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Application Summary

Competition Details

Competition Title:	Textbook Transformation Grants, Round Thirteen (Spring 2019-Spring 2020)
Category:	University System of Georgia
Award Cycle:	Round 13
Submission Deadline:	01/14/2019 at 11:59 PM

Application Information

Submitted By:	Christopher Saldana
Application ID:	2874
Application Title:	418
Date Submitted:	01/15/2019 at 7:34 AM

Personal Details

Institution Name(s):	Georgia Institute of Technology
Applicant First Name:	Christopher
Applicant Last Name:	Saldana
Applicant Email Address:	christopher.saldana@me.gatech.edu
Applicant Phone Number:	404-385-3735
Primary Appointment Title:	Assistant Professor
Submitter First Name:	Christopher
Submitter Last Name:	Saldana
Submitter Email Address:	christopher.saldana@me.gatech.edu
Submitter Phone Number:	404-385-3735
Submitter Title:	Assistant Professor

Application Details

Proposal Title

418

Final Semester of Project

Spring 2020

Requested Amount of Funding

\$30,000

Type of Grant

No-or-Low-Cost-to-Students Learning Materials

Course Title(s)

Creative Decisions and Design

Course Number(s)

ME2110

Team Member 1 Name

Dr. Jeffrey Donnell

Team Member 1 Email

jeffrey.donnell@me.gatech.edu

Team Member 2 Name

Dr. Richard Simmons

Team Member 2 Email

richard.simmons@me.gatech.edu

Team Member 3 Name

Ms. Kristi Mehaffey

Team Member 3 Email

kristi.mehaffey@me.gatech.edu

Team Member 4 Name

Dr. Roxanne Moore

Team Member 4 Email

roxanne.moore@gatech.edu

Additional Team Members (Name and email address for each)

Dr. Thomas Kurfess (kurfess@gatech.edu), Dr. Cassandra Telenko (cassandra@gatech.edu), Dr. Hassan Rashidi (hrashidi@gatech.edu)

Sponsor Name

Dr. Samuel Graham

Sponsor Title

Eugene C. Gwaltney, Jr. School Chair and Professor

Sponsor Department

George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology

Original Required Commercial Materials (title, author, price)

1) Required Textbook

Introductory Mechanical Design Tools, W. Singhose, J. Donnell, Lulu publishers, \$37.58

(<http://www.lulu.com/shop/william-singhose-and-jeff-donnell/introductory-mechanical-design-tools/paperback/product-23433585.html>)

2) Required Computing Materials

National Instruments, myRIO student embedded device, \$243.75 (<https://www.ni.com/en-us/shop/select/myrio-student-embedded-device>)

Average Number of Students per Course Section Affected by Project in One Academic Year

20

Average Number of Sections Affected by Project in One Academic Year

30

Total Number of Students Affected by Project in One Academic Year

600

Average Number of Students Affected per Summer Semester

100

Average Number of Students Affected per Fall Semester

275

Average Number of Students Affected per Spring Semester

225

Original Total Cost per Student

\$281.33

Post-Project Cost per Student

\$35.00

Post-Project Savings per Student

\$246.33

Projected Total Annual Student Savings per Academic Year

\$147,798

Using OpenStax Textbook?

No

Project Goals

The overall goal of the proposed project is to develop and deploy new open-source, low-cost, interactive coursework materials for a high-enrollment core course on integrated mechanical design and fabrication. In developing and deploying these open-source, low-cost coursework materials, the team's goal in terms of student cost is to achieve significant per student savings of \$246.33 per student, with an overall impact of \$147,798.00 per year. In terms of student success, the team seeks to deploy course materials using modern programming languages (e.g., Python) that facilitate students to access a diverse community of developers beyond the classroom. The course materials that will be developed will allow the students to create new systems and designs that will translate into enhanced materials creation in the execution of this course as well as throughout the design curriculum at Georgia Tech. Further, the new textbook will be an interactive resource that allows students to directly interface with the learning materials in an interactive format, which hitherto has not been realized in the domain of mechanical design. From a pedagogical perspective, the team seeks to teach new concepts for Python-based programming to students at an earlier stage of the students' academic careers. The resulting outcomes on understanding of logical programming design will be directly measured and assessed to ensure ability of the new materials to improve learning outcomes.

