Annual Report

BENTLY CENTER FOR ENGINEERING INNOVATION
AWARDS AND WORK COMPLETED

2020 – 2021

Compiled by John Chen, Bently Center Director 2021-2024
June 2021

CAL POLY

Introduction

The Donald E. Bently Center for Engineering Innovation was established in spring 2003 through a substantial donation by Donald E. Bently. The Center is contained within the Mechanical Engineering (ME) Department. The purpose of the endowment is to promote innovation within the discipline, support applied research, expand the curriculum and bring vision and breadth to engineering instruction. The mission of the Center is advancement of research, education, and the practice of mechanical engineering with innovation as a guiding principle. Rotor dynamics is the primary focus of the center; however, the center supports a broad range of secondary focus areas.

Every year the Center issues a request for proposals to the Cal Poly ME faculty to sponsor faculty release time. The proposals are reviewed by a committee consisting of the Bently Center Director, ME Department Chair, and a third reviewer, typically the CENG Associate/Assistant Dean of Research. Awards are made based on criteria that includes meeting the mission of the Center, leveraging the award, deliverables, past performance, need and the proposal quality. The Bently Director is awarded 24 WTUs per year and expected to further the mission of the Center and administer the endowment, RFP process and documentation.

Awardees that are granted 12 – 18 WTUs are given the title of "*Bently Professors.*" In addition to the *Bently Professor* awards, smaller awards are granted as well. Brief biographical sketches of the 2020-21 Bently Professor(s) are given below.

Jacques Belanger, Assistant Professor

Dr. Belanger's main research interests are renewable energy and sustainability. Prior to joining Cal Poly in 2017, he worked in the solar industry for over ten years. His research focuses on utility scale solar field power optimization, solar field power generation forecasting and micro-grid design and management. Dr. Belanger teaches courses in nuclear energy in cooperation with the Diablo Canyon Nuclear Power Plant and courses in thermal sciences.

Final project reports are due a month after the end of the Bently support period. The reports include a the awardee's name, the number of weighted teaching units (WTUs) granted in the award, a summary of accomplishments, publications and other deliverables, student impacts, proposals and other leverage.

Below is a list of all the 2020-2021 awardee names, proposal titles, and the number of WTUs awarded. A report from each awardee is included in the following pages. Note that, due to a clerical error during this transition year between Bently Center directors, some reports were missing and are noted below.

List of Awardees

Awardee, Proposal Title, Number of WTUs awarded — Page

Charlene Birdsong, Professor and Director of the Bently Center for Innovation, "Bently Center Administration and Automotive Safety and Automation", 25.5 WTUs Awarded

Summary of Accomplishments

The assigned time was used in two main areas: first in the administration of the Bently Center for Innovation and second, in the professional development in the area of automotive safety and automation.

Bently Center Administration

The administrative activities for the 2019-2020 year included distributing the annual request for proposals, organizing the proposal review committee, meeting with the committee to review all proposals and collecting input for recommendations to fund specific proposals, announcing the awards, soliciting reports from each awardee and documenting the awards in this report.

In addition, to these regular annual activities other administrative activities were conducted. A taskforce was created in the Mechanical Engineering Department to review the charter and procedures for the Bentley awards. The Bently Center Taskforce included 5 ME faculty members including the Bentley Center Director and met periodically during the fall 2019 term. The committee was asked to review the charter and RFP procedures and make recommendations for changes and improvements. The conclusions of the taskforce included two main results: 1) student impact should be more explicit in the RFP rubric, and 2) a short definition of each RFP rubric category should be provided by the director and included in the RFP. The director received the taskforce input and made changes to the 2020 RFP that addressed the conclusions and streamlined the rubric categories. The taskforce report and the new rubric used for the 2020 RFP is attached in the Appendix.

Professional Development

Assigned time was used to pursue professional development in the area of automotive safety and automation. These activities included sponsoring and advising undergraduate students on senior projects, summer research projects and student competitions, developing hardware that will be used in the controls laboratory, advising MS students, collaborating with industrial sponsors and managing externally funded sponsored projects.

