

TRUMAN STATE UNIVERSITY  
Kirksville 63501

OFFICIAL MINUTES  
OF THE  
BOARD OF GOVERNORS

Page 1

OPEN SESSION  
OF MEETING ON  
OCTOBER 20, 2023

The Board of Governors for Truman State University met on Friday, October 20, 2023, on the University campus in Kirksville, Missouri. The meeting was held in the Conference Room (3000) of the Student Union Building. The open session of the meeting was called to order shortly after 1:00 p.m. by the Chair of the Board, Cheryl J. Cozette.

All seven voting members participated in the meeting: Sarah Burkemper, Philip J. Christofferson, Cheryl J. Cozette, Jennifer Kopp Dameron, Nancy Gingrich, Bill Lovegreen, and K. Brooks Miller, Jr.

Two non-voting members also participated in the meeting: Ella Schnake, the Student Representative, and Mike McClaskey, an out-of-state member. The second out-of-state member position is vacant.

Call to Order, Chair Report, and Public Comment

Governor Cozette called the meeting to order and welcomed all in attendance. During the Public Comment section of the meeting, Governor Cozette recognized Dr. Marc Becker, Professor of History, who had requested to speak on behalf of the Truman State University American Association of University Professors (AAUP) Chapter. Dr. Becker shared a statement from AAUP regarding their recently completed State of the University survey.

Amendments to Consent Agenda

Governor Lovegreen moved that the following three items be removed from the Consent Agenda:

- ITEM K.2 Extension of Marketing Management Services
- ITEM K.4 Resolution Amending Section 13.050 of the Code of Policies of the Board of Governors Pertaining to Naming Opportunities
- ITEM K.5 Request for Naming Opportunities

The motion was seconded by Governor Gingrich and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted.

Governor Christofferson moved that the following two items be tabled until the December meeting of the Board:

- ITEM K.4 Resolution Amending Section 13.050 of the Code of Policies of the Board of Governors Pertaining to Naming Opportunities
- ITEM K.5 Request for Naming Opportunities

The motion was seconded by Governor Burkemper and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted.

Minutes for Open Session of Meeting on August 5, 2023

Governor Gingrich moved for the adoption of the following resolution:

BE IT RESOLVED that the minutes for the open session of the meeting on August 5, 2023, be approved.

TRUMAN STATE UNIVERSITY  
Kirksville 63501

OFFICIAL MINUTES  
OF THE  
BOARD OF GOVERNORS

Page 2

OPEN SESSION  
OF MEETING ON  
OCTOBER 20, 2023

The motion was seconded by Governor Christofferson and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted.

Audit Report

Representatives of RubinBrown LLP accounting firm reviewed a draft of the annual audit of the University.

President's Report

Dr. Susan L. Thomas, University President, reported on several items of current interest. In addition to sharing her selected engagements report, she highlighted three academic initiatives. First, she noted that Truman recently received good press as the first school in Missouri to offer a bachelor's degree in cannabis and natural medicinals, providing a significant opportunity for Truman students to be successful in a burgeoning field. Second, she applauded the tireless work of Dr. Stephanie Maiden, Associate Professor of Biology, [and Biology colleagues Drs. Brett Berke, Joyce Patrick, Hajee Mendis, and Daniela Ostrowaski (now at ATSU)] to secure a Major Research Instrumentation (MRI) grant from the National Science Foundation to purchase a benchtop fluorescent confocal microscope essential for Truman to be competitive in preparing students for the modern STEM workforce. Finally, she referenced a second grant from NSF, which will give Truman and three other primarily undergraduate Missouri universities access to a new supercomputer housed at the University of Missouri-Columbia and used mainly for undergraduate research and courses. Dr. Colin DeGraf, Assistant Professor of Physics, joined the partnership for this grant. The project resulted from a planning grant that brought faculty from around the state (including Dr. DeGraf and Dr. Scott Thatcher, Associate Professor of Statistics). Lastly, she reported that over 50 individuals have enrolled in Truman 101: How Truman Functions and provided an update on the Kirk Building construction project and the status of the Greenwood Interprofessional Autism Center.

Enrollment Report

Dr. Tyana Lange, Vice President for Student Engagement, Enrollment and Marketing, provided an enrollment report analyzing this year's enrollment numbers and sharing enrollment goals for the 2024-25 Academic Year.

Annual Athletics Report

Jerry Wollmering, Director of Athletics, shared the annual Athletics Report.

Annual Staff Council Report

Kerrion Dean, Chair of the Staff Council and Program Coordinator for the Center for Diversity and Inclusion, provided the annual Staff Council Report.

Academic Affairs and Student Services Committee Report

As Chair of the Academic Affairs and Student Services Committee, Governor Dameron provided a report on the committee meeting held on October 16.

Extension of Marketing Management Services

Governor Christofferson moved for the adoption of the following resolution:

BE IT RESOLVED that the President of the University, or her designee, is hereby authorized to execute a contract with Enliven Agency, LLC, to provide data science marketing services to the University for the period of October 23, 2023, through June 30, 2024, at a cost not to exceed \$100,000; and

BE IT FURTHER RESOLVED that the proposal from Enliven Agency, LLC, to perform brand and marketing management services to support recruitment efforts at a cost not to exceed 18,000, be approved; and

BE IT FURTHER RESOLVED that copies of the proposals be included as exhibits with the minutes of this meeting.

The motion was seconded by Governor Burkemper and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted, and the Secretary designated copies of the documents as Exhibits A and B.

Finance and Auditing Committee Report

Governor Burkemper, Chair of the Finance and Auditing Committee, provided a report on the committee meeting held on October 17.

Financial Report

Governor Burkemper presented the Financial Report, which included a review as of August 31, 2023, of education and general revenues and expenditures and auxiliary system revenues and expenditures, and a review as of August 31, 2023, of the Truman State University Foundation revenues and expenditures.

Budget and Capital Projects Committee Report

As Chair of the Budget and Capital Projects Committee, Governor Christofferson provided a report on the committee meeting held on October 18.

Construction Projects Report

Governor Christofferson provided an update on construction projects approved by the Board at previous meetings.

Contracts for Construction Projects and Equipment Purchases

Governor Christofferson reported that one item of equipment totaling \$25,000 to \$100,000 had been approved since the last meeting of the Board.

Equipment Purchase

2023-002 Light Duty Truck

Cost

\$44,747

Consent Agenda

Governor Dameron moved for the adoption of the following resolution:

BE IT RESOLVED that the following consent agenda items be approved and attached to the minutes as exhibits:

- ITEM K.1     Equipment Purchase – Benchtop Confocal Microscope
- ITEM K.3     HVAC Engineering Services

TRUMAN STATE UNIVERSITY  
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OFFICIAL MINUTES  
OF THE  
BOARD OF GOVERNORS

Page 4

OPEN SESSION  
OF MEETING ON  
OCTOBER 20, 2023

The motion was seconded by Governor Gingrich and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted, and the Secretary designated copies of the documents as Exhibits C and D.

Agenda Items for Future Meetings

Governor Cozette reviewed a list of projected agenda items for the regular meetings during the following year.