Statement of Transformation

The course under consideration in this work is ME2110 (Creative Decisions and Design), a required sophomore-level course for students majoring in Mechanical Engineering. It also is cross-listed as a Denning Technology & Management (T&M) Program requirement for College of Business students. It has a total enrollment of 600 students per academic year and is taught in the fall, spring and summer semesters. The goal of the course is to introduce students to a range of topics that include structured design, fabrication, mechatronics, and technical communication. The course teaches important principles and tools to students critical to other courses at Georgia Tech, including ME3057 (Experimental Methods Laboratory), ME3210 (Design Materials and Manufacture) and ME4182 (Capstone Design), as well as students activities in extracurricular build programs, including the Vertically Integrated Projects (VIP) Program, Create-X, the Invention Studio, and various student competition teams (Robojackets, GT Motorsports, EcoCar, GT Off-Road, GT Solar Racing, HyTech Racing, Wreck Racing). The course is the highest rated mechanical engineering course in formal senior exit surveys as students have recognized the importance of these principles in their development throughout their academic careers.

The course presently makes use of a textbook (cost \$37.58) that covers the overall structured design process as well as formal technical writing principles. In addition to the textbook, the students are required to obtain an embedded student device (cost \$243.75) that is used by the students in building mechatronic systems throughout the course. The total cost to each student is \$281.33 and the proposed development effort is focused on significantly reducing this cost, while also introducing new and more modern course materials that cover topics of substantially greater utility to the students considering the technological advancements in the field as well as the improvements in so-called 'maker space' facilities at Georgia Tech.

The first course improvement that will be made will be to develop and deploy an open-source text for the course. While the previous text covered basic design process and technical writing, it does not provide substantial examples of the use of core design tools on real-world products. Further, the current text does not address a core activity in maker spaces – fabrication and safety. Most importantly, the textbook is a static resource that does not allow for students to interact with the learning materials except through assigned classroom exercises and homeworks. To address these deficiencies, the new course materials will provide new end-to-end case studies of structured design problems for students to learn about the design process in a product-centric approach to supplement the technique-centric approach common in typical delivery modalities. Additionally, the new course materials will provide a thorough review of basic laboratory and maker space operations to introduce students to fabrication. This will include suggested practices and visual depictions of good mechanical design for students to absorb and understand the concepts. As many students entering college-level programs have limited hands-on fabrication experience, it is envisioned that an integrated resource for learning about fabrication techniques while also providing beginner and intermediate level practical guidelines. Finally, the textbook will include interactive components where students can use design tools through web-based interfaces in the text materials, this interactive component will be a significant advancement of the state-of-the-art in pedagogical implementations for mechanical design. These materials will be provided open source to students in this course and to students around the world through the main course website.

The second course improvement that will be made will be to develop and deploy use of a low-cost embedded device that relies on open-source programming implementations. The present system prescribed for students to purchase is a closed and relatively high-cost system wherein students and professionals are essentially designing within a hardware ecosystem that limits opportunities for exploring low-cost devices and, in a similar manner, student entrepreneurial pursuits. To address this deficiency, the new course materials that will be developed and deployed will seek to introduce low-cost embedded systems (e.g., Raspberry Pi, Particle Photon, Beaglebone) for students mechatronics designs. These systems make use of open-source computing languages like Python that are far more advantageous for students to learn relative to closed programming systems, especially in terms of future applicability and relevant career skills. These low-cost embedded systems are critical especially in the broader viewpoint as many advancements in the consumer electronics, mobile computing, and internet-of-things sectors are based on these open platforms. Further, in accessing these open-source programming capabilities, students will have access to a rich and interactive developer community, which will open opportunities for learning outside of the classroom. New course materials will be developed to train students on these systems and programming languages and example code repositories (e.g., GitHub) will be leveraged for providing a student-oriented developer community in this class and around the world. These materials will be provided open source to students in this course and to students around the world through the main course website.