Publications and other Deliverables

Poster Sessions

Cal Poly College of Engineering Summer Undergraduate Research Project Symposium, fall 2019, poster, "Scaled Autonomous Vehicle Development and Testing"

Cal Poly College of Engineering Summer Undergraduate Research Project Symposium, fall 2020, poster, "High Speed Autonomous Vehicle Development"

Student Impact

Student Projects

Electronics and software for autonomous truck project, fall 2019-spring 2019 undergraduate ME students: Nate Furbeyre, Fernando Mondragon and Ricky Tan. Project continued through fall 2020 with undergraduate student Ben Robinson manufacturing a second chassis and MS student Robby Ketchum revising the electronics hardware to implement improvements identified in the prototype development.

Tractor Trailer State Estimation Senior Project Sponsor. I sponsored an ME428 team of 3 undergraduate MEs to develop a sensor system that allows a tractor trailer vehicle to estimate the angular position, velocity and size of a trailer based on remote sensing placed only on the tractor. Funded with professional development funds.

Development of DC Servo Lab Trainer system. 2018-2020 I worked with a team inclulding Charlie Refvem and James Gearhart to replace the outdated DC Servo trainer "Motomatic" apparatus in the Parker Controls Lab with a more modern apparatus. Charlie Refvem developed the digital microcontroller board and software. James Gearhart started with the prototype developed by a senior project that I sponsored in 2017 and redesigned the mechanical design to improve the ruggedness and manufacturability. The plan is to produce 10 units for the lab. Expected roll out date is fall 2021.

High Speed Autonomous Vehicle Development and Indy Autonomous Challenge. Summer 2020, I supervised 2 SURP students, Daniel Leavitt, Electrical Engineering and James Roberts, Computer Science to participate in an industry sponsored grand challenge to develop software that will allow an Indy Lights Formula racecar to drive autonomously in a head to head race at the Indianapolis Raceway. The sponsored donated access to ANSYS SCADE and VR Experience software running on Microsoft virtual computers for software development. Students collaborated with autonomous systems industrial partners including GM Cruise and United Technologies. They developed software that allowed a virtual racecar to navigate the race course.

Proposals and Other Leverage

Active awards during the period of support

Co-PI with Simon Xing and Joseph Joseph Callenes-Sloan, industry sponsored project to apply laser interferometery to mechanical systems for system identification, real-time feedback control and electronic interface development. spring 2021-spring 2022, Keysight Technologies $335,000 (funded)

Proposals submitted during the period of support

None.

Development of a Renewable Energy Laboratory for Research and Education

Awardee

Jacques Belanger, Ph.D., P.E., Assistant Professor, jjbelang@calpoly.edu

Award

Table 1 - Number of WTUs awarded by term

	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Number of WTU awarded	3	1	5	3

Overview

The main goal of the research project this last year was to create a functional micro-grid for the renewable energy research and education laboratory. The long-term objective for the lab is to give the opportunity to as many students as possible to get involved in solar and wind energy, energy storage, energy generation forecasting and microgrid technologies. All the main components of the laboratory are now in place and in working order. The integration of the different components of the lab with the micro-grid represented the majority of the deliverables that had been included in this year's proposal. The lab is now ready for some in-person research this summer and for years to come.