Dates for Future Meetings

Governor Burkemper moved for the adoption of the following resolution:

BE IT RESOLVED that the next regular meeting of the Board of Governors be scheduled for Saturday, December 2, 2023, on the University campus in Kirksville, Missouri, beginning at 1:00 p.m., with the understanding that the Chair may alter the starting time and/or place for the meeting by giving due notice of such change; and

BE IT FURTHER RESOLVED that other regular meetings of the Board during the next year be tentatively scheduled for the following dates:

Saturday, February 3, 2024;  
Saturday, April 6, 2024;  
Saturday, June 15, 2024;  
Saturday, August 3, 2024; and  
Friday, October 25, 2024.

The motion was seconded by Governor Christofferson and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted.

Agenda Items for Closed Session

Governor Dameron moved for the adoption of the following resolution:

BE IT RESOLVED that this meeting be continued in closed session, with closed records and closed votes as permitted by law, for consideration of the following items as authorized by Section 610.021, Revised Statutes of Missouri:

1. Approval of minutes for the closed session of the last meeting under Subsection 14 of the statute for "Records which are protected from disclosure by law";
2. Individual personnel actions under Subsection 3 of the statute for "Hiring, firing, disciplining or promoting of particular employees by a public governmental body when personal information about the employee is discussed or recorded"; and
3. Confidential communications with the General Counsel, as defined in Subsection 1 of the statute.

TRUMAN STATE UNIVERSITY  
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OFFICIAL MINUTES  
OF THE  
BOARD OF GOVERNORS

Page 5

OPEN SESSION  
OF MEETING ON  
OCTOBER 20, 2023

The motion was seconded by Governor Christofferson and carried by a unanimous vote of 7 to 0, with Governors Burkemper, Christofferson, Cozette, Dameron, Gingrich, Lovegreen, and Miller voting Aye. Governor Cozette declared the motion to be duly adopted.

The closed session of the meeting began shortly after 3:10 p.m.

The open session of the meeting resumed shortly after 4:55 p.m.

With no further business, Governor Lovegreen moved that the meeting be adjourned. The motion was seconded by Governor Gingrich and carried by a unanimous vote of 7 to 0. Governor Cozette declared the motion to be duly adopted, and the meeting adjourned shortly after 5:00 p.m.



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Philip J. Christofferson  
Secretary of the Board of Governors

I hereby certify that the foregoing minutes were approved by the Board of Governors on the 2<sup>nd</sup> day of December 2023.



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Cheryl J. Cozette  
Chair of the Board of Governors

**STATEMENT OF WORK FOR:  
TRUMAN STATE UNIVERSITY**

**2023-24 DATA SCIENCE MEDIA & MARKETING SERVICES**

**SEPTEMBER 15, 2023**

TRUMAN STATE UNIVERSITY | HAYDEN WILSEY, ASSOCIATE DIRECTOR OF MARKETING



ENLIVEN AGENCY, LLC | CONOR O'FLAHERTY  
244 MADISON AVENUE, SUITE 1220, NEW YORK, NY 10016

**STATEMENT OF WORK FOR: TRUMAN STATE UNIVERSITY (09/15/23)  
2023-24 DATA SCIENCES MEDIA & MARKETING SERVICES****PROJECT OVERVIEW**

Truman State University has been awarded a grant with the purpose of promoting Data Science across the state of Missouri. This initiative aims to introduce the captivating world of Data Science while also showcasing the abundant opportunities that exist. Additionally, it will highlight the numerous benefits of pursuing a career in Data Science and illuminate various career pathways for individuals interested in entering this dynamic field.

**SERVICES****A. Executive Leadership**

Enliven's Leadership Team will be assigned to guide Client in:

- a. Concept Development
- b. Creative Direction
- c. Project Management
- d. Planning & Scheduling

**B. Creative Services**

A Creative Services Team will lead Client in the following:

- a. Concept Development
- b. Creative Direction
- c. Graphic Design
- d. Copywriting
- e. Digital Display Production
- f. Social Media Production

**C. Media Services**

A Media Services Team will lead Client in the following:

- a. Media Planning
- b. Media Buying
- c. Coordination and Trafficking
- d. Tracking, Measurement and Optimization
- e. Campaign Reporting

**CAMPAIGN PLAN**

- Increase awareness of the opportunities that exist within the Data Science industry and Truman State University's Data Science programs throughout the state of Missouri.
- Engage the audience through social media channels and drive high-intent website traffic.
- Drive recruitment of undergraduate and graduate students for Truman State University's Data Science programs.

For this campaign we propose a multi-tiered strategy, comprised of three sub-campaigns: Awareness, Engagement, and Enrollment.

By adopting this full-funnel approach, we aim to achieve comprehensive market coverage, a greater value offering, and the flexibility to adapt mid-campaign based on real-time results and institutional needs.

***Awareness***

The core objective of the awareness campaign is to attract attention to the wide-ranging opportunities available in the field of Data Science. Through our carefully crafted campaign message, we will effectively communicate the multiple pathways leading to a gratifying career in Data Science, emphasizing its remarkable benefits.

This message will be seamlessly integrated across both digital and traditional channels, encouraging interested individuals to delve deeper into the subject by visiting the dedicated Data Science webpage.

- Webpage Redesign
- Digital Media (Display, Social, and Video)
- Traditional Media (Outdoor and Radio)
- Campaign Creative

***Engagement***

The focal point of the engagement campaign will revolve around a strategically crafted content piece. This piece will provide an immersive exploration into the Data Science career path.

Featured on both the Data Science webpage and relevant social media accounts, this blog-style content piece will be complemented by a supporting video to enhance the storytelling experience.

- Content/Video Development
- Digital Media (Display, Social, and Video)
- Campaign Creative



***Enrollment***

The enrollment campaign aims to actively encourage inquiries and applications for Truman's Data Science degree programs. Leveraging a targeted approach, we will focus on utilizing search and social media channels to reach prospective students. Additionally, we will tap into known audience segments that we can specifically target, maximizing the campaign's effectiveness.

- Digital Media (Display, Search and Social)
- Campaign Creative

**TARGET AUDIENCE**

- Missouri residents with an interest in progressing their career in Data Science.
- Prospective undergraduate students, transfer students, and their parents.
- Prospective graduate students.

**GEOGRAPHY**

- State of Missouri

**FLIGHT DATES**

- October 16, 2023 – May 31, 2024

**CORE BUDGET**

- \$100,000.

**KPIs**

- Impressions
- Website traffic (Clicks, CTR).
- Lead generation and nurturing (Apply, Enroll & Visit website clicks).