If successful, these changes and new course materials have significant total savings impact on the students at Georgia Tech in the amount of \$147,798.00 per year. Of equal if not greater importance are the enhancements that will be made in terms of student learning on fabrication and programming.

Transformation Action Plan

Team Member Roles The overall project will be led by Dr. Christopher Saldana. Dr. Saldana is the lead instructor for ME2110 and is responsible for overall coordination and design of the course. Dr. Saldana will lead the identification, review, selection and creation of the new course materials across the project team. The team members include regular instructors of ME2110 and the author of the presently used textbook (Dr. Jeffrey Donnell). Among these instructors are subject matter experts on the structured design process, as well as fabrication and maker space technologies. Subject matter experts on the structured design process include Dr. Cassandra Telenko and Dr. Roxanne Moore. Subject matter experts on fabrication and maker spaces include Dr. Hassan Rashidi, Dr. Thomas Kurfess, Dr. Simmons and Ms. Mehaffey. The team members will be asked to review and provide input on the developed course materials in each of their respective subject matter areas. Ms. Kristi Mehaffey also serves as an undergraduate academic advisor with keen understanding on the design and measurement of student learning outcomes. Dr. Roxanne Moore is also an expert on pedagogical theory as well as is a staff member in the Center for Education Integrating Science, Mathematics, and Computing (CEISMC). This expertise and balance in assessment and pedagogical theory will be critical in a successful transformation in the classroom through the developed materials. Dr. Donnell, who authored the current textbook, will be critical in effectively developing the new open-source materials for the course. Dr. Donnell wrote the textbook that will be replaced and converted it to iBook form. Dr. Donnell is well acquainted with the problems of building interactivity into e-textbooks and open educational material systems. Through this activity, Dr. Donnell is keen to move beyond static book format and towards a vision that is flexible and interactive.

Preliminary Evaluation of Existing OER Materials The team conducted an initial investigation on existing OER materials for the proposed development of course materials. At present, no centralized open-source educational materials are centrally found for integrated design, fabrication and mechatronics training. Indeed, a number of textbooks, including that of the existing course, are available to students. However, no open-source materials are provided especially in terms of integration of low-cost student embedded devices. It is likely that this is the case considering the more recent introduction of these technologies for students and consumers.

Redesign for Transformation The present course focuses on teaching structure design tools (e.g., quality function deployment, concept generation and selection) in a technique-focused manner. The proposed development will be augmented by an adapted set of instructional modules with a product-focused or case study-based discussion activities so to reinforce student learning in vertically-integrated examples of the course concepts. The lead instructor will develop these modules and integrate them with the open-source materials in formal narrative, report-style examples with annotated insertions provided to explain major concepts. Additionally, the proposed development will involve design of new training materials for low-cost embedded devices and the development of new open-source programming libraries that students can use to deploy mechatronics systems quickly. By having a sample code repository, students may be able to learn by adaptation and rapidly test concepts and ideas. The lead instructor and team members will work with current course graduate teaching assistants to develop these repositories and training materials and will provide these open-source for students at Georgia Tech and abroad.

Delivery of Materials In addition to the GALILEO Open Learning Materials Platform, the materials will be hosted across code repositories for student code sharing (e.g., GitHub) and facilitation of project collaboration.

Quantitative & Qualitative Measures

To ensure improvement of student outcomes in the proposed development activity, a number of quantitative and qualitative measures will be tracked in the project. These will be assessed in the spring 2019 semester to establish a baseline for the course. Pilot implementations in the summer 2019 and fall 2019 semesters will be used to gain initial understanding of the course changes. Full implementations in spring 2020 semester will be important toward establishing the overall impact of the changes and new course materials. As these assessments will be used internally for development, IRB approval will not be needed. If the team decides to pursue publishing of the final outcomes, they will seek IRB approval. Below each of the metrics that will be tracked are described.

