1. State the proposed Institute/Center’s name and purpose.

“Montana Engineering Education Research Center (MEERC)”

We are proposing the creation of an engineering education research center within the College of Engineering at Montana State University, Bozeman. The center will enable our faculty to better leverage interdisciplinary synergies in order to transform engineering education at MSU and become a leader in an effort of vital national importance. Transformation in engineering education is necessary in order to overcome long-standing issues in undergraduate engineering and computer science programs and educate inclusive communities of engineering students prepared to solve 21st century challenges.

2. A comprehensive statement of the Institute/Center’s mission and its relationship to the University mission.

A. State the Institute/Center’s mission.

The mission of the Montana Engineering Education Research Center is to transform engineering education at MSU and become a national leader in engineering education research. This center will enable MSU faculty to tackle the big research questions and challenges facing engineering education today with an overarching vision of improving student success.

B. Identify the Institute/Center’s goals and objectives.

- **Goal 1: Significantly increase the research productivity** in the area of engineering education at MSU. Within three years of creating this center we will:
  - Increase the amount of externally-funded engineering education research being conducted at MSU 5-fold from $300k/year to $1.5M/year.
  - Increase the number of scholarly articles published on engineering education by MSU faculty 3-fold from 5/year to 15/year.

- **Goal 2: Initiate large-scale research studies** at MSU to generate empirical findings to address the challenges facing engineering education. Within two years of creating this center we will initiate externally-funded research projects at MSU to further our understanding on how to:
  - Improve student learning of complex engineering concepts.
  - Improve the efficiency of engineering education in order to increase retention rates and reduce time-to-graduation.
  - Broaden participation of underrepresented groups within engineering, specifically women and Native Americans.
  - Explain why students opt out of engineering during their degree or after entering the workforce.
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- **Goal 3:** Implement large-scale educational interventions at MSU to address the challenges facing engineering education. Within three years of creating this center these interventions will create data-driven strategies to enhance student success with specific emphasis on improving student learning, increasing student retention, and broadening participation.

- **Goal 4:** Establish MSU as a leader within the American Society of Engineering Education (ASEE). Within three years of creating this center MSU will increase its national profile in ASEE through holding leadership roles, disseminating our findings in high impact ASEE outlets, and participating in national educational initiatives.

- **Goal 5:** Contribute to the training of tomorrow's professoriate by increasing the number of students pursuing doctoral degrees at MSU through funding by external grants and by providing pedagogical training for Ph.D. students desiring to pursue academic careers. Within 2 years we will initiate funding for 2-3 Ph.D. students. It should be noted that these Ph.D. students will likely be in the departments of Psychology and Education. Using external research funds secured through the College of Engineering to support non-COE Ph.D. students represents an unprecedented approach to increasing graduate student production and is made possible by MEERC’s interdisciplinary nature.

Within 2 years we will also deploy pedagogical training activities for COE Ph.D. students desiring to pursue academic careers. The training activities will include formal education on teaching strategies followed by individual mentoring by faculty and classroom teaching experience. The formal component of this training will leverage existing courses/resources from the College Teaching Certificate (CTC) in the College of Education, Health and Human Development.

C. **What specific need is being responded to in developing the proposed Institute/Center?**

Educating the engineers of the 21st century has become a national imperative. We need more engineers, more diverse engineers, and engineers who are better prepared to solve complex problems in an interdisciplinary, global context. MSU should be an important player in this national imperative. MSU’s College of Engineering has experienced dramatic growth in the past 5 years. This has led to a record number of students (3000+) and faculty (75).

There are a variety of exciting activities occurring and developing within MSU’s College of Engineering that motivate the creation of this center. First, College of Engineering faculty currently have an unprecedented number of active grants from the National Science Foundation to conduct educational projects. These awards have been won using the traditional *lone wolf* approach (7 NSF educational grants in the past 5 years totaling $1.3M). We now believe we have formed critical mass in this research area, gained sufficient institutional knowledge on how to propose and conduct this research, and formed critical interdisciplinary collaborations to form a center. Collectively, faculty within the center will be able to win external-funding and output scholarly products at a rate that is higher than individual faculty working alone.