## MEDIA PLAN

TRUMAN STATE UNIVERSITY - DATA SCIENCE MEDIA PLAN						
Flight Start Date	Flight End Date	Geo / Market	Placement	Targeting	Cost	
<b>Awareness</b>						
Fine-tuned activations (TBD)		Missouri	CTV/OTT	People-based; Prospecting: Prospective UG students; Retargeting	\$24,150.00	
Fine-tuned activations (TBD)			Outdoor	-	\$10,500.00	
Fine-tuned activations (TBD)			Radio	-	\$6,000.00	
October 16, 2023	May 31, 2024		Programmatic Display	People-based; Prospecting: Prospective students; Influencers of Prospective Students	\$3,800.00	
October 16, 2023	May 31, 2024		Meta	People-based; Prospecting: Prospective students; Influencers of Prospective Students	\$5,000.00	
Fine-tuned activations (TBD)			3-mi radius around select locations (See Geo tab)	Geofencing	Geo-based	\$1,200.00
					\$50,650.00	
<b>Engagement</b>						
October 16, 2023	May 31, 2024	Missouri	Programmatic Display	People-based; Prospecting: Prospective UG students; Retargeting	\$3,000.00	
October 16, 2023	May 31, 2024		Meta	People-based; Prospecting: Prospective UG students; Retargeting	\$3,000.00	
					\$6,000.00	
<b>Enrollment</b>						
<b>Undergraduate (Data Science 4+1 and Business Analytics Programs)</b>						
October 16, 2023	May 31, 2024	Missouri	Programmatic Display	People-based; Prospecting: Prospective UG students; Retargeting	\$2,200.00	
October 16, 2023	May 31, 2024		Meta	People-based; Prospecting: Prospective UG students; Retargeting	\$4,500.00	
October 16, 2023	May 31, 2024		Google SEM	Keyword-based	\$2,100.00	
					\$8,800.00	
<b>Graduate (Data Science and Analytic Storytelling Program)</b>						
October 16, 2023	May 31, 2024	Missouri	Programmatic Display	People-based; Prospecting: Prospective Grad students; Retargeting	\$4,350.00	
October 16, 2023	May 31, 2024		Meta	People-based; Prospecting: Prospective Grad students; Retargeting	\$9,000.00	
October 16, 2023	May 31, 2024		Google SEM	Keyword-based	\$5,000.00	
					\$18,350.00	
					\$83,800.00	

**PROJECT DELIVERABLES**

- **Truman State University Data Science Campaign Radio Advertising**
  - Development and production of One (1) :30 radio spot
  - Services delivered by Enliven will include the following:
    - Script development
    - VO Casting and Recording
    - VO Licensing
    - Music Track Selection and Licensing
    - Audio Production and Mastering
  - Development is subject to Two (2) phases of Client review
  - Production files delivered in .MP3 and .WAV formats
  
- **Truman State University Data Science Campaign Outdoor Advertising**
  - Development and production of One (1) digital billboard
  - Development is subject to Two (2) phases of Client review
  - Production files delivered dependent on vendor specifications
  
- **Truman State University Data Science Campaign Digital Advertising**
  - A full suite of standard digital display and social ad units using approved campaign concept
  - Four (4) sets of digital display and social ad units including the following sizes:
    - 728x90
    - 300x250
    - 300x600
    - 320x50
    - 300x50
    - Meta Newsfeed and/or Video Ads
  - Development is subject to Two (2) phases of Client review
  - Production files delivered in .GIF, .JPG and .MP4 formats
  
- **Truman State University Data Science Campaign Video Advertising**
  - Production of One (1) :30 and One (1) :15 video edit
  - Production of One (1) 1-3 minute video edit
  - Production services delivered by Enliven will include the following:
    - Editing
    - Motion Graphic Development and Integration
    - Audio Track Licensing and Integration
    - Color Correction, Audio Mastering and Finishing
  - Development is subject to Two (2) phases of Client review
  - Production files delivered in .MOV and .MP4 formats
  
- **Truman State University Data Science Webpage Design and Content**
  - Production of One (1) webpage design layout
  - Content production for One (1) webpage
  - Webpage production does not include any coding or implementation of code from agency



**PROJECT FEES**

<b>MARKETING SERVICES</b>	<b>Fees</b>
Awareness Campaign	\$50,650
Engagement Campaign	\$6,000
Enrollment Undergraduate Campaign	\$8,800
Enrollment Graduate Campaign	\$18,350
Creative Development	\$9,700
Webpage Design	\$3,000
Content Development	\$3,500
<b>Total Fees</b>	<b>\$100,000</b>

Additional consulting services for marketing and creative development outside of those outlined within the Statement of Work will be billed to Truman State University at a blended rate of \$150 p/hr. These costs will be pre-approved by Truman State University and billed separately.



**PROPOSAL FOR:  
TRUMAN STATE UNIVERSITY**

**BRAND AND MARKETING MANAGEMENT RETAINER AGREEMENT FALL  
2023 EXTENSION**

**OCTOBER 13, 2023**

TRUMAN STATE UNIVERSITY | TYANA LANGE, VICE PRESIDENT FOR ENROLLMENT  
MANAGEMENT AND MARKETING



BRAND AND MARKETING MANAGEMENT RETAINER AGREEMENT FALL

ENLIVEN AGENCY, LLC | CONOR O'FLAHERTY  
244 MADISON AVENUE, SUITE 1220, NEW YORK, NY 10016

OCTOBER 13, 2023

TRUMAN STATE UNIVERSITY | TYANA LANGE, VICE PRESIDENT FOR ENROLLMENT  
MANAGEMENT AND MARKETING

**PROPOSAL FOR: TRUMAN STATE UNIVERSITY (10/13/23)  
BRAND AND MARKETING MANAGEMENT RETAINER AGREEMENT  
FALL 2023 EXTENSION**

**PROJECT OVERVIEW**

Truman State University wishes to extend the services of Enliven via an additional One Hundred Twenty (120) hour retainer agreement which will see the agency provide brand and marketing management services to support the university's Marketing Team throughout the Fall 2023 semester. Working directly with Hayden Wilsey (Associate Director of Marketing), Allison Gus (Director of Admissions), and Richie Howell (Digital Content Specialist), Enliven will serve Truman State University via an integrated team of experienced agency professionals to support all facets of marketing while offering a fluid and responsive approach to evolving creative needs for:

- o Admissions
- o Marketing
- o Publications
- o Public Relations
- o Residence Life

The following proposal outlines Enliven's process, deliverables, and fees for the execution of this project.

**SERVICES****A. Executive Leadership**

Enliven's Leadership Team will be assigned to guide Client in:

- a. Brand Strategy and Positioning
- b. Marketing Communications, Campaign, Media and Content Planning
- c. Tracking, Measurement and Optimization

**B. Creative Services**

A Creative Services Team will lead Client in the following:

- a. Concept Development
- b. Creative Direction
- c. Graphic Design
- d. Copywriting
- e. Production

**BRAND AND MARKETING MANAGEMENT RETAINER: PROCESS AND DELIVERABLES**

- o Dedicated Enliven Team including Founder, Copywriter, Senior Designer and Junior Designer
  - o Marketing management including all current marketing plans, media plans, target audiences, campaigns, and marketing collateral
    - Collaboration with Truman State University team and existing partners to ensure all current admissions marketing is optimized and new targeting opportunities are identified to help drive enrollment for Fall 2024
  - o Strategic guidance on the management and consistent application of the Truman State University brand
  - o Fluid and responsive approach to evolving marketing/creative needs
  - o Creative services for the development of deliverables including marketing campaigns/messaging, digital advertising, print advertising, radio advertising, video advertising, social media advertising, social media graphics and marketing/recruitment collateral
- o Seamless access to specialist services on an as needed basis via Enliven’s network of industry leading professionals and partners
- o Weekly Status Call with Enliven to review projects and time allocations/management
  - o Calls with Truman State University partners and vendors on an as needed basis
- o One Hundred Twenty (120) hour retainer agreement with a blended and discounted hourly rate of \$150 p/r. for all creative services delivered commencing October 18<sup>th</sup>, 2023

**PROJECT FEES**

<b>BRAND AND MARKETING MANAGEMENT RETAINER AGREEMENT EXTENSION</b>		<b>Fees</b>
One Hundred Twenty (120) hours Creative Services at \$150 p/r.		<b>\$18,000</b>
<b>Total Fees</b>		<b>\$18,000</b>

**EXPENSES**

Statement does not include expenses for travel, accommodation, transportation, printing, shipping, voice over recording, music, studio rental, photography, videography, licensing/rights fees, and other ancillary project related costs. These costs will be pre-approved and billed separately.