Summary of Accomplishments

1. Implementation of the microgrid system with all its energy management, energy storage and power generating components

Co-investigator: Dr. Andrew Davol (ME professor)

Restrictions related to the pandemic made progress sometime difficult this last year but ultimately, we were able to complete and turn on the power of the micro-grid during the spring quarter. The key component of the system is the controller-inverter that manages the power distribution and creates a small isolated power grid. Figure 1 (left) shows the controller-inverter and a number of circuit breakers and power outlets used to manage power inputs and outputs for the system. On the right side of Figure 1, you can see the energy storage capacity of the system. It is composed of four Lithium-ion batteries providing a total of 4.8 kW-hr of energy storage. Figure 2 shows the three energy sources used to generate the energy needed to run the micro-grid. On the left, you have the dual-axis tracking solar panel that has been part of the solar lab for a couple of years but had not generated any power until this spring. In the center, shown is the adjustable fixed mount solar panel system designed by students for their senior project in 2019-20. The fabrication of the mount components was completed and the mount system was put

together during this academic year. This adjustable fixed mount can accommodate up to three panels. Finally, on the right, the new wind turbine was installed on the top of Building 13. The system can provide up to 1.8 kW of peak power, representing an average daily energy generation of about 7.5 kW-hr. This is equivalent to an energy requirement for an efficient small house.

Figure 1: On the left, a view of the micro-grid system controller-inverter. The front panel also includes a number of circuit breakers and power outlets. On the right, the four Lithium-ion batteries providing 4.8 kW-hr of energy storage.

Figure 2: The micro-grid has three power sources. On the left, the dual-axis tracking solar panel. In the center, the adjustable fixed mount solar panel system that can accommodate up to three panels. On the right, the 400W wind turbine installed on the top of Building 13.

The micro-grid is now up and running, ready to support a number of research projects involving SURP and graduate students this summer. The first two projects will use the lab solar panels to

study the effects of partial shading on the power generation of the panels and developing a better thermal model to estimate the temperature of the panels, when exposed to solar radiation and wind. The temperature of photovoltaic cells influences its ability to generate electricity. One of our students is also looking into improving the overall wind power generation of our system by relocating the turbine and identifying optimum turbine design for our location. On the educational side, we are working on developing content using different components of the lab. One example would be to have the students from ME 128 come to the lab to get a hands-on introduction to the renewable energy field.

2. Total Sky Imager (TSI) system integration and installation on the roof of building 13

Co-investigator: Weston Montgomery (ME graduate student), Dr. Maria Pantoja (Computer Science & Software Engineering professor)

The second important component of the lab we have been focusing on this year was our research capabilities in the field of energy generation forecasting. The ultimate goal of that program is to be able to forecast up to 30 minutes in advance the actual power generation of a typical utility scale solar field like our Cal Poly Gold Tree solar field.

Figure 3: Complete Total Sky Imager (TSI) system tested on May 14, 2021. System consists of a Raspberry Pi, TSI camera, LTE router, lithium battery, and solar panel.

Up to now, we have performed this research work using images extracted from the Total Sky Imager (TSI) installed at the Gold Tree solar field. Having no direct control over that TSI camera's settings and image frequency proved to be a big challenge for this research project. Weston Montgomery, for his master's thesis, has developed a new TSI system to remedy that issue. The system is shown in Figure 3 with its own solar panel and power management battery

pack. It is a self-contained system and can be left in the field for a number of days without any outside support. At this time, however, the system has not been entirely weatherized and could be damaged in bad weather. Therefore, for the near future, this TSI system will be mounted on the roof of building 13 and connected to the solar lab where testing and data collection will be easier to perform. The lab will also provide protection from the weather to some of the unweatherized components of the system. This new TSI camera will now be an integral part of the renewable energy laboratory and will be completely under our control. This more flexible setup will significantly improve our data collection and research capabilities in this energy forecasting program.

Figure 4 below shows the type of analysis that can be performed with the TSI system. The image is first processed to generate a black and white image where black indicates areas with blue sky and white indicates cloudy areas of the sky. A very large data set of these time stamped images can be generated over time. The novel approach used here in analyzing the images is to use Machine Learning algorithms, specifically Deep Learning (DL) to forecast future cloud coverage instead of the more traditional method of cloud identification and movement prediction. DL algorithms have been proven to produce good results solving spatiotemporal problems like this one. This novel approach could in the long term develop into a sophisticated weather forecasting tool for power producers. This work is done in cooperation with Professor Maria Pantoja from Computer Science & Software Engineering (CSSE). A number of her students worked on this project over the last two years and two SURP students joined the team this summer.

