





MINNESOTA STATE Engineering Center of Excellence

507.389.1201 ENGINEERING.MSU.EDU ENGINEERING@MNSU.EDU



Melissa Huppert, Ph.D. STEM Outreach Director Jason Bruns Center Director Loralea Baldwin Administrative Assistant



WHAT WE DO

The Minnesota State Engineering Center of Excellence facilitates relationships by engaging academic institutions with industry and provides educational outreach by inspiring interest in science, technology, engineering, and math (STEM). These efforts shape the next generation of engineers who will solve real-world problems. The Engineering Center of Excellence fosters accessibility to the latest technologies, workforce programs, and post-secondary education. Collectively, advancing Minnesota's engineering innovation and competitiveness by enhancing education, engaging industry and inspiring students.

01

ENGAGE.

[CULTIVATE + ENHANCE + LEVERAGE]

We cultivate relationships and enhance existing partnerships to leverage new resources.

02

03

EDUCATE.

[THEORY + PRACTICE + REAL WORLD]

We bring together theory, practice and real-world solutions through innovative educational programs.

EXPERIENCE.

[LEARN + INSPIRE + LEAD]

We create opportunities to inspire the future workforce and provide thought leadership to industry professionals.

Director's Overview

Each year as I write this, I am always amazed at how great of a team the Minnesota State Engineering Center of Excellence has along with the support of other Minnesota State campuses, secondary educators, and industry members.

As we continue to bring new and innovative engineering and engineering technology programming for outreach, we are surrounded by people wanting to assist us in our endeavor because we are committed to making the experience positive and innovative.

In the summer of 2022, we held our in-person Engineering Center of Excellence advisory council meeting at Coldspring, Inc. for a day of innovative thinking and identifying key priority focus areas. These contributions help the team move forward with our Strategic Roadmap and gather new insights and support, deepening our current work.

In the early afternoon portion of our agenda, we shared our background for the Advisory Council Members to gain an understanding of our current programming along with key program areas. Conversation followed, supporting the "initiative priorities", generated by last summer's Advisory Council meeting. We tasked the Advisory Council to generate ways to incorporate these initiative priorities into our "key program" areas of Explore Engineering, Project/Problem-Based Curriculum, and Professional Development.

Each key program area is explored with the "lens" of our initiative priorities of making engineering more inviting to underrepresented populations and helping businesses engage with youth interested in engineering and engineering technology. The harvest of this activity led to great implementable projects.

Our winter Engineering Center of Excellence advisory council meeting was in a virtual format.

In this planning meeting, we came together to share a summary of how the center implemented several harvest ideas we received from the summer planning meeting. Two National Science Foundation grants were recommended; Broadening Participation in Engineering and Experiential Learning for Emerging and Novel Technologies.

The most influential key partnerships came from our host university, Minnesota State University, Mankato, and one of the world's largest engineering companies, our relationship with Siemens Corporation.

Finally, the Engineering Center is excited to serve on engineering and engineering technology advisory committees, both statewide and nationally. These include ASEE College Industry Partnership Division (CIP), MN SkillsUSA, Minnesota Foundation for Student Organizations (MFSO), Siemens Academic Advisory Board, Century College Additive and Digital Manufacturing, SciMathMN, CHIPS for America, Minnesota Statewide Tour of Manufacturing, and Tour of Manufacturing of South Central Minnesota. We are proud of our service in supporting these diverse but important organizations and allowing the center team to contribute to their advisory committees.

We have a great team, so come be part of it!

All the best, Jason





Target Audiences

College Presidents, Chief Academic Officers, and Deans

Provide strategic communication to increase awareness and perceived value of the Center and encourage administrative support for educator collaboration.

Industry Employers and Associations

Provide thought-leadership and develop partnerships to expand opportunities for students, improve curriculum, and develop pathways into the workforce.

Post-Secondary Educators

Foster collaborations to strategically transform existing curriculum, programs and provide professional development to better meet industry, students and societal needs.

Secondary Administrators, Counselors, and Educators

Identify and develop curriculum, provide educator training and facilitate collaborations to inspire students and increase awareness of career opportunities in Minnesota.

Post-Secondary Students

Create ties between students and perspective employers through internships, capstone opportunities, job shadowing, research and other programs.

Secondary Students

Offer career exploration and skill development programs to increase awareness and interest in engineering, engineering technology, and related career pathways.