ITEM K.1

Equipment Purchase – Benchtop Confocal Microscope

DESCRIPTION AND BACKGROUND

The National Science Foundation (NSF) has committed to fund the purchase of a benchtop confocal microscope through a Major Research Instrumentation (MRI) grant. A confocal microscope is essential for Truman to be competitive in preparing its students for careers in modern biology. The grant application was submitted by faculty members from the Biology Department. A letter from Dr. Stephanie Maiden, Associate Professor of Biology, along with a description of the grant and the manufacturer’s quote, follow this page.

The University followed its normal procurement policy for a sole-source purchase, including requesting a sole-source justification from both the Biology Department and the vendor, conducting a search for a similar product to ensure no other alternatives exist, and advertising its intent to accept the manufacturer’s sole source justification on the University’s open bid website and the State of Missouri’s statewide eProcurement system.

RECOMMENDED ACTION

BE IT RESOLVED that the purchase of the following items be approved:

<u>Item</u>	<u>Budget</u>
Andor BC43 Benchtop Confocal Microscope	\$283,481

Moved by \_\_\_\_\_  
Seconded by \_\_\_\_\_

	<u>Aye</u>	<u>Nay</u>
Vote: Burkemper	_____	_____
Christofferson	_____	_____
Cozette	_____	_____
Dameron	_____	_____
Gingrich	_____	_____
Lovegreen	_____	_____
Miller	_____	_____

ATTACHMENTS

Letter from Dr. Stephanie Maiden, Associate Professor of Biology  
Andor Technology Inc. Proposal





Department of Biology  
660.785.4597 (phone)  
660.785.4045 (fax)  
biology@truman.edu

Magruder Hall 2004  
100 East Normal Avenue  
Kirksville, MO 63501-4221

September 14, 2023

Dear Truman State University Board of Governors,

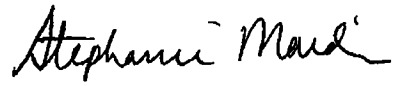
We are pleased to announce that the National Science Foundation (NSF) has awarded funding of \$283,481 for the purchase of a fluorescent confocal microscope through the Major Research Instrumentation (MRI) program. Fluorescent confocal microscopy is an essential tool in cell and developmental biology fields, allowing scientists to visualize cell structures more clearly when they have been “marked” with a fluorescent molecule. This acquisition will allow faculty at Truman to train undergraduates in this technique through both curricular and extracurricular (i.e., research) projects, preparing them for the modern STEM workforce.

The grant proposal was submitted by faculty members in the Biology Department, including Drs. Stephanie Maiden, Brett Berke, Joyce Patrick, Hajee Mendis, and Daniela Ostrowski (now at ATSU). Each faculty member works with a different model organism; therefore, we needed a confocal microscope that could meet a variety of needs. The Andor BC43 boasts four imaging modalities: brightfield, differential phase contrast, fluorescent widefield, and fluorescent confocal microscopy. During the demonstration, we found that the instrument had the speed and sensitivity for live confocal imaging as well as the resolution expected and desired for fixed samples. Furthermore, for whole microscopic animals (e.g., roundworms) or large tissue sections (e.g., brain), it was important that we be able to stitch together images to cover the whole area without accruing distortions. The Andor BC43 has patented Borealis illumination, which uniformly illuminates the sample and allows for seamless stitching of images. We also wanted an instrument that would be more amenable to classroom and undergraduate use. The Andor BC43 is a *benchtop* confocal microscope, meaning all of the necessary components are enclosed in a box as a single unit. There is no need for a dark room to protect fluorescent samples so a larger room can be used that will hold more students, and the instrument is controlled by a computer so that there is less chance for manual errors to occur that could otherwise damage the instrument.

Andor provided sole-source documentation for the BC43, largely based on the Borealis illumination and the number of different imaging modalities. A Single Feasible Source Purchase document was posted on Truman’s website for 13 days to make sure that no other company could delivery this same equipment.

In summary, acquisition of the Andor BC43 benchtop fluorescent confocal microscope will allow impactful cell and developmental biology research to continue at Truman, as well as the training of undergraduate students in modern microscopy methods. Attached is the full grant proposal should you want or need additional information. We request your approval for the purchase of this instrument using the funds provided by the NSF.

Sincerely,

A handwritten signature in cursive script that reads "Stephanie Maiden".

Stephanie Maiden, Ph.D.  
Associate Professor of Biology  
Phone: 660-785-4634  
Email: [smaiden@truman.edu](mailto:smaiden@truman.edu)

## **INFORMATION ABOUT THE PROPOSAL**

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**Instrument Location:** Truman State University, Kirksville, MO

**Instrument Being Acquired:** Fluorescent confocal microscope

## **RESEARCH ACTIVITIES TO BE ENABLED**

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### **Environment**

Truman State University in Kirksville, Missouri, is the state's only public liberal arts and sciences university with a current enrollment of 3,890 undergraduate students and 335 graduate students.<sup>1</sup> For 26 consecutive years, Truman has been ranked the #1 public school in the Midwest region by U.S. News & World Report's "America's Best Colleges".<sup>2</sup> In 2022, Truman ranked #6 in the Midwest region overall, the only Missouri public school in the top 70 institutions.<sup>3</sup> Truman was also ranked #1 out of Midwest region public schools on the "Best Undergraduate Teaching" list, landing #8 out of 24 public and private institutions overall.<sup>4</sup> In 2022, Washington Monthly ranked Truman #7 among 200 U.S. master's universities, a ranking that takes into account an institution's research and impact on social mobility.<sup>5</sup> Our curriculum emphasizes the development of critical thinking skills, participation in high-impact experiences, and working collaboratively to solve complex problems. Engaging undergraduate students in research is one of the most direct ways to accomplish all three of these goals.