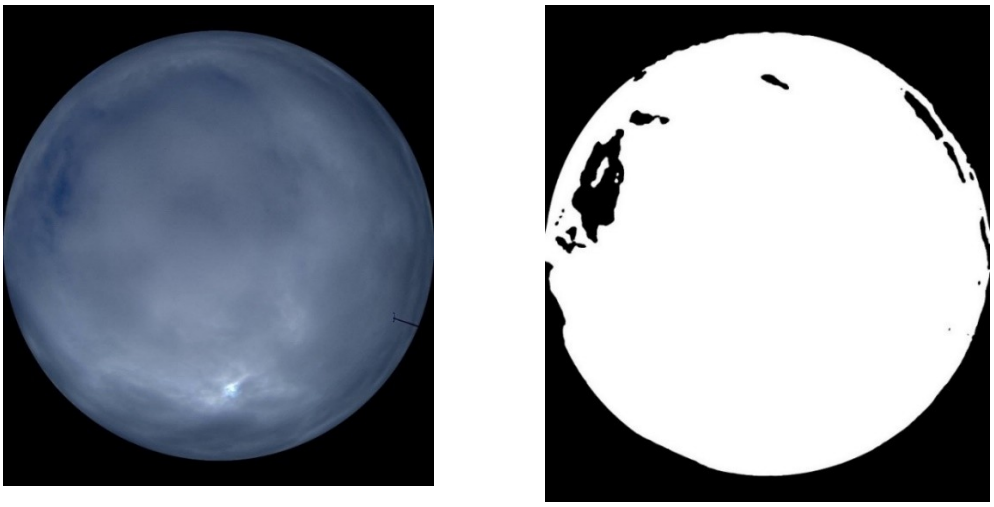


Figure 4: Cropped Image Captured at 4:51pm on May 14, 2021 (Left) next to the processed black and white image (Right). The black areas on the image now indicate the location of blue sky and the white areas indicate cloud coverage.

Recent results from this investigation were presented at the *2021 Computer Science Conference for CSU Undergraduates* on March 6, 2021. David A. Yu and Divya Satrawada from CSSE and Weston Montgomery from ME gave the presentation for the conference.

Awardee

Dr. Andrew Davol, Ph.D., P.E., Professor of Mechanical Engineering, adavol@calpoly.edu

Award

8 units Spring 2021

Summary of Accomplishments

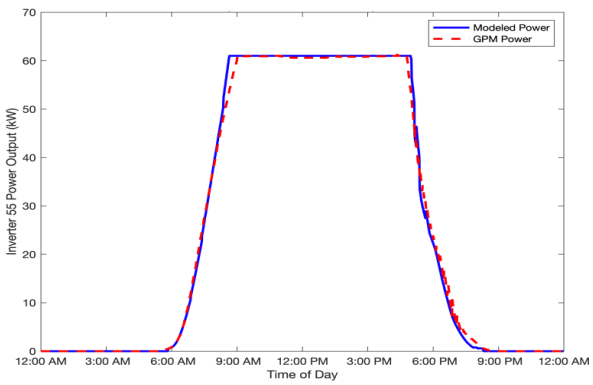
The major short-term goal of this work was to accurately predict power output from the Gold Tree Solar Array on Cal Poly's campus, taking into account irradiation, the shading between rows, the properties of the commercial solar panels being used, and known relations between the angle of incidence of the sun on the panels and the electrical power output to maximize the energy output from the array.

Before this work began preliminary models had been created using skewed topography similar to a section of the Gold Tree Array. We had demonstrated the ability to accurately predict the shading between rows for any date and time and preliminarily were predicting the instantaneous power output.