Second, there is a push from the national funding agencies to propose research that is interdisciplinary in nature to solve the most pressing problems of our day. In the field of engineering education research, this means teams must not contain solely engineering faculty,
but also researchers from the fields of behavioral & social science and education. A center will provide a formal infrastructure at MSU to facilitate interdisciplinary research on engineering education and lead to an increase in scholarly output by our faculty on critical challenges facing our nation.

Third, there has been a recent increase in federal, foundation, and industrial funding opportunities that aim to advance our understanding of how to better prepare the engineering workforce and promote diversity within the field. Our group feels we are being limited in the number of opportunities we can pursue in our current, lone wolf approach. A center will create synergies that will optimize the proposal preparation process, project implementation, and dissemination and lead to higher research productivity.

Finally, the planned Norm Asbjornson Innovation Center will provide an educational laboratory in which to develop, test, and assess educational interventions and innovations. The creation of this center in conjunction with our new building (whose theme is *engineering innovation*) will aid us in becoming nationally recognized in the engineering education research arena.

**D. Describe how the Institute/Center benefits the department, college, or institution.**

This center will provide a formal infrastructure for proposing and conducting engineering education research. It will benefit individual departments by facilitating cross-departmental collaborations. Engineering faculty will gain knowledge about how to conduct education research within their respective departments while faculty from non-engineering departments (psychology, sociology, education, etc.) will be able to study engineering student success on an expansive student body. These types of studies are historically difficult without departmental buy-in from the instructors teaching the courses and/or management the curriculums.

The college of engineering will ultimately benefit from the interventions developed by the research conducted on enhancing student success and improving efficiency. Improving student success will raise the prestige of the college, which can lead to increased enrollments, increased donations, and an overall better educational experience for COE students. Improving educational efficiency will allow COE to optimally apply its resources to better serve its students.

The institution will benefit by establishing a research center that is a leader within its field. This will increases MSU’s prestige, which can lead to increased enrollments, recruitment of high caliber faculty, and increased research productivity. The specific goals for this center will also directly contribute to raising MSU’s Carnegie classification (i.e., increasing graduate student production in both STEM and non-STEM programs, increasing research expenditures, and increasing publications).

**E. Describe the Institute/Center’s relationship to the University mission.**

The MEERC is well aligned with the MSU Strategic plan as outlined below.

**MSU Strategic Plan Goal:** MSU prepares students to graduate equipped for careers and further education. The research that will be conducted by faculty within the MEERC specifically seeks to understand student motivation in choosing to pursue a degree in engineering, motivation to persist to graduation, and motivation to enter and stay in the engineering workforce. The MEERC
research also focuses on educational efficiency and will deploy interventions to improve student success. The collective activity of the MEERC will directly serve to:

- Perform in-depth assessment of student learning and take action to improve learning of critical knowledge and skills (MSU Strategic Plan: Objective L.1)

- Understand the mechanisms in which students decide to opt out of engineering and take action to keep them enrolled. This will have a direct impact on increasing graduation rates at MSU (MSU Strategic Plan: Objective L.2).

- Understand why engineering graduates don’t choose to pursue an engineering career, and for those that do, why they leave the profession early in their careers. This research on the professional formation of the engineering workforce will directly contribute to increasing job placement for our students and promoting life-long learning throughout their careers (MSU Strategic Plan: Objective L.3).

MSU Strategic Plan Goal: MSU will raise its national and international prominence in research, creativity, and scholarly achievement. The specific objectives that the MEERC will seek to accomplish are directly aligned with this MSU goal. They are:

- Increase productivity in the area of engineering education research with specific focus on increasing the number of externally funded projects, increasing the number of research publications by our faculty, and becoming a leader in the American Society of Engineering Education (MSU Strategic Plan: Objective D.1). The MEERC’s objectives are designed to support the center’s mission, which is stated as:

  “The mission of the Montana Engineering Education Research Center is to transform engineering education at MSU and become a national leader in engineering education research.”

  The mission, objectives, and activities within the MEERC are all directly aligned with this MSU Strategic Plan Goal. The creation of the MEERC will provide the infrastructure to support our interdisciplinary research activities (MSU Strategic Plan: Objective D.2).

- The MEERC also has a specific objective of increasing graduate student production (MSU Strategic Plan: Objective D.3). Our approach is unique in that funds awarded to College of Engineering faculty will be used to support Ph.D. students in non-COE departments (psychology and education). This represents a new source of Ph.D. graduates for MSU.