In life science research, microscopy is an essential tool at all levels of investigation, whether that be differential gene expression among cells, analyzing protein localization within a single cell, determining the cellular architecture of a tissue, or studying cell movements and patterning during development. The PI and co-PIs of this proposal apply fluorescent microscopy across a broad array of model organisms to understand the molecular mechanisms that drive cell function and variation. Unfortunately, a critical component on Truman's ten-year-old spinning-disk confocal microscope failed about 3.5 years ago. Discussions with the original provider of the system revealed that an exact replacement part does not exist. Updating the motor that drives the spinning disk requires updating many other components at great expense on a now aged imaging system. This proposal requests funds for a new fluorescent confocal microscope that will take advantage of newer technological advances and allow for impactful cell and developmental biology research to continue at Truman.

The research described below, conducted exclusively by Truman undergraduates and investigators in northeast Missouri, includes studying the impact of microtubules and associated proteins in the developing *Caenorhabditis elegans* embryonic epidermis, the nuclear events driving synapse development in *Drosophila*, the cellular mechanisms of respiratory dysfunction in rats, and beneficial biofilm formation on plant roots. Fluorescent confocal microscopy is absolutely essential to the success of these projects.

### **Major Research Projects**

**I. Project Title:** Determining the role of microtubule-associated proteins in developing the *Caenorhabditis elegans* embryonic epidermis

**Principal Investigator:** Stephanie L. Maiden, Ph.D., Associate Professor of Biology, Truman State University

**Impacted Students:** 29 Truman undergraduates since 2015 (19 women, 10 men; 3 McNair Scholars, 1 MOLSAMP, and 1 STEP Scholar); average of 5-6 students per year for an average 4-semester independent project.

**Description:** The Maiden lab focuses on the role of microtubules in the development and function of epithelial tissues using the roundworm *C. elegans* as a genetic model organism. Microtubules are hollow protein structures that are essential for cell viability because they provide the basis for intracellular transport, chromosome separation during cell division, and contribute to the overall shape of cells and resistance to mechanical force. These activities are impacted by microtubule-associated proteins (MAPs), which can affect microtubule assembly, organization, and interaction with other cell structures.<sup>6</sup> Our long-

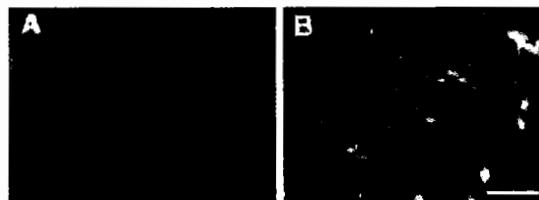
term goal is to understand how various MAPs interact cooperatively during embryonic development to influence microtubule structure and function in epidermal cells.

Formation of the epidermis during embryonic development in *C. elegans* provides a model tissue to study the importance of MAPs in epithelial cells during dynamic cellular events. During embryogenesis, the epithelial cells that will become the epidermis stop dividing and undergo a series of cell movements and cell shape changes referred to as epidermal morphogenesis.<sup>7,8</sup> During dorsal intercalation, two rows of epithelial cells become wedge-shaped and interdigitate with one another.<sup>9</sup> Around the same time, ventral epithelial cells migrate over underlying cells to make contact with their contralateral neighbors, sealing the embryo in an epithelial sheet.<sup>10</sup> Near the end of this process, both the F-actin and microtubule cytoskeletons form parallel arrays of circumferentially-oriented fibers in the dorsal and ventral epithelial cells and a less-organized meshwork in lateral seam cells.<sup>11</sup> Actomyosin-mediated contractions distributed along these cytoskeletal networks drives cell shape changes that shorten the cells along the dorsal-ventral axis while extending the cells along the anterior-posterior axis, elongating the embryo into a long, thin worm. Cell adhesions and intact actin and microtubule cytoskeletons are required for epidermal morphogenesis as perturbations cause embryonic lethality and morphological defects.<sup>7,8,11,12</sup>

The microtubule organization in these epithelial cells is similar to that seen in vertebrate animals but only a few *C. elegans* MAPs have been identified as important in determining that overall structure.<sup>13</sup> The specific sub-projects outlined below aim to characterize the function of the MAPs we have found to be involved in patterning the embryonic epidermis in *C. elegans*. This research may also uncover previously unidentified MAP genes critical to the cell shape changes and migrations in vertebrate development. For each of these sub-projects, multipoint fluorescent confocal microscopy is absolutely essential to acquire data with enough spatial and temporal resolution to determine how these MAPs impact microtubules in the epidermis, as well as to reduce phototoxicity during live imaging of embryonic development.

#### 1) Determining the role of UNC-33/CRMP in epidermal morphogenesis of *C. elegans*

The *unc-33* gene in *C. elegans* encodes a homolog to collapsin response mediator proteins,<sup>14-16</sup> or CRMPs, which are thought to control microtubule growth by binding to  $\alpha$ -tubulin/ $\beta$ -tubulin heterodimers<sup>17</sup> or the microtubule itself.<sup>18</sup> Several alleles of *unc-33* exist that demonstrate defects in axonal outgrowth and guidance, resulting in paralyzed and uncoordinated animals.<sup>14-16,18-19</sup> These animals have also been reported to be shorter and stouter than wildtype (WT) animals (*dumpy*)<sup>20</sup> but with no clear explanation why. Many *dumpy* animals are associated with alleles that encode defective cuticle proteins<sup>21</sup> but some alleles have been found to be important for proper epidermal morphogenesis, including those of *sma-1*,<sup>22,23</sup> *let-502*,<sup>13,24,25</sup> and *lin-26*.<sup>26</sup> Therefore, we hypothesized that *unc-33* may also play a role in epidermal morphogenesis. Through 4D differential interference contrast (DIC) microscopy, we found that homozygous *unc-33(e204)* embryos exhibit delayed progression through ventral enclosure and body elongation when compared to WT.<sup>27</sup> Immunofluorescent staining of  $\alpha$ -tubulin and subsequent confocal microscopy did not reveal large-scale microtubule defects in these animals (data not shown) but the resolution of our previous confocal microscope was fairly low. Attempts with live imaging of WT embryos expressing  $\alpha$ -tubulin::GFP only revealed brighter “bundles” and a hazy background (Fig. 1A). In comparison, microtubules in this same strain are clearly distinguishable in micrographs from the Andor BC43 confocal microscope (Fig. 1B), which would allow us to better quantify the numbers of microtubules, the spacing between them, and their apicobasal position. To determine if the developmental delays are caused by defects in microtubule growth, it will be necessary to analyze the dynamics of epidermal microtubules in living embryos. During the BC43 demo, continuous imaging for 345 seconds with 1  $\mu$ m sections throughout the entire embryo resulted in minimal bleaching of



**Figure 1.** Fluorescent confocal microscopy of WT dorsal epidermal cells expressing  $\alpha$ -tubulin::GFP. Images are  $f_{max}$ -intensity z-projections from four focal planes 1  $\mu$ m apart. (A) Old spinning-disk confocal (B) Andor BC43. Scale bar = 5  $\mu$ m.