Metrics that will be tracked in terms of student learning outcomes and student opinions/impressions. Student learning outcomes will be quantitatively assessed through student performance on course assignments including reports, homeworks, and quizzes. Further, this will be evaluated in quantitative writing-based assessments. These student deliverables will inform on the ability of the new course materials to improve student learning outcomes in terms of understanding of the design process, application of design tools, programming, mechatronics and fabrication principles and guidelines. Mean and distribution of student scores will be reported to understand the impact of these changes on student learning outcomes. Student opinions and impressions are also important to monitor to understand impact of the changes on student satisfaction. Course-Instructor Opinion Survey (CIOS) is the end-of-semester mechanism for assessing final student opinion and impressions. CIOS will be used to assess student response regarding their opinion of the impact of the course on their technical skillset and the appropriateness of the learning material. These metrics will be made available in aggregate/summary form (e.g., without personally identifiable information - PII) so outside adopters of these new materials have a preliminary understanding of the effectiveness of these materials.

Timeline

The timeline below is provided to explain the anticipated progress for this project from inception of the project to the final report. Major milestones are identified separately from major tasks, but included in the timeline.

Major Tasks

- Task 1. Development of open course text on structured design, technical communication, safety and fabrication. Phase 1: Author Instructor Draft Copy. February 2019 – June 2019. Phase 2: Peer Review and Edit. July 2019 – August 2019. Phase 3: Pilot Deployment. August 2019 – December 2019. Phase 4: Revise Instructor Draft Copy. August 2019 – December 2019. Phase 5: Implement Student Comments. December 2019. Phase 6: Full Deployment. January 2020 – May 2020.
- Task 2. Development of open course training materials for low-cost mechatronics systems. Phase 1: Author Instructor Draft Copy. February 2019 – June 2019. Phase 2: Peer Review and Edit. July 2019 – August 2019. Phase 3: Pilot Deployment. August 2019 – December 2019. Phase 4: Revise Instructor Draft Copy. August 2019 – December 2019. Phase 5: Implement Student Comments. December 2019. Phase 6: Full Deployment. January 2020 – May 2020.

Major Milestones

- February 2019 – Project Kickoff
- May 2019 – Semester Status Report
- July 2019 – Semester Status Report
- December 2019 – Semester Status Report
- May 2020 – Semester Status Report and Final Report

Budget

The overall projected expenses are as follows and includes personnel expenses and projected costs associated with travel and training materials.

- Faculty and Staff Time (course release) for development: \$29,200
- Travel (2 Team Members): \$800
- Total: \$30,000

Sustainability Plan

The course under proposed development is a major core course in the Mechanical Engineering curriculum at Georgia Tech, with intrinsic tie-in to the College of Business through the Denning Technology & Management (T&M) Program. As it is a required course in the curriculum for both of these programs, it will be offered every semester (fall, spring, summer) for the foreseeable future. Additionally, the course is deployed to other institutions nationwide and internationally (e.g., China, South Korea) as part of collaborations with other institutions. Additionally, ME2110 is a foundational course in the design curricula at Georgia Tech, this feeding other courses in Experimental Methods (ME3057) and Mechanical Engineering Systems (ME4056). The materials developed under this project would be quickly adapted for online delivery in ME3057 and ME4056. Thus, developments made through this grant program will have a major and lasting effect on students in Georgia as well as students domestically and abroad. The proposer as well as the team members are all regular instructors of this course and, as such, will be able to maintain and update course materials into the future. To ensure that the outcomes and new learning materials will be shared, the project team will seek to share this work in the form of presentations at collaborating institutions and at pedagogically-focused conferences such as the American Society for Engineering Education. Furthermore, the project team will seek to publish these results in academic journals so to demonstrate the effectiveness of these materials to improve student experiences and learning outcomes.