MSU Strategic Plan Goal: Members of the MSU community will be leaders, scholars and engaged citizens of their local, national, and global communities. The MEERC seeks to become a leader in the field of engineering education research and has a specific objective to “become a leader in the American Society of Engineering Education”. ASEE is the leading society in this field and has sections and zones across the country that facilitate community engagement. MSU seeks to become more involved in ASEE in order to establish the MEERC as a leader in its field (MSU Strategic Plan: Objective E.3).
MSU Strategic Plan Goal: By integrating learning, discovery and engagement the MSU community will improve the world. The research that the MEERC will conduct specifically integrates learning and discovery by implementing hypothesis-driven interventions to improve the education of engineering students (MSU Strategic Plan: Objective I.1). The ultimate mission of the MEERC is to transform engineering education. The discoveries that will be made by the MEERC will have a broader impact across our state, nation, and ultimately improve engineering education globally. This challenging work requires interdisciplinary teams of researchers from the fields of engineering, behavioral/social science, psychology, and education. The existence of the MEERC will directly increase interdisciplinary research on campus (MSU Strategic Plan: Objective I.2).

MSU Strategic Plan Goal: MSU is committed to widening access to higher education and ensuring equality of opportunity for all. Specific objectives of the MEERC include “improving engineering education efficiency” and “Broadening participation of underrepresented groups within engineering, specifically women and Native Americans”. These activities directly contribute to this particular MSU Strategic Plan Goal (MSU Strategic Plan: Objective A.1 & Objective A.2).

3. Briefly describe the Institute/Center’s anticipated activities.

The MEERC will facilitate the development of large-scale research proposals as well as the implementation of projects resulting from new awards. This will be accomplished by taking a higher level view of the research opportunities available, assembling interdisciplinary teams of researchers who have the knowledge to conduct such research, and providing logistical support to the development and implementation of this research. The MEERC will also coordinate and support activities to establish MSU as a leader in this field in American Society for Engineering Education.

A. Identify faculty expertise available for participation in the Institute/Center’s activities.

The team of researchers who are currently driving the establishment of this center are listed below. Faculty from this group are actively involved in engineering education research and have secured external funding from a variety of state and federal sources over the past decade. This has included funding from the National Science foundation, NASA, Montana Space Grant Consortium, and the Montana Office of the Commission of Higher Education.

Brock LaMeres, Electrical & Computer Engineering
Paul Gannon, Chemical & Biological Engineering
Jim Becker, Electrical & Computer Engineering
Ryan Anderson, Chemical & Biological Engineering
Carolyn Plumb, College of Engineering
Colter Ellis, Sociology & Anthropology
Bryce Hughes, Adult and Higher Education
Jessie Smith, Psychology
Nick Lux, Education
Jennifer Green, Mathematical Sciences
Kevin Amende, Mechanical & Industrial Engineering
William Schell, Mechanical & Industrial Engineering
Effat Rady, Head of Pre-Engineering, Flathead Valley Community College, Kalispell, MT
Kathryn Plymesser, Pre-Engineering, Montana State University – Billings, MT
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Mark Jacobson, Pre-Engineering, Montana State University – Billings, MT
Thomas Trickle, Professor of Engineering, Salish Kootenai College – Pablo, MT

We anticipate that additional faculty will join MEERC activities when its creation is made public to the MSU community.

B. Which departments on campus will be involved and how will the Institute/Center contribute to the academic programs of the institution?

- Department of Electrical & Computer Engineering
- Department of Chemical & Biological Engineering
- Department of Computer Science
- Department of Mechanical & Industrial Engineering
- Department of Civil Engineering
- Department of Education
- Department of Psychology
- Department of Sociology & Anthropology

The MEERC will facilitate interdisciplinary research at MSU that includes faculty from the above listed departments. The MEERC will provide the infrastructure to allow faculty to propose and conduct large scale research projects targeted at transforming engineering education.

4. Identify the organizational structure of the Institute/Center within the institution.

The MEERC will reside in the College of Engineering at MSU. One faculty member will serve as the center director and will coordinate the activities of the MEERC. The center director will report directly to the Dean of the College of Engineering and also be advised by an advisory council.