$\alpha$ -tubulin::GFP. It did take 6.9 seconds between time points, but if the image size, binning, exposure, and number of sections were optimized, this could be reduced to 1 second between time points. Several existing strains of *C. elegans* express fluorescent translational fusions that will be useful for this project when paired with *unc-33* alleles, including those with epidermal-specific expression of a microtubule plus-end binding protein, EBP-2::GFP, and an  $\alpha$ -tubulin, TBA-2::GFP.<sup>13</sup>

Conflicting evidence exists regarding whether CRMP family members exert their effects by binding to tubulin heterodimers or intact microtubules.<sup>17,18</sup> By using CRISPR-Cas9 gene editing technology to add a fluorescent tag to the endogenous *unc-33* gene in *C. elegans*,<sup>28-31</sup> we would be able to use confocal microscopy to look at the localization and distribution of UNC-33 in the epidermis of WT and homozygous *unc-33* mutant embryos. By using different fluorescent genes, novel strains could be created (e.g., UNC-33::RFP and  $\alpha$ -tubulin::GFP) to examine UNC-33 and microtubules simultaneously throughout development. 4D confocal microscopy would give us the spatial and temporal resolution necessary to examine colocalization of fluorescent UNC-33 with various microtubule reporters.

## 2) Determining the role of TBCD-1 during epidermal morphogenesis of *C. elegans*

The *tbcd-1* gene in *C. elegans* encodes the homolog to TBCD, or tubulin-specific chaperone D.<sup>32</sup> This protein functions in concert with other tubulin-specific chaperones to facilitate the folding of heterodimer-competent  $\alpha$ - and  $\beta$ -tubulin and their subsequent dimerization.<sup>33-35</sup> TBCD specifically interacts with  $\beta$ -tubulin and promotes association with  $\alpha$ -tubulin by binding to its coupled chaperone, TBCE. Because of its role in this process and the importance of microtubules in *C. elegans* embryogenesis, *tbcd-1* became an attractive target as a potential mediator of epidermal morphogenesis. This hypothesis is further supported by data demonstrating that *evl-20(RNAi)* disrupts epidermal enclosure and body elongation.<sup>36</sup> EVL-20 is homologous to ADP-ribosylation factor-like 2 (ARL2), which has been shown to be important for TBCD function.<sup>37,38</sup> Because there are no well-characterized alleles of *tbcd-1* in *C. elegans*, we used RNA interference (RNAi) to knockdown *tbcd-1* in WT animals and found that there were a range of defects during epidermal morphogenesis, including a complete failure of ventral enclosure, body morphology defects, or cells being extruded during body elongation (data not shown). To determine if *tbcd-1* knockdown is in fact perturbing the microtubule cytoskeleton in the epidermis, similar experiments to the *unc-33* project would be performed to compare the overall microtubule network to the rate of microtubule growth in various epidermal cells as the embryos develop. To do so will require a number of fluorescent transgenes and time-lapse confocal microscopy in order to acquire data with enough spatial and temporal resolution for analysis.

Because there are no well-characterized alleles for *tbcd-1*, CRISPR-Cas9 gene editing technology will also be used to create novel alleles of this gene by altering homologous sequences that may be important for TBCD-1 function,<sup>28-31</sup> as well as to add a fluorescent tag so that we can use confocal microscopy to look at the spatial and temporal expression of TBCD-1 in WT and *tbcd-1* mutant embryos. The potential identification of weak loss-of-function alleles of *tbcd-1* would open up new lines of investigation for understanding TBCD-1 function in *C. elegans*.

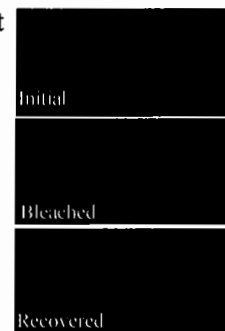
**Impact of confocal microscopy:** For both projects, 4D confocal imaging of  $\alpha$ -tubulin::GFP would allow visualization of the entire microtubule network and quantification of changes in gross morphology and distribution throughout the epidermis, while EBP-2::GFP imaging will allow us to determine microtubule growth rates in different epidermal cells. We can also analyze cell polarity, localization of MAPs, colocalization of MAPs with each other or microtubules, effects on other cytoskeletons, and how all of these might change over time. The Andor BC43 multipoint confocal microscope is a critical tool for these and future live imaging projects due to the low photobleaching, low phototoxicity, and the highly sensitive camera that can detect low-level signals during live imaging.

**II. Project Title:** Identifying mechanisms of synaptic development at the *Drosophila* NMJ

**Principal Investigator:** Brett A. Berke, Ph.D., Associate Professor of Biology, Truman State University

**Impacted Students:** 74 Truman undergraduates since 2015 (46 women, 28 men; 2 McNair Scholars); average of 14.6 students per year for an average 3.2-semester long independent project.

**Description:** The larval neuromuscular junction (NMJ) of *Drosophila* is a robust model for characterizing molecular mechanisms of synaptic development.<sup>39,40</sup> After learning a simple filet dissection and immuno-staining protocol, TSU undergraduates take advantage of the stereotyped innervation of the larval NMJ to study the molecular mechanisms during independent experiments. *Drosophila* offers well-characterized genetic mutations and numerous transgenes that can be expressed in presynaptic motoneurons and/or postsynaptic muscles after a simple genetic cross. Synapses between these identified cells can then be viewed with confocal microscopy. The movement of fluorescently-tagged organelles is tracked in live-dissected preparations, while fluorescent staining allows pre- and post-synaptic molecules to be imaged at high resolution. Previous microscopy experiments have shown that bi-directional signaling, in both directions across the NMJ, influences synaptic structure. In the anterograde direction, neuronal activity modulates the number of synaptic boutons<sup>39</sup> and the amount of glutamate released from motoneuron terminals. Mitochondria that arrive at these developing terminals provide energy for glutamate release, repolarization of presynaptic terminals, and redox signaling.<sup>41-43</sup> In the retrograde direction, bodywall muscles release a bone morphogenetic protein (BMP) that modulates presynaptic transcription to 'permit' normal and activity-dependent NMJ expansion during development.<sup>39,40</sup> The projects outlined below further explore these mechanisms of bi-directional growth regulation.



**Figure 2.** An example of mitochondrial FRAP. Top, initial fluorescence in two nerves. Middle, same field, fully bleached, 30min later. Lower, same field, recovered with new fluorescent mitochondria, 20min later.

### 1) Do *Cyp1* Mutations Alter Mitochondrial Transport or Localization?

Cyclophilin 1 (*Cyp1*) is the *Drosophila* homologue of mammalian CypD, a mitochondrial chaperone that regulates redox signaling and cell death by opening a large-conducting, mitochondrial pore.<sup>44</sup> Research students in my lab have identified *Cyp1* as a regulator of larval crawling behavior (in preparation); *Cyp1* mutations increase larval searching behavior (consisting of a pause in forward crawling, followed by head swinging and continued crawling). To understand the synaptic mechanisms of this phenotype, we measured NMJ size in a *Cyp1* mutant, finding an increased number of synaptic boutons (Mean±SEM; Control, 48±1.6; mutant, 54±1.8, n=12-15; p < 0.05). In mice, CypD-expressing mitochondria are more common at synapses.<sup>45</sup> We cannot ask a similar question at the larval NMJ since the necessary antibodies do not exist. Instead, we are asking whether *Cyp1* mutations alter the transport or synaptic localization of mitochondria, in general.