Acknowledgment

Grant Acceptance

[Acknowledged] I understand and acknowledge that acceptance of Affordable Learning Georgia grant funding constitutes a commitment to comply with the required activities listed in the RFP and that my submitted proposal will serve as the statement of work that must be completed by my project team. I further understand and acknowledge that failure to complete the deliverables in the statement of work may result in termination of the agreement and funding.



The George W. Woodruff School of Mechanical Engineering
Samuel Graham, Jr., Ph.D., Eugene C. Gwaltney, Jr. School Chair

January 8, 2019

Dear Selection Committee,

I would like to express my support for the proposed project led by Professor Saldana and involving several other faculty and staff from our school. The project is focused on a sophomore-level design/build course, ME2110 – Creative Decisions and Design. This is an important course for our department that teaches students the fundamentals of the design process as well as important elements of fabrication. This is a required core course in the mechanical engineering curriculum and also integrates with students in our College of Business through a technology management minor program. As Georgia Tech is recognized as a leader in these topical areas, the ME2110 course has also been deployed at several of our partner institutions abroad in China and South Korea.

Improving the student experience through development of low cost educational materials is critical for our students who are facing challenges associated with increased cost of attendance due to rising tuition and other ancillary enrollment-related fees. The proposed development activity will significantly reduce the cost per student through low-cost learning materials. Further, the development has a rather large total savings impact considering the high student enrollment in our program, as well as the other programs abroad that have deployed this course. It should be noted that not only do that these changes result in significant student cost savings, these changes will also modernize the associated learning materials to match the rapid introduction of fabrication and maker spaces at our institution, as well as that of others.

Our school recognizes the importance of this course to academic careers of our students and, as such, this course will be offered well into the future. In terms of sustainability of the program development outcomes, Professor Saldana and the other team members of this proposal are regularly assigned this course in their annual teaching duties and they have been quite successful in garnering various teaching awards associated with the delivery of this course. As such, their continued involvement in ME2110 will ensure continuity of the program development results and the sustainability of the outcomes through continued updating of the developed course materials.

Sincerely,

A handwritten signature in black ink that reads "Samuel Graham, Jr." in a cursive script.

Samuel Graham, Jr.

Atlanta, Georgia 30332-0405 U.S.A
sgraham@gatech.edu

Phone 404-894-3200
Fax 404-894-1658

<http://www.me.gatech.edu/>



Textbook Transformation Grants, Round Thirteen (Spring 2019 –Spring 2020) Proposal Form and Narrative

Notes

- The proposal form and narrative .docx file is for offline drafting and review. Submitters must use the InfoReady Review online form for proposal submission.
- The only way to submit the official proposal is through the online form in Georgia Tech's InfoReady Review. The link to the online application is on the [Round 13 RFP Page](#).
- The italic text we provide is meant for clarifications and can be deleted.

Applicant, Team, and Sponsor Information

The **applicant** is the proposed Project Lead for the grant project. The **submitter** is the person submitting the application (which may be a Grants Officer or Administrator). The submitter will often be the applicant – if so, leave the submitter fields blank.

Institution(s)	Georgia Institute of Technology
Applicant Name	Christopher Saldana
Applicant Email	christopher.saldana@me.gatech.edu
Applicant Phone #	404-385-3735
Applicant Position/Title	Assistant Professor
Submitter Name	
Submitter Email	
Submitter Phone #	
Submitter Position	

Please provide the first/last names and email addresses of all team members within the proposed project. Include the applicant (Project Lead) in this list. Do not include prefixes or suffixes such as Ms., Dr., Ph.D., etc.

	Name	Email Address
Team Member 1	Dr. Jeffrey Donnell	jeffrey.donnell@me.gatech.edu
Team Member 2	Dr. Richard Simmons	richard.simmons@me.gatech.edu
Team Member 3	Ms. Kristi Mehaffey	kristi.mehaffey@me.gatech.edu
Team Member 4	Dr. Cassandra Telenko	cassandra@gatech.edu
Team Member 5	Dr. Roxanne Moore	roxanne.moore@gatech.edu
Team Member 6	Dr. Thomas Kurfess	kurfess@gatech.edu
Team Member 7	Dr. Hassan Rashidi	hrashidi@gatech.edu
Team Member 8		

If you have any more team members to add, please enter their names and email addresses in the text box below.