The MEERC will invite all faculty at MSU who have a shared interest in transforming engineering education to become members. A web page will be created with an invitation form that will allow faculty to sign up and receive notifications of center activities and upcoming training/seminar/workshop events. Faculty wishing to engage more formally in research activities will contact the center director and then be put in touch with other faculty with similar interests.

A. Identify all agencies, organizations and/or institutions that will be involved.

- The College of Engineering
- The College of Education, Health and Human Development
- The College of Letters and Sciences

B. Identify advisory council information.

An advisory council will be formed for the MEERC. Its members will be comprised of college representatives (COE, EHHD, and L&S) along with national members from other engineering education centers and industrial partners. The council will meet by teleconference twice per year.
5. Identify first year and continuing finances necessary to support the Center/Institute, including the sources of funding.

**Existing Funding**

Our current implementation team has four active grants from the National Science Foundation that are serving as the motivation to form this center.


- “Engineering a Culture of Engagement”, National Science Foundation, (Award ID: 1544147), $150,000, PIs: Brock LaMeres & Jessie Smith, 1/16-12/17.


- “Research Initiation: Effectively Integrating Sustainability within an Engineering Program”, (Award ID: 1544174), PIs: Paul Gannon, Carolyn Plumb, & Ryan Anderson, $150,000.

**Seed Funding**

Our team is working with the MSU administration and the MSU Foundation to secure seed funding to ensure the rapid success of the MEERC. Our goal is to secure one-time seed funding to support a 3-year start-up period. The seed funding will be used for the following:

- Annual support for one faculty member to serve as the center director. The director will be responsible for the overall operation of the center and coordination of large-scale research activities within the center. This support will be used for course buy-outs, summer salary, or as an administrative stipend. Funds will also support travel to other engineering education research centers to heighten the visibility of MSU’s center in addition to learning from our peer institutions.

- Annual support for three faculty development grants. These grants can be used for course buy-outs or summer salary support for faculty to develop engineering education research proposals, conduct ongoing education investigations, or develop dissemination products. Funds will also support travel to federal funding agency headquarters to meet with program officers.

- Annual support for one faculty member to focus on raising MSU’s leadership role in ASEE. Funds will support activities that raise the profile of MSU within ASEE. Funds will also support travel to ASEE conferences and meetings.

- Annual support to bring in a nationally renowned engineering education speaker to MSU. The speaker will give a campus-wide seminar followed by meeting with individual faculty engaged in engineering education research.

- Non-cash support for grant-writing and administrative assistance associated with center activities.
Future Funding

The goal of the MEERC with respect to funding is to increase our research expenditures 5-fold from $300k/year to $1.5M/year within three years. This level of funding will be able to sustain the start-up activities listed above directly from our grants.

A. Will additional faculty and other resources be required to implement this Center/Institute? If yes, please describe the need and indicate the plan for meeting this need.

No additional faculty, staff, or building space is needed by the MEERC. The MEERC will use grant writing assistance from existing services on campus (i.e., OSP, COE, Center for Faculty Excellence, etc.)

B. Are other, additional resources required to ensure the success of the proposed Center/Institute? If yes, please describe the need and indicate the plan for meeting this need.

n/a

6. Describe other similar Centers/Institutes or research capacities in the state and surrounding region.

To our knowledge, there are no other centers in the state of Montana focusing specifically on engineering education research. The following is a list of other institutions with similar centers.

- Purdue – School of Engineering Education (ENE)  
  https://engineering.purdue.edu/ENE
- Michigan State – Center for Engineering Education Research (CEER)  
  http://ceer.egr.msu.edu/home
- University of Pittsburgh – Engineering Education Research Center (EERC)  
  http://www.engineering.pitt.edu/eerc/
- University of Texas at Austin - Engineering Education Research Center (EERC) opens in 2017  
  http://www.engr.utexas.edu/eerc
- Northwestern University - NorthWestern Center for Engineering Education Research (NCEER)  
  http://www.nceer.northwestern.edu/
- Univ. of Michigan – Center for Research on Learning and Teaching in Engineering (M-CRLT-ENGIN)  
  http://crlte.engin.umich.edu/
- University of Washington – Center for Engineering Learning & Teaching (CELT)  
  http://depts.washington.edu/celtweb/
- MIT – Teaching and Learning Laboratory  
  http://tll.mit.edu/help/education-research-mit
- Tufts University – Center for Engineering Education (CEEO)  
  http://www.ceeo.tufts.edu/research/
- University of Oklahoma – Sooner Engineering Education Center (SEED)  
  https://vpr-norman.ou.edu/centers-institutes/list/sooner-engineering-education-center
- University of Illinois – Engineering Education Research Group (EERC)  
  https://publish.illinois.edu/engineering-education-research/
A. Describe the relationship between the proposed Center/Institute and any similar Centers/Institutes, programs, or research capacities within the Montana University System.