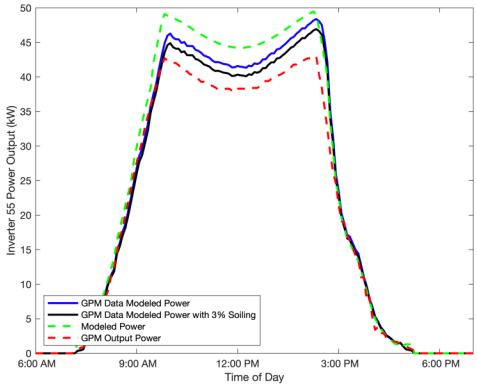
In this current work we had proposed accurately mapping the topography of an identified section of the array that had been shown to have substantial shading and using our models to recommend parameters for REC Solar to implement into the existing software to improve the energy output. The parameter that REC can control is the spacing between the torque tubes input into the software. We refer to this as the "modified spacing" used to make the software alter the tracking algorithm.

With the support of the Bently Center for Innovation we were able to accomplish all of our short-term goals. The z1 section of the Gold Tree Array was mapped using a laser to get the relative locations of the rows as accurately as possible. Improved models were developed for predicting point-of-array radiation and panel temperature based on date and "typical" weather conditions. Our current ability to predict power production on a shaded section is demonstrated in Figure 1. The actual output from the site (GPM data) is used for comparison. With the improved geometry and predictive models, we were able to perform an optimization for each month of the year to maximize the energy production of this zone by varying the morning and evening torque tube spacing inputs for the control software. We are overpredicting peak output during unshaded conditions in the winter but this has no effect on the optimization as only during shading does our model have an effect. The output from this analysis is show in table 1.

The most important result from this analysis is that the optimum backtracking is not the setting that totally avoids shading between rows but rather is a compromise between shading and having the panels sub optimally oriented relative to the sun position. Figure 2 demonstrates this showing the amount of shading as a function of the modified torque tube spacing input and the optimized values.



a) June 18th 2020

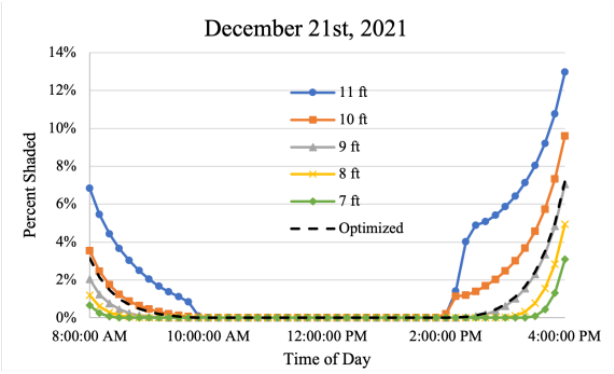


b) January 16th 2020

Figure 1, Power predictions for June and January. In June the inverter reaches its cap at 60 kW. We are currently working on improving our mid-day peak production modeling although we are matching well in the morning and evening when shading is occuring which is what is important for the optimization.

Table 1, Modified tube spacing for zone z1 to optimize energy production

Month	West Tube Spacing (ft)	East Tube Spacing (ft)	Energy Increase from Nominal (KWh)	Energy Increase from Nominal (%)
January	9.07	10.14	5,552	6.88
February	9.12	10.14	6,606	6.98
March	9.12	9.71	9,814	7.74
April	9.12	9.60	11,996	8.72
May	9.17	9.55	13,923	9.04
June	9.22	9.50	13,478	8.75
July	9.17	9.50	14,022	8.95
August	9.12	9.55	13,183	8.97
September	9.12	9.65	10,774	8.32
October	9.17	9.79	7,573	6.98
November	9.07	9.84	5,784	6.89
December	9.07	9.79	5,011	6.83
Year			117,695	8.14