N/A

Please provide the sponsor's name, title, department, and institution. The sponsor is the provider of your Letter of Support.

Dr. Samuel Graham, Eugene C. Gwaltney, Jr. School Chair and Professor, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology

Project Information and Impact Data

Title of Grant Project	Open-Source Materials for Introductory Integrated Mechanical Design and Makerspace Courses
Type of Grant	<i>No-or-Low-Cost-to-Students Learning Materials</i>
Requested Amount of Funding	\$30,000
Course Names and Course Numbers	ME2110: Creative Decisions and Design
Final Semester of Project	<i>Spring 2020</i>
Average Number of Students Per Course Section Affected by Project	20
Average Number of Sections Affected by Project in One Academic Year	30
Total Number of Students Affected by Project in One Academic Year	600
Average Number of Students Affected per Summer Semester	100
Average Number of Students Affected per Fall Semester	275
Average Number of Students Affected per Spring Semester	225
Title/Author of Original Required Materials	1) <i>Required Textbook</i> <i>Introductory Mechanical Design Tools</i> , W. Singhose, J. Donnell, Lulu publishers, \$37.58 (http://www.lulu.com/shop/william-singhose-and-jeff-donnell/introductory-mechanical-design-tools/paperback/product-23433585.html) 2) <i>Required Computing Materials</i> <i>National Instruments, myRIO student embedded device</i> , \$243.75 (https://www.ni.com/en-us/shop/select/myrio-student-embedded-device)

Original Total Cost Per Student	\$281.33
Post-Project Cost Per Student	\$35.00
Post-Project Savings Per Student	\$246.33
Projected Total Annual Student Savings Per Academic Year	\$147,798.00
Using OpenStax Textbook?	No

Narrative Section

1. Project Goals

The overall goal of the proposed project is to develop and deploy new open-source, low-cost, interactive coursework materials for a high-enrollment core course on integrated mechanical design and fabrication. In developing and deploying these open-source, low-cost coursework materials, the team's goal in terms of student cost is to achieve significant per student savings of \$246.33 per student, with an overall impact of \$147,798.00 per year. In terms of student success, the team seeks to deploy course materials using modern programming languages (e.g., Python) that facilitate students to access a diverse community of developers beyond the classroom. The course materials that will be developed will allow the students to create new systems and designs that will translate into enhanced materials creation in the execution of this course as well as throughout the design curriculum at Georgia Tech. Further, the new textbook will be an interactive resource that allows students to directly interface with the learning materials in an interactive format, which hitherto has not been realized in the domain of mechanical design. From a pedagogical perspective, the team seeks to teach new concepts for Python-based programming to students at an earlier stage of the students' academic careers. The resulting outcomes on understanding of logical programming design will be directly measured and assessed to ensure ability of the new materials to improve learning outcomes.

2. Statement of Transformation

The course under consideration in this work is ME2110 (Creative Decisions and Design), a required sophomore-level course for students majoring in Mechanical Engineering. It also is cross-listed as a Denning Technology & Management (T&M) Program requirement for College of Business students. It has a total enrollment of 600 students per academic year and is taught in the fall, spring and summer semesters. The goal of the course is to introduce students to a range of topics that include structured design, fabrication, mechatronics, and technical communication. The course teaches important principles and tools to students critical to other courses at Georgia Tech, including ME3057 (Experimental Methods Laboratory), ME3210 (Design Materials and Manufacture) and ME4182 (Capstone Design), as well as students activities in extracurricular build programs, including the Vertically Integrated Projects (VIP) Program, Create-X, the Invention Studio, and various student competition teams (Robojackets, GT Motorsports, EcoCar, GT Off-Road, GT Solar Racing, HyTech Racing, Wreck Racing). The

course is the highest rated mechanical engineering course in formal senior exit surveys as students have recognized the importance of these principles in their development throughout their academic careers.