Using the bipartite GAL4-UAS expression system of *Drosophila*, we are expressing GFP in the mitochondria of motoneurons.<sup>43</sup> Images of mitochondria collected with our current confocal system using fluorescence recovery after photobleaching (FRAP, with a Xenon lamp) verifies that active mitochondrial transport occurs within larval nerves (Figure 2). However, the lack of a functional 488nm laser limits our ability to photobleach small regions of peripheral nerves, and the system's poor spatial resolution limits our ability to identify and track mitochondria in nerves and presynaptic boutons. Four-dimensional confocal imaging will enable us to photobleach smaller nerve regions and terminal branches, providing better spatial resolution for identification and localization. *Three students will acquire high magnification images of mitochondrial GFP.*

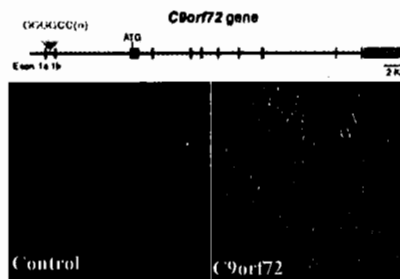
### 2) Characterizing how c9ORF72 mutations alter pMAD nucleocytoplasmic transport

Mutations in the *chromosome 9 open reading frame 72 (c9orf72)* gene of *Drosophila* produce toxic proteins. Hexanucleotide repeats (GGGGCC, G<sub>4</sub>C<sub>-2</sub>) within the gene's first intron (Fig. 3, top)<sup>46</sup> are normal, yet large expansions stimulate repeat associated non-ATG (RAN) translation [the most toxic contain proline-arginine (PR) and Glycine-arginine (GR)].<sup>47</sup> Expression of PR and GR proteins alter synaptic development but exactly how this occurs is not known.<sup>48-50</sup> Expression in the adult eye shows that

the proteins suppress nucleocytoplasmic transport<sup>47,48,51-53</sup> by physically blocking nuclear pores,<sup>54,55</sup> something that may also occur in motoneurons.

In fact, we observed that mutant proteins may cause the nuclear exclusion of an important growth factor for NMJ development (phosphorylated Mad, pMad; Fig. 3, bottom). pMad-dependent transcription is downstream of a bone morphogenetic protein (BMP) signal, which connects single muscle fibers with the nuclei of motoneurons.<sup>39,40</sup> When presynaptic transcriptional modulation by pMad is suppressed during *Drosophila* development, NMJ size is reduced to a similar extent as with *c9orf72* mutations.<sup>39</sup> This similarity led to our hypothesis that pMAD contributes to smaller synapses in *c9orf72* mutants. Our current imaging system was able to identify the nuclear exclusion of pMAD, but the BC43 system will greatly improve our ability to quantify the time-course of pMad's transport blockade.

Transgenes containing di-peptide repeat proteins will be expressed in motoneurons at experimentally-controlled times using the GeneSwitch modification of the GAL4-UAS system.<sup>56-58</sup> GeneSwitch uses a modified GAL4 molecule that requires methipristone (RU486) for binding to UAS sites and for activating transgene expression. Transgenes are expressed only when RU486 is delivered through the food or by larval bathing. The GS-GAL4-UAS system is currently used in the Berke lab, and I have extensive experience applying it in studies of NMJ development and pMad signaling.<sup>39</sup> Toxic C9orf72 proteins (with 36 and 100 repeats) will be expressed throughout larval development to verify our initial finding of pMAD nuclear exclusion (Fig. 3, bottom). We will then induce mutant protein expression by larval bathing, followed by pMAD imaging in fixed/stained preparations at different times over the next 8 hours.<sup>57</sup> Confocal microscopy with the Andor BC43 will enable us to quantify the buildup of fluorescence within motoneuron nuclei, using the changing ratio of cytoplasmic to nuclear fluorescence as a metric for nucleocytoplasmic transport defects over time. With this data, we will estimate the rate of Mad import and, potentially, export across the motoneuron's nuclear membrane. *Three students will acquire high magnification images of pMAD and its blocked transport by toxic proteins.*



**Figure 3.** The c9ORF72 gene and the effects of mutant proteins on pMad localization. Top, *c9orf72* structure depicted with the number of G<sub>4</sub>C<sub>2</sub> repeats between exons 1a and 1b.<sup>51</sup> Bottom, fluorescent images of the larval ventral nerve cord showing pMad localization in the nuclei of controls (left) and in the cytoplasm of a c9ORF72 mutant (right).

**Impact of confocal microscopy:** The Andor BC43 imaging system will improve our ability to track mitochondria and pMad within *Drosophila* larval preparations. This system provides high spatial resolution combined with the ability to bleach small areas, which will help us quantify changes in FRAP and fluorescent localization over time. Additionally, the proposed experiments will provide students with rich experiences that integrate genetics and cell biology, enabling them to make hypotheses about cellular and molecular mechanisms involved in synapse development.

**III. Project Title:** Determining the cellular mechanisms of respiratory dysfunction in rats

**Principal Investigator:** Daniela Ostrowski, Ph.D., Assistant Professor of Biology, Truman State University

**Impacted Students:** 20 Truman undergraduates since 2016 (16 women, 4 men); average of 3 students per year for an average 3-semester independent project.

**Description:** The Ostrowski lab is interested in the cellular mechanisms underlying respiratory dysfunction in rats. Brain regions that regulate respiratory functions are located in the brainstem. My focus is on the nucleus tractus solitarius, nTS, which is the first integration site of chemoreceptor input and the major site that modulates respiratory function.<sup>59</sup> Recently, we were able to show morphological changes within the nTS that very likely contribute to respiratory changes.<sup>60</sup> As a next step, we are interested in specific signaling pathways that lead to morphological changes seen in the nTS. Glutamate is the main excitatory



neurotransmitter in the brain and increased levels of glutamate is associated with neuronal dysfunction and cell death.<sup>61</sup> Therefore, we will focus on the glutamate signaling in the nTS and its role in respiratory dysfunction (Project 1). In addition, scientific studies strongly point towards a dysregulation of the brain insulin signaling pathway in synaptic loss and cell death.<sup>62</sup> Application of insulin directly on nTS neurons (via micropipette injection) in anesthetized rats resulted in blood pressure changes,<sup>63</sup> indicating that activation of the insulin signaling pathway directly modulates neuronal activity. Future studies will therefore focus on the function of insulin in the nTS and its contribution to respiratory dysfunction (Project 2).

The projects undertaken in my laboratory are part of a collaboration with Dr. Tim Ostrowski from A. T. Still University (ATSU), Department of Physiology, located here in Kirksville. ATSU provides quality osteopathic medical education in a rich research environment, and collaborations between the two institutes hugely facilitate scholarly activity. Dr. Tim Ostrowski generates the animal model that manifests respiratory dysfunction by intracerebroventricular injections of streptozotocin, STZ. His lab provides the brain tissue needed for my students' projects and we co-mentor both Truman and ATSU students. Our successful collaboration resulted in a NIH Research Enhancement Award (R15) to study the role of oxidative species as underlying mechanisms of respiratory dysfunction. A high-quality confocal fluorescent microscope is necessary to fulfill the requirements of the grant-related projects. Following several demonstrations of currently available microscopy systems, the proposed Andor BC43 benchtop confocal meets all the standards needed for my student's research projects (see description below).