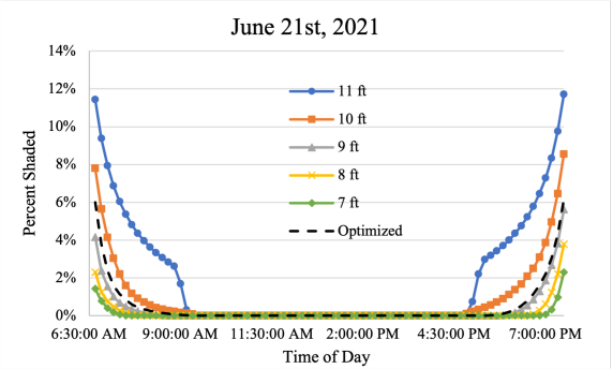


Figure 2, Percent area shaded on panels for December 21st and June 21st, 2021 for different modified torque tube spacings. The higher the modified torque tube spacing, the more shading there is throughout the day. The optimized value is not the minimum amount of shading but instead a balance between shading and POA irradiance.

Publications and other Deliverables

The data in Table 1 is being transmitted to REC solar and they plan to have an operator input the optimized settings for the z1 tracker at the beginning of every month. We will monitor this zone after the new settings are implemented to assess the effect on the total energy production. One master's thesis has been completed and submitted in June 2021. Two manuscripts are in work and we plan to submit them in November to the ASME Power Conference for 2022.

Student Impact

Master's Theses:

Logan Smith - *Power Output Modeling and Optimization for a Single Axis Tracking Solar Farm on Skewed Topography Causing Extensive Shading, June 2021*

Katelynn Dinius – *Refined Power Output Model for Shaded Solar Panels, Expected completion December 2021*

Independent Study – Spring 2021

Leo Taranta-Slack	3 units
Nathan Piantanida	1 unit

Summer Undergraduate Research Program

Shea Charkowski	Summer 2020
Sophie Getty	Summer 2021
Ryan Dubois	Summer 2021

Proposals and other Leverage

Based on our progress this year we have secured 2021-2022 funding of $5,000 from the REC/Cal Poly research fund supporting the Gold Tree Solar Array. We have been using this funding 100% for student support.

FINAL REPORT FOR BENTLY CENTER AWARD (2020-2021)

Andrew Kean, Professor, DOE National Renewable Energy Laboratory Collegiate Wind Competition Advising, 3 WTUs Awarded

Awardee

Andrew Kean, Professor, Mechanical Engineering, akean@calpoly.edu

Award

3 total units

Summary of Accomplishments

With the support of the Bently Center, I was able to advise the Cal Poly Wind Power IRA during our first effort at the Department of Energy/National Renewable Energy Laboratory's Collegiate Wind Competition which took place in June 2021. The competition was held virtually, and featured designing/building/testing a small wind turbine and creating a plan for a large-scale wind farm. Cal Poly was represented by a multidisciplinary team with students from both inside and outside of the College of Engineering.

Many of the competition deliverables were forms of applied mechanical engineering research. Specifically, competition participants needed to 1) create an effective mechanical, electrical, and aerodynamic wind turbine and load design that is safe and reliable for testing in an on-site wind tunnel and 2) create a site plan and cost of energy analysis for a 100-MW wind farm in eastern Colorado. The turbine design involved dynamometer testing, rotor strength testing, and power curve measurements. The student team performed this applied research under my supervision, with generous support of the AERO department in using their low-speed wind tunnel.

It was our first year participating and we got an incredible 3rd place. Many teams have been participating for years (under the same set of rules), so we did remarkably well for a first-time team. It is a competitive process to even be allowed to compete, as it requires being selected for a federal grant. The online competition was kicked off by Jennifer Granholm, Secretary of Energy. At the conclusion of the event, our U.S. Representative Salud Carbajal, made the following statement about our team, "Congratulations to Cal Poly's Wind Energy Team for their recognition in the 2021 Collegiate Wind Competition! They embodied the 'learn by doing motto,' tackling this real world project with dedication and determination. We know renewable energy is the future, so it is imperative that we have a workforce that is prepared for these future-oriented jobs. We will need smart people, like the members of the Cal Poly Wind Energy Team, to lead the way."