Marketing Channels

The vast majority of the Fiscal Year 2023 outreach was conducted in online settings. As such, the Minnesota State Engineering Center of Excellence continued to refine its digital marketing efforts with a focus on:

- 1. Website redesign
- 2. Continual Social Media refinement/posting
- 3. Addition of EMDC Facebook page

The use of email campaigns to directly target audiences and direct them to the center's website was the most impactful means of marketing. The overall email open rate was 53%, which is 13% above the industry average. The majority of program-specific email campaigns had open rates of 50-67% and click rates of 2-5%. The use of email campaigns is a vital marketing strategy for the center.

The Minnesota State Engineering Center of Excellence website continues to be a strong marketing tool. The Engineering Machine Design Contest accounted for 39% of the site visits, followed by the Home Page (23%), Reverse Ind Engineering Challenge (6%), STEM Educator Workshop (6%), Staff Page (4%), and Workforce Partnership Seminar (3%).

Our new EMDC Facebook page had a reach of 642. Our first year with Instagram yielded a reach of 366. The Centers YouTube channel had 371 Views and 1.1K Impressions. LinkedIn gained 136 total followers. The center's Facebook page reach decreased by 79.53% to 1,102. This change is largely due to not utilizing paid Facebook target marketing this year. We continue to explore new ways to connect through social media channels.



26%





Per Year





Direct Impact

FY23 was not only a return to "normal" after COVID-19, but an expansive year. The data shared on this page is reflective of the center's direct and indirect reach (e.g. a teacher delivering center content to their students).

Engagement with educators increased by 134% from FY22 to FY23. This increase is reflective of the prioritization of promoting center programs and resources to educators in an effort to expand reach and increase capacity by empowering those that work directly with students. Student outreach and engagement in the center's programs increased by over 374% from FY22 and excelled beyond pre-pandemic numbers by increasing 115% from FY20 to FY23. For the first time, engagement across the K-12 sector was evenly spread among K-5th, 6th-8th, and 9th-12th.

Looking toward FY24, the center is excited about strategic program growth. The next several pages of this report outline the impact and future direction of key program areas.



Key Program Areas

The Minnesota State Engineering Center of Excellence aligns its work and initiatives in three key program areas: Explore Engineering, Project/Problem-based Curriculum, and Professional Development. These key program areas were identified as strategic ways for the center to fulfill its mission and align with the **Minnesota State Centers of Excellence Common Strategic Directions**:

ENGAGING INDUSTRY

Seeking the voice and expertise of industry and community partners is integral throughout the work of the centers. Centers facilitate **rich**, **interactive networks** to inform and guide our workforce of the future.

ENHANCING EDUCATION

Centers will be a catalyst and conduit for the latest industry knowledge to benefit our faculty and staff and to provide students with an **innovative**, **high-quality** education.

INSPIRING STUDENTS

Centers will provide high school and college students with opportunities to **meaningfully expand their knowledge** of careers and acquire skills and knowledge for their chosen profession.







Key Program Areas Explore Engineering

The Minnesota State Engineering Center of Excellence is committed to providing free or low-cost experiential-based programs and curricula explicitly designed with the needs of Minnesota K-16 educators and future workforce demands in focus. Taking into consideration project/problembased curriculum and resources already available to educators, the Engineering Center strives to develop new programs that reduce barriers to access and participation while filling the gaps not addressed by other resources.

Project/Problem-Based Curriculum

The Minnesota State Engineering Center of Excellence values high-quality curricula which allow students to acquire relevant skills and industry pertinent knowledge through project/problem-based curricula. We vet and endorse curricula that inspire student career exploration and emphasize engineering investigation as a means to an end, not to an end in itself. The Engineering Center is committed to facilitating dual credit opportunities with its endorsed curriculum.

Professional Development

The Minnesota State Engineering Center of Excellence regularly provides professional development opportunities for K-16 engineering and STEM educators, stakeholders, and the workforce. These opportunities help to bridge the gap between K-12 and college/university educational offerings, industry trends, and workforce needs. It is through these efforts that learners will be provided with the most innovative, relevant, and quality education possible.

Explore Engineering Resources

KEY PROGRAM AREA: EXPLORE ENGINEERING

The Explore Engineering program includes various resources that support educators as they work to inspire interest in engineering and engineering-related careers with 3rd - 12th grade students, especially those from underserved populations. Most of these resources are available to be downloaded from the center website for free. During FY23, the center's wesbite was updated with an automated process that requires users to submit a simple form in order to access a resource, allowing the center to collect basic data on the expected use of these resources.