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The first course improvement that will be made will be to develop and deploy an open-source text for the course. While the previous text covered basic design process and technical writing, it does not provide substantial examples of the use of core design tools on real-world products. Further, the current text does not address a core activity in maker spaces – fabrication and safety. Most importantly, the textbook is a static resource that does not allow for students to interact with the learning materials except through assigned classroom exercises and homeworks. To address these deficiencies, the new course materials will provide new end-to-end case studies of structured design problems for students to learn about the design process in a product-centric approach to supplement the technique-centric approach common in typical delivery modalities. Additionally, the new course materials will provide a thorough review of basic laboratory and maker space operations to introduce students to fabrication. This will include suggested practices and visual depictions of good mechanical design for students to absorb and understand the concepts. As many students entering college-level programs have limited hands-on fabrication experience, it is envisioned that an integrated resource for learning about fabrication techniques while also providing beginner and intermediate level practical guidelines. Finally, the textbook will include interactive components where students can use design tools through web-based interfaces in the text materials, this interactive component will be a significant advancement of the state-of-the-art in pedagogical implementations for mechanical design. These materials will be provided open source to students in this course and to students around the world through the main course website.

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viewpoint as many advancements in the consumer electronics, mobile computing, and internet-of-things sectors are based on these open platforms. Further, in accessing these open-source programming capabilities, students will have access to a rich and interactive developer community, which will open opportunities for learning outside of the classroom. New course materials will be developed to train students on these systems and programming languages and example code repositories (e.g., GitHub) will be leveraged for providing a student-oriented developer community in this class and around the world. These materials will be provided open source to students in this course and to students around the world through the main course website.

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3. Transformation Action Plan

Team Member Roles The overall project will be led by Dr. Christopher Saldana. Dr. Saldana is the lead instructor for ME2110 and is responsible for overall coordination and design of the course. Dr. Saldana will lead the identification, review, selection and creation of the new course materials across the project team. The team members include regular instructors of ME2110 and the author of the presently used textbook (Dr. Jeffrey Donnell). Among these instructors are subject matter experts on the structured design process, as well as fabrication and maker space technologies. Subject matter experts on the structured design process include Dr. Cassandra Telenko and Dr. Roxanne Moore. Subject matter experts on fabrication and maker spaces include Dr. Hassan Rashidi, Dr. Thomas Kurfess, Dr. Simmons and Ms. Mehaffey. The team members will be asked to review and provide input on the developed course materials in each of their respective subject matter areas. Ms. Kristi Mehaffey also serves as an undergraduate academic advisor with keen understanding on the design and measurement of student learning outcomes. Dr. Roxanne Moore is also an expert on pedagogical theory as well as is a staff member in the Center for Education Integrating Science, Mathematics, and Computing (CEISMC). This expertise and balance in assessment and pedagogical theory will be critical in a successful transformation in the classroom through the developed materials. Dr. Donnell, who authored the current textbook, will be critical in effectively developing the new open-source materials for the course. Dr. Donnell wrote the textbook that will be replaced and converted it to iBook form. Dr. Donnell is well acquainted with the problems of building interactivity into e-textbooks and open educational material systems. Through this activity, Dr. Donnell is keen to move beyond static book format and towards a vision that is flexible and interactive.

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the case considering the more recent introduction of these technologies for students and consumers.

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Delivery of Materials In addition to the GALILEO Open Learning Materials Platform, the materials will be hosted across code repositories for student code sharing (e.g., GitHub) and facilitation of project collaboration.

4. Quantitative and Qualitative Measures

To ensure improvement of student outcomes in the proposed development activity, a number of quantitative and qualitative measures will be tracked in the project. These will be assessed in the spring 2019 semester to establish a baseline for the course. Pilot implementations in the summer 2019 and fall 2019 semesters will be used to gain initial understanding of the course changes. Full implementations in spring 2020 semester will be important toward establishing the overall impact of the changes and new course materials. As these assessments will be used internally for development, IRB approval will not be needed. If the team decides to pursue publishing of the final outcomes, they will seek IRB approval. Below each of the metrics that will be tracked are described.