The successes of our team have been publicized on numerous websites, Cal Poly's social media pages, and in the Santa Maria Times newspaper.

Publications and other Deliverables

Competition-related reports

1. Industry-contacts deliverable
2. Turbine technical design report
3. Team-story report
4. Distributed-manufacturing plan
5. 100 MW Wind Project development plan
6. Outreach plan

Competition-related presentations

1. Connections creations
2. Turbine design
3. Project development
4. Turbine testing video

Student Impact

About 20 students both in and outside of CENG participated in the competition on behalf of Cal Poly. Below is a photograph which NREL requested of one of the team meetings:

Supervision of student projects

1. Cal Poly Wind Power also sponsored ME three senior projects and one EE senior project, so even students outside of the organization benefited from our efforts.

Proposals and Other Leverage

Active awards during the period of support

1. **National Renewable Energy Laboratory** (Andrew Kean, PI)
2020-2021; $ 20,000. ***Title*****:** Cal Poly participation in the 2021 Collegiate Wind Competition. ***Status:*** This contract has been completed and all funds paid to Cal Poly.

Proposals submitted during the period of support

1. **National Renewable Energy Laboratory** (Andrew Kean, PI)
2021-2022; $ 20,000. ***Title*****:** Cal Poly participation in the 2022 Collegiate Wind Competition. ***Status:*** We were unfortunately not funded for next year.

FINAL REPORT FOR BENTLY CENTER AWARD (2020-2021)

Awardee

Stephen M. Klisch, Professor, Mechanical Engineering, sklisch@calpoly.edu

Award

8 units (3 in 2020 Summer quarter, 2 in 2021 Winter quarter, 3 in 2021 Spring quarter).

Summary of Accomplishments

As stated in the original proposal, the **objectives** of the assigned time were to 1) lead an interdisciplinary research team of students and faculty in new scholarly directions and 2) develop external research proposals. To accomplish those objectives, I worked closely with a large, interdisciplinary team of Human Motion Biomechanics (HMB) Lab students and faculty. That team included 16 Cal Poly students (11 ME, 5 BME) and 8 Cal Poly Faculty members: Scott Hazelwood (Biomedical Engineering), Britta Berg-Johansen (Biomedical Engineering), Christie O'Hara (Kinesiology & Public Health), Paige Johnson (Kinesiology & Public Health), Scott Reaves (Food Science & Nutrition), Jeff Sklar (Statistics), Suzanne Phelan (Kinesiology & Public Health), and Long Wang (Civil & Environmental Engineering). During the period of support, my primary activities included

- working with HMB lab students & faculty to manage a challenging transition to virtual research due to COVID-19 restrictions;
- mentoring students as they worked on pitching, sports, and exercise biomechanics projects focused on injury & disease prevention;
- mentoring current and former students as they developed 3 peer-reviewed journal papers (1 published, 1 in review, 1 in preparation);
- mentoring current and former students as they submitted and/or presented 2 peer-reviewed conference papers;
- developing and/or submitting 4 research proposals (3 external to Cal Poly); and
- maintaining IRB protocols for HMB Lab biomechanics research.

Publications and other Deliverables (Cal Poly students in bold)

Peer-reviewed journal papers

1. **Skaro J**, Hazelwood SJ, Klisch SM. Knee angles after crosstalk correction with principal component analysis in gait and cycling. *ASME Journal of Biomechanical Engineering,* 143(5): 054501 (Feb 22), 2021. https://doi.org/10.1115/1.4049809.
2. **Jennings DJ**, Reaves SK, Sklar J, Brown C, McPhee J, Hazelwood SJ, Klisch SM. 3-D inertial parameter calculations from body composition imaging and overweight-related indices for youth pitching arm kinetics. *ASME Journal of Biomechanical Engineering,* in review, 2021
3. **Fernandez R**, Hazelwood SJ, Klisch SM. Knee joint contact forces of unilateral transtibial amputees during cycling: implications for rehabilitation and lifelong fitness. In preparation, 2021.