#### 1) Glutamate signaling within the nTS and its contribution to respiratory dysfunction

The nTS is the major integration site of breathing control into the CNS. Using an animal model that shows respiratory dysfunction when challenged with hypoxia, my collaborator and I were able to show morphological changes within the nTS, including synaptic loss, as well as astro- and microgliosis.<sup>60</sup> *Future studies* will use specific antibody markers that highlight elements of glutamate signaling (e.g., transporter on glutamate vesicles: vGluT, glutamate receptor: GluR2, and for glutamate recycling: Glutamate synthetase) to provide a complete understanding of the cellular changes causing respiratory issues. A detailed study for glutamate receptor distribution and its quantitative analysis using the current fluorescent microscope is very difficult. Brain sections are 30  $\mu\text{m}$  thick and fluorescence from outside the focal plane makes cells appear blurry. The Andor BC43 benchtop confocal microscope enhances the level of detail in our data, allowing us to accurately reconstruct a 3D image of nTS cells in combination with elements of the glutamate signaling pathway. Micrographs of stained glia cells were obtained during an Andor BC43 demonstration to illustrate that the system provides the necessary resolution for our planned analysis (Fig. 4A, arrowheads). The advanced Imaris for Neuroscientists software package provided by Andor will simplify data analysis for undergraduate students. In addition, the advanced stitching mode of the Andor system will allow us to capture and stitch high resolution images in a short period of time (Fig. 4B), which will help quantify changes in cell morphology over larger areas of the brain.

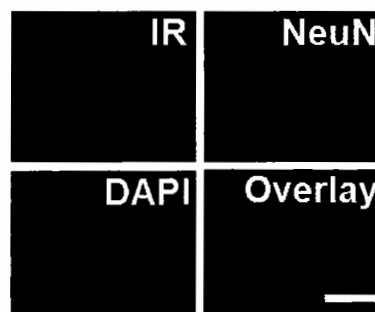


**Figure 4.** Immunohistochemical staining of the nTS (A) and the hippocampus (B) showing neurons in green (anti-NeuN), nuclei in blue (DAPI), and glial fibers (anti-GFAP) in white. Pictures taken with the Andor BC43 confocal microscope. Optical sectioning and image stacks allow for detailed 3D reconstruction of glial fibers (A, arrowheads). Seamless stitched montages of images allows for detailed analysis in large brain areas (B). Scale bar: A = 20 $\mu\text{m}$ , B = 500 $\mu\text{m}$



## 2) The role of insulin signaling in respiratory dysfunction

Insulin is a hormone that is necessary for our cells to utilize glucose, to produce energy. For a long time, the function of central insulin signaling in the brain was unnoticed, because glucose absorption into brain cells is insulin-independent. However, insulin receptors are present in the brain and impairment of insulin signaling causes neuronal death.<sup>64,65</sup> So far, we were able to detect insulin receptors in the nTS (Fig. 5), but because of out-of-focus light, we were not able to detect any insulin receptor expression changes between control and animals with respiratory dysfunction and we were not able to study its specific association within the tissues (e.g., in neurons or glial cells). A new confocal system is therefore necessary to continue this study. In addition, *future studies* are needed to understand the effect of insulin on nTS cell activity using live imaging of brain slices or cultured cells. Insulin application directly on nTS neurons altered their activity,<sup>63</sup> however changes of the insulin signaling pathway in nTS neurons important for breathing have not been studied yet. Using fluorescent dyes that visualize the membrane potential (e.g., FluoVolt™) and calcium (e.g., Fura-2, AM), the neuronal activity and effects of insulin signaling in live brain slices or primary cultured cells can be studied. I have extensive experience with primary cultures of neuronal cells<sup>66</sup> and my collaborator Dr. Tim Ostrowski has experience in generating brain sections for patch clamp recordings where cells stay in network and alive for several hours.<sup>67</sup>



**Figure 5.** Immunohistochemical staining of insulin receptor (red), neurons (green), and nuclei (blue) in the nTS. Scale bar = 20  $\mu$ m.

**Impact of confocal microscopy:** Confocal microscopy is an essential tool for my student's research projects and needed for the qualitative and quantitative analysis of cellular changes associated with respiratory dysfunction. A new system will allow optical sectioning, the ability to analyze up to four fluorescent signals in the same sample, scanning highest-resolution images from large brain areas, and sensitive time-lapse live imaging of neurons in brain slices and/or cultured cells. While other systems may have similar functions, the Andor benchtop confocal microscope is a compact system and easy to operate and therefore preferred for undergraduate research.

#### IV. Project Title: Biofilm formation by *Bacillus subtilis* on plant roots

**Principal Investigators:** Joyce Patrick, Ph.D., Assistant Professor of Biology, Truman State University and Balapuwaduge Hajeewaka Mendis, Ph. D., Assistant Professor of Biology, Truman State University

**Impacted Students:** 21 Truman undergraduates since 2015 (15 women, 6 men; 1 MOLSAMP, 2 STEP Scholars); average of 2-3 students per year, for an average 3.4 semester independent project.

**Description:** The Patrick lab is interested in genetic regulation of multicellular behaviors in the model soil bacterium *Bacillus subtilis* and its relationship to plant-microbe interactions. *B. subtilis* is a member of the plant-growth promoting rhizobacteria, a group of bacteria that colonize plants and promote growth through protection or immune stimulation. *B. subtilis* promotes growth in maize via siderophore production and nitrogen fixation, and in rice via ACC deaminase, among other mechanisms.<sup>68-75</sup> Colonization of plant roots with *B. subtilis* requires both swarming motility and biofilm formation, as well as chemotaxis.<sup>70,71,76</sup>

Swarming is a coordinated bacterial motility that allows rapid migration over and colonization of a surface.<sup>77</sup> Swarming by the undomesticated strain NCIB 3610 requires high cell density and the production of the wetting agent surfactin.<sup>78,79</sup> *B. subtilis* also has the ability to form a biofilm, which results in the aggregation of bacteria on a surface and the production of an extracellular matrix to hold cells in place and form a physical barrier.<sup>80</sup> In the laboratory setting, *B. subtilis* forms a biofilm on the root surface of *Arabidopsis thaliana*.<sup>81</sup> *B. subtilis* colonization of plant roots results in induced systemic resistance (ISR) in the plant, and has been demonstrated in several plant species.<sup>73,82</sup> Surfactin may be partly responsible for stimulation of ISR by *B. subtilis*.<sup>82</sup> In addition, the formation of a biofilm around the root could provide a

physical barrier against other bacterial pathogens that might be harmful to the plant.<sup>69</sup>

Last semester a research student received an internal grant, Grants in Aid of Scholarship and Research, from the Office of Student Research at Truman State University to pilot the protocols for growing seedlings and culturing *B. subtilis* biofilms on the seedlings.

**1) *B. subtilis* biofilm formation on