The Explore Engineering Curriculum is standards-based, designed for 3rd - 8th grade, and suitable for formal and non-formal settings. The curriculum was developed in partnership with Minnesota 4-H. The first cohort of educators piloted the curriculum in FY22-FY23. One educator stated: "The lessons are so well crafted; it's obvious a lot of thought and time was poured into them. Kids will love this and teachers, too! Students thrive when they have time together in open-ended, hands-on activities... Thank you for sharing these resources. Students will greatly benefit from these activities." Based on educator feedback, FY24 will include revisions and a marketing plan for the curriculum.

The **Explore Engineering Card Games** we designed to inspire interest in engineering and an introduction to primary concepts such as the engineering design processes, engineering notebooks, and engineering disciplines. These games are integrated with the Explore Engineering Curriculum, as well as stand-alone activities. In FY23, the card games accounted for almost 30% of the resources download on the center's website.



Additional on-demand resources available for download on the center's website are the **Engineering Design Challenge** modules which are suitable for both online and in-person educational settings. These accounted for over 32% of the resources downloaded on the center's website.

A new resource to be released in FY24 include the **Engineering Lean** and **Engineering Lean**: **Leadership Curriculum**. This curriculum focuses on continuous improvement methodology, an approach that eliminates wasteful processes to deliver more value with fewer resources. Pilot cohort training events with approximately 60 educators and industry members are scheduled for summer/fall FY24.

Explore Engineering Resources

KEY PROGRAM AREA: EXPLORE ENGINEERING

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Another resource to be released in FY24 is the **Minnesota Engineering and Engineering Technology (MEET) Recruitment Cards**. This deck of cards will feature the MEET programs available through Minnesota State Colleges and Universities, as well as highlight important career information such as salary, education requirements, and key traits. This deck of cards will have gameplay instructions and be used as a tool for increasing awareness of MEET program and careers in a fun and simple way.

The center piloted a new **Explore Engineering Day Camp** model with MSU's CSET. The new model creates partnerships with local youthserving organizations and limits the liability and college resources needed to offer summer camp programming.

Youth organization partners in 2023 included 4-H, YMCA, and ACES. Approximately 100 youth participated in the programming.



Website Resource Downloads

Mechatronics QAS

KEY PROGRAM AREA: PROFESSIONAL DEVELOPMENT

The Engineering Center of Excellence **Mechatronics Quality Assessment System** (QAS) is entering its finishing stages. This initiative aimed to develop an industry customerfocused robotics/instrumentation technology (mechatronics) program standardization, a common improvement assessment plan, and a new program collective assessment tool known as a Quality Assessment System (QAS). Current participants in this project are the Minnesota State Colleges of Southeast Technical, Hennepin Technical, and Ridgewater engineering technology programs.

In this program, the Center facilitated opportunities for partnerships by bringing new and existing program faculty together to share best practices regarding how and what works in this area of CTE programming. The QAS includes specific requirements necessary for the adoption of processes by developing, implementing, and improving course content and assessment plan rubrics. This was achieved by conducting a program GAP Analysis and leveraging 80% alignment to the national standards from Packaging Machinery Manufacturers Institute (PMMI) while maintaining 20% community industry workforce needs.

The outcome of this will result in well-prepared, standardized industry-aligned learners to work in local industry and/or anywhere in the world. Members from Siemens Center for Advanced Manufacturing also participated in the assessment of the new programming, providing an industry perspective. This program is expected to be completed by the end of the calendar year 2023 with plans to share it with other Minnesota State mechatronic programs.

Siemens STEM Curriculum

KEY PROGRAM AREA: PROJECT/PROBLEM-BASED CURRICULUM

The Minnesota State Engineering Center of Excellence and Siemens Corporation have an ongoing partnership to share their secondary Siemens CTE curriculum. This curriculum, tailored for secondary school students, employs project/problem-based learning in the field of engineering.

It comprises a series of year-long courses that progressively build upon one another: Engineering Design, Manufacturing and Automation, Mechatronics and the Internet of Things (IoT), and Engineering Research and Development. Together, these courses explore Industry 4.0, the forthcoming industrial revolution. To support teachers in implementing the curriculum effectively, approximately ten teachers from various schools across Minnesota are currently benefiting from free summer teacher training. Upon completion, participating teachers can earn 3 master's credits. Additionally, students who successfully complete Course 1 can earn articulated credits.

Looking ahead, the plans for the Siemens CTE curriculum in Minnesota involve expanding its availability to more schools and encouraging greater student participation in the Siemens program. There is also a commitment to enhancing post-secondary credit recognition for students who successfully complete this curriculum.

Engineering Lean

KEY PROGRAM AREAS: EXPLORE ENGINEERING & PROFESSIONAL DEVELOPMENT

In the summer of 2023, the center began a new initiative, **Engineering Lean**. This initiative was created in collaboration with Anoka Technical College Professional Workforce Training and Organizational Partners, LLC.