Peer-reviewed conference papers

1. **Fong C**, **Sax R**, Escamilla R, Aguinaldo A, Hazelwood SJ, Klisch SM. Youth pitching kinematics: association with body overweight parameters. *Summer Biomechanics, Bioengineering & Biotransport Conference*, 2021.
2. **Fernandez R**, Hazelwood SJ, Klisch SM. Knee joint contact forces of unilateral transtibial amputees during cycling: implications for rehabilitation and lifelong fitness. *Summer Biomechanics, Bioengineering & Biotransport Conference*, 2021.

Student Impact

Student awards

1. Reymil Fernandez, 1st Place, B.S. Level Student Paper Competition (ASME BED), Summer Biomechanics, Bioengineering, and Biotransport Conference, 2021 (Principal Investigator).
2. Reymil Fernandez, Outstanding Graduate Student Award, Cal Poly, 2021 (Principal Investigator).

Supervision of M.S. students

1. Kaila Lawson. The application of post-hoc correction methods for soft tissue artifact and marker misplacement in youth gait knee kinematics. *M.S. Thesis, Cal Poly,* June, 2021.
2. Carlos Soto. Failure analysis of the ulnar collateral ligament for youth baseball pitchers. *M.S. Thesis, Cal Poly,* June, 2021.
3. Reymil Fernandez, MS thesis research, expected graduation August, 2021.
4. Sam Porter, MS thesis research, expected graduation December, 2021.
5. Christina Fong, MS thesis research, expected graduation June, 2022.
6. Sam Tucker, non-thesis research.

Supervision of B.S. students

1. Ryan Sax (ME), BS research, 2019-2021
2. Marissa Martinez (BME), BS research, 2020-2021
3. Karthik Padmanabhan (ME), BS research, 2020-2021
4. Hunter Morse (ME), BS research, 2020-present
5. Sydney Donaldson (ME), BS research, 2021-present
6. Kendall Gentzen (BME), BS research, 2021-present
7. Ally Lai (BME), BS research, 2021-present
8. Samantha Moberly (ME), BS research, 2021-present
9. Ethan Nikcevich (ME), BS research, 2021-present
10. Sarah Pickering (BME), BS research, 2021-present

Proposals and other Leverage

Proposals submitted during the period of support

1. **NIH Academic Research Enhancement Award (AREA)** (PI Klisch). 4/1/21-3/31/24; $420,900 (total costs). *Title*: Youth pitching biomechanics: DXA-driven analysis, obesity, and coaching intervention. *Submitted June 25, 2020. Status: not awarded; to be submitted as a revision application.*

2. **NIH Academic Research Enhancement Award (AREA)** (PI Klisch). 7/1/21-6/30/24; $415,499 (total costs). *Title*: Soccer playing, overweight and obesity, and OA-related knee

biomechanics in youths. *Submitted October 25, 2020. Status: not awarded; to be submitted as a revision application.*

3. **Research, Scholarly, and Creative Activities Program (Cal Poly)** (PI Klisch). Summer 2021 – Spring 2022; 8 WTUs assigned time. *Title*: A new interdisciplinary scholarly direction for Cal Poly's Human Motion Biomechanics Lab. *Submitted February 2021. Status: not awarded.*

4. **Donald E. Bently Center for Engineering Innovation** (PI Klisch).
Fall 2021; 3 WTUs assigned time. *Title*: Bridge funding: renewing external support for Cal Poly's HMB Lab. *Submitted March 2021. Status: funded.*

Proposals in development during the period of support
1. **Department of Defense Congressionally Directed Medical Research Program (CDMRC)** (co-PIs Klisch, Phelan, Hackman, Wang, Werner). *Title*: Strengthening resilience and readiness in new military personnel: an interdisciplinary & inclusive intervention. *Status: anticipated pre-proposal submission in Fall 2021.*