Metrics that will be tracked in terms of student learning outcomes and student opinions/impressions. Student learning outcomes will be quantitatively assessed through student performance on course assignments including reports, homeworks, and quizzes. Further, this will be evaluated in quantitative writing-based assessments. These student deliverables will inform on the ability of the new course materials to improve student learning outcomes in terms of understanding of the design process, application of design tools, programming, mechatronics and fabrication principles and guidelines. Mean and distribution of student scores will be reported to understand the impact of these changes on student learning outcomes. Student opinions and impressions are also important to monitor to understand impact of the changes on student satisfaction. Course-Instructor Opinion Survey (CIOS) is the end-of-semester mechanism for assessing final student opinion and impressions. CIOS will be used to assess student response regarding their opinion of the impact of the course on their

technical skillset and the appropriateness of the learning material. These metrics will be made available in aggregate/summary form (e.g., without personally identifiable information - PII) so outside adopters of these new materials have a preliminary understanding of the effectiveness of these materials.

5. Timeline

The timeline below is provided to explain the anticipated progress for this project from inception of the project to the final report. Major milestones are identified separately from major tasks, but included in the timeline.

Major Tasks

- Task 1. Development of open course text on structured design, technical communication, safety and fabrication.
 - Phase 1: Author Instructor Draft Copy. February 2019 – June 2019.
 - Phase 2: Peer Review and Edit. July 2019 – August 2019.
 - Phase 3: Pilot Deployment. August 2019 – December 2019.
 - Phase 4: Revise Instructor Draft Copy. August 2019 – December 2019.
 - Phase 5: Implement Student Comments. December 2019.
 - Phase 6: Full Deployment. January 2020 – May 2020.
- Task 2. Development of open course training materials for low-cost mechatronics systems.
 - Phase 1: Author Instructor Draft Copy. February 2019 – June 2019.
 - Phase 2: Peer Review and Edit. July 2019 – August 2019.
 - Phase 3: Pilot Deployment. August 2019 – December 2019.
 - Phase 4: Revise Instructor Draft Copy. August 2019 – December 2019.
 - Phase 5: Implement Student Comments. December 2019.
 - Phase 6: Full Deployment. January 2020 – May 2020.

Major Milestones

- February 2019 – Project Kickoff
- May 2019 – Semester Status Report
- July 2019 – Semester Status Report
- December 2019 – Semester Status Report
- May 2020 – Semester Status Report and Final Report

6. Budget

The overall projected expenses are as follows and includes personnel expenses and projected costs associated with travel and training materials.

- Faculty and Staff Time (course release) for development: \$29,200
- Travel (2 Team Members): \$800
- Total: \$30,000

7. Sustainability Plan

The course under proposed development is a major core course in the Mechanical Engineering curriculum at Georgia Tech, with intrinsic tie-in to the College of Business thorough the Denning

Technology & Management (T&M) Program. As it is a required course in the curriculum for both of these programs, it will be offered every semester (fall, spring, summer) for the foreseeable future. Additionally, the course is deployed to other institutions nationwide and internationally (e.g., China, South Korea) as part of collaborations with other institutions. Additionally, ME2110 is a foundational course in the design curricula at Georgia Tech, this feeding other courses in Experimental Methods (ME3057) and Mechanical Engineering Systems (ME4056). The materials developed under this project would be quickly adapted for online delivery in ME3057 and ME4056. Thus, developments made thorough this grant program will have a major and lasting effect on students in Georgia as well as students domestically and abroad. The proposer as well as the team members are all regular instructors of this course and, as such, will be able to maintain and update course materials into the future. To ensure that the outcomes and new learning materials will be shared, the project team will seek to share this work in the form of presentations at collaborating institutions and at pedagogically-focused conferences such as the American Society for Engineering Education. Furthermore, the project team will seek to publish these results in academic journals so to demonstrate the effectiveness of these materials to improve student experiences and learning outcomes.