This initiative's curriculum will be available online for secondary and post-secondary educators and industry members. The vision for Engineering Lean is to provide exposure to real-world resources that can be leveraged in the classroom along with tools that will fulfill the industry's need for Lean training exposure for new managers and employees.

Linking academia and industry together to synchronize training efforts will support the need for continually evaluating and improving processes not only in our work but our everyday lives. The first Engineering Lean Curriculum involves the creation of ten 50-minute interactive Lean training modules.

The curriculum introduces learners to a variety of Lean tools such as: Waste Identification (Value Add vs. Non-Value Add), 5S and Visual Workplace, Spaghetti diagrams, TAKT Time vs. Cycle Time, and Push vs. Pull principles. Module diagram and picture references are from different employment sectors such as manufacturing, construction, retail, and medical, allowing for career exploration. Modules are designed with minimal supply costs.

The second Engineering Lean module will be released in the fall of 2023. This Lean Leader curriculum will contain seven 50-minute Lean Leader training modules to build student "soft skills" and leadership skills that many are lacking, in preparation for the CTE field.

A list of potential training examples is as follows, but not limited to: Lean in the Personal Life (Emotional Intelligence), Understanding and





Valuing Differences in People, Servant Leadership: Leadership with Purpose, Communication and People Skills, and Conflict Management. Module diagrams/picture references will be from different employment sectors such as manufacturing, construction, retail, and medical. Modules designed with minimal supply costs.

Professional development for CTE personnel and non-CTE teachers/faculty/counselors for this CTE curriculum initiative from the Engineering Center. The initial "Train-The-Trainer" session for Engineering Lean took place in the summer of 2023 with 26 trainees. Participants were secondary educators, post-secondary educators, Centers of Excellence, and sponsorship industry trainers. A pilot training for the second module, Engineering Lean: Leadership, is being planned for September 2023.

EMDC and REC

KEY PROGRAM AREA: EXPLORE ENGINEERING

The Engineering Machine Design Contest

(EMDC) is an opportunity for teams of 5th-12th grade students to design and build a complex machine using everyday objects with the guidance of a coach. The completed machine will use multiple steps to complete a simple task. Students are able to explore science, technology, engineering, and mathematics (STEM) principles while having fun in a collaborative environment. Each year a competition theme is chosen to guide the machine build and allow for whimsical creativity to flourish. This past year the theme was Into Orbit: Transforming Space Technology.

EMDC contests were in full action with a total of eight regional contests, 62 teams, and 372 students - a 22% increase from the previous year. Collectively, students spent an estimated 2.5 years' worth of time preparing for the EMDC. The Championship event included 36 of these teams and an estimated 450+ students, coaches, and spectators in attendance. It was hosted at Anoka Technical College in Anoka, Minnesota.

In the sixth year of the program's existence, major accomplishments included the addition of a new regional contest (St. Cloud State University), the refinement of a custom tabulation system, the commitment of *new and previous corporate sponsors (*3M, Seimens, ECI, ISG*, and Anderson Dahlen*), the creation of the 3M Resource Center - a fix-it station made up of 3M products, and the addition of the Redesign Round. The Redesign Round provided nonfinalist teams with the opportunity to demonstrate their ability to innovate and think on their toes.

As interest in the program grows, the focus for the 2024 season includes working with regional contest organizers to strengthen their existing program, developing educator/coach resources, refining the program marketing plan including the development of promotional and informational videos, and increasing corporate sponsorships.



The **Reverse Engineering Challenge** (REC) was expanded this year from being a same-day engineering contest to an activity and kit-based resource. The main premise of the REC is for teams of 2-5 students to disassemble a given object and imagine an innovative way to use its parts to solve a given challenge, including the development of a rough prototype.

During FY23, the REC was disseminated to educators as a kit, direct-delivered at career exploration events, and facilitated as a contest held in conjunction with the Minnesota 4-H Engineering Design Challenge event. Approximately 360 REC kits were disseminated in FY23 resulting in an estimated 1,080 students reached.

Going into FY24, the focus will be on the development of standardized activity lessons that can be easily adapted for different ages, time lengths, and content focus. Additionally, REC kits will be more broadly distributed at conferences and outreach events. Resources will be developed for educators to easily use the REC as a sub-for-the-day resource.

