously. We are able to address student needs on a much more personal and in a much more attentive manner.

Our teaching team has been fortunate to have the opportunity to team-teach, due in large part to supportive administrators at both Hibbing Community College and Hibbing High School who have strongly supported this unique teaching style and realize its importance to the education of the pre-engineering and technical student. To finance this venture, Mr. Roy Smith of Iron Range Resources and the Applied Learning Institute, a key member of the advisory committee, has championed this effort and found support with cabinet members.

The Challenges

The joining of a fast moving results oriented entity (industry) to a slower moving process focused entity (public institutions) can create challenges in itself. Initially this created frustration from both sides. As well, project championing was initially an issue. Organizational politics are difficult to weave through when one is internal to the organization, and almost impossible when external.

Where this collaboration loses strength is in the external pushing or the internal pulling, but no owner to make it happen. The success of this committee has been through not having one champion, but three – two from within the schools, and one from without. A champion who is internal to their process that can run with action items needed to be done on “their side of the fence.” Sitting across the table from one another, the conversation becomes much different. There is more “What do you need?” and “How soon?” on one side and on the other real needs are expressed. The plan details can then be laid out, and everyone is making progress and is on the same page. Thus, it is absolutely critical to have one or two driving from the inside and one making sure the external parties can get it done. Inter-organizational cooperation fails if each organization doesn’t own the initiative. In this case, the initiative is engineering education. Each

member champions activities within her/his own sphere of influence. Once these internal and external drivers of the process became evident, results followed.

Each (public and private sectors) had to work through a learning curve to understand the other's processes better and learn to leverage each other's strengths and overcome any respective weaknesses.

Final Thoughts

The Engineering Advisory committee has demonstrated a commitment to the current students of the Iron Range to ensure the longevity of the region itself. The success to-date has been a result of the *volunteers* from the area, both on the committee and those providing the classes and promoting in their own way opportunities for all the students on the Iron Range the experience and the thrill of innovation and creation which is the heart of Engineering. Perhaps the name should be changed to “The Engineering *Doing* Committee!”

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