The MEERC will complement existing activities at MSU, but will not duplicate them. The MEERC’s primary focus is transforming engineering education through research. This is different from centers which focus on providing students support services to improve student success or provide activities for faculty development. The MEERC will conduct externally-funded research to understand how to improve education and then implement interventions at MSU and test their effectiveness. The following figure shows how the MEERC complements existing MSU activities.

B. In cases of substantial duplication, explain the differences between these and the need for the proposed Center/Institute at an additional institution. Describe any efforts that were made to collaborate with these Centers/Institutes, programs or research capacities. If no efforts were made explain why.

n/a

7. Assessment: How will the success of the program be measured?

The success of the MEERC will be assessed at year 3 by the Office of the Dean of the College of Engineering and by the MEERC advisory council. The success of the MEERC will be measured against its specific goals/outcomes:

- Goal 1: Significantly increase research expenditures and publications in the area of engineering education research by MSU faculty.
- Goal 2: Initiate large-scale research students at MSU on engineering education.
- Goal 3: Implement large-scale research interventions at MSU on engineering education.
- Goal 4: Establish MSU as a leader within ASEE.
- Goal 5: Increase graduate student production.
8. State the internal campus review and approval process which has occurred prior to submission to the Commissioner's Office. Indicate, where appropriate, involvement by faculty, students, community members, professional constituencies, etc.

Our proposal has been reviewed by the Dean of the College of Engineering and the COE Leadership Council (Dean’s office staff & COE department heads). We have also conducted a survey of the COE faculty (results below). Our members will be giving a COE research seminar on 4/15/16 to discuss the MEERC. The following reviews are current scheduled: 1) Research Council: 4/7/16; Faculty Senate: 4/13/16; Dean’s Council: 5/10/16. The proposal will then go to the Provost, President, and BOR).
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Survey Comments: Do you have any additional comments about engineering education research? (Optional)

- We still need more people to teach basic engineering courses - without the basics the students lose
- There should be some level of interaction with local companies. Get them involved.
- This seems like the perfect time to establish an engineering education research center.
- I have done both engineering education "research" and more traditional product/materials/investigative research: From those efforts and the work of others I've determined that engineering education research is a soft side effort, aligned only loosely with effective teaching. I think most engineering education research is performed to generate papers/presentations at conferences attended by others who have done similar work, but dissemination of this work to a larger audience is weak. Adoption of 'novel' approaches is also weak. I think this type of work does help a little to further engineering education but only just. It is not well aligned with more traditional research efforts which are more valuable across the board.
- COE should seek external support for this as well.
- As far as the research center goes, it would depend on what the goals and plan of execution was.
- I do believe engineering education is a valid research endeavor as even a mutual component of more traditional research, however, I am not sure I feel it would be valid as an engineering faculty's only research endeavor.
- I believe that engineering education research is increasingly skewed towards the trendy - so called innovations (which usually aren't), and diversity - while marginalizing the realm of actual engineering learning. If the MSU COE invests in this, it would be nice to have some assurance that the resources won't be siphoned off into the wasteland of the trends of the day.
- While certainly a good idea, we have plenty of good ideas in the COE. If like-minded faculty want to coalesce and join together, then go ahead! However, if this was science based research, COE resources wouldn't be requested.
- It is about time!
- I am a research professor and do not teach.
- Having resources (training, examples, support, etc.) available would significantly increase/improve the chance of including research into the classroom.
- COE funding should be used for more pressing needs related to facing the growing enrollment. Examples are TAs support, scholarships, possibility to have several section of a single course in order to decrease to number of students per class
- Discussions/presentations on the topic at MSU would be useful
- It helps busy professor do their jobs more effectively and is incredibly valuable. Its nice to have someone distill the current research into a ready to deploy classroom technique