Workforce Partnership & STEM Educator

KEY PROGRAM AREA: PROFESSIONAL DEVELOPMENT

Our **Engineering and Engineering Technology STEM Educator Workshop** is a professional development opportunity for secondary and post-secondary educators to learn about pedagogically supported foundations for teaching engineering and technology-related techniques. These skills apply to all Science, Technology, Engineering, and Mathematics (STEM) educators and help with student retention and success, as well as increasing the workforce in STEM careers.

In the fall of 2022, Dr. Roue spoke on the "Five Pillars of Education", industry involvement, project-based learning, global citizenship, entrepreneurship, and service learning.

Our spring 2023 presenter, Dr. Merredith Portsmore presented "Introducing Novel Engineering", leveraging books already in classrooms as a starting point for hands-on engineering.

The center looks forward to continuing to supply free professional development to STEM educators, assisting them by improving their pedagogy and student retention through pertinent topics. **Engineering and Manufacturing Workforce Partnership Seminars** take place twice a year and are an assembly of industry, academia, and state employees taking an active approach to solving workforce and industry challenges. The vision of this program is to build partnerships that restructure and accelerate the Minnesota workforce education system, meeting workforce demands in manufacturing, engineering, and engineering technology.

In Fall 2022, the topic "Transitioning Youth with Disabilities to Employment", was presented by DEED/Workforce Vocational Rehabilitation Services (VRS) Gaining insight on statistics, myths, and etiquette, as well as how to partner with their program. Steve Kalina from Minnesota Precision Manufacturing Association (MPMA) shared success stories on how MPMA has connected youth with disabilities with businesses, helping to meet workforce needs.

The center plans to continue to grow this collaborative effort with industry, educational, and professional association partners, offering free professional development on relevant topics.

STEM Educator Workshop Participants

92% of participants would recommend this program to others.



96% agreed this program...

- Built awareness and/or connections between education and industry.
- Connected the dots and enhanced the quality of engineering and engineering technology education and real-world application.
- Enhanced the quality of engineering and engineering technology education with real-world application.

Workforce Partnership Seminar Participants

Most program evaluation respondents (75%) would recommend this program to others.







ENGINEERING & ENGINEERING TECHNOLOGY PROGRAMS

MINNSTATE.EDU/CAMPUSESPROGRAMS





The Team

STAFF



Jason Bruns, BSME, MBA Center Director



Melissa Huppert, Ph.D. STEM Outreach Director



Loralea Baldwin Administrative Assistant



Smriti Manandhar Graduate Marketing Assistant

INDUSTRY ADVISORY MEMBERS

Theo Black President, Minnesota Federation of Engineering, Science and Technology Societies (MFESTS)

Les Engel, President, Engel Metallurgical Ltd.

Steve Kalina, Executive Director, Minnesota Precision Manufacturing Association

Kurt Korkowski, Senior Systems Engineering Manager, Seagate Technology

Fletcher McNair, Productive Maintenance Coordinator, Coldspring USA

Dawn Lubahn, Youth Program Manager, Minnesota

Department of Employment and Economic Development

Kwaku Ofei-Budu, Jr., Senior Supervisor of Warehousing & Inventory, Abbott

Tom Skahen, CEO, Opus Motorcar Co

(DEED) - CareerForce, Winona

ACADEMIC ADVISORY MEMBERS

Elaina Bleifield, Vice President for Academic and Student Affairs, Anoka Technical College

Aaron Budge, Acting Dean, College of Science, Engineering and Technology, Minnesota State University, Mankato

Joan Carter, Department Chair of Physical Sciences, Engineering, and Technology, Inver Hills College

Zach_Eidelbes, Learning, Teaching, and Equity Coordinator | CAPS Coordinator, Shakopee Public Schools **Matthew Feuerborn**, Dean of Instruction (Technical Programs), Ridgewater College

Cary Komoto, Dean, Science, Technology, Engineering, Math & Education Division, Normandale Community College

Carl Sandness, Physics, Chemistry, Pre-Engineering Faculty | Carl D. Perkins Secondary Coordinator, Hibbing High School

Molly Schaefer, Director of Polytech Operations, Minnesota State University, Mankato

Involved!

Jetwork

Provide Sponsorship or In-kind Support

Provide Expertise, Mentorship or Present to Secondary Students or Educators

and Educators

Members

with Indust

Host or Organize an Event

Host Facility, Lab or Campus Tours to Secondary Students, Educators, & Others

Promote STEM Careers to Underserved and Underrepresented Populations

Engineering Machine Design Contest Volunteer to

Judge.

Coach.

Share your expertise!

Promote Pathway & Recruitment Into Careers or Post-secondary Programs

Advanced Explore Career Engineering Curriculum Programming

LEAN Engineering

Engineering & Engineering Technology Teacher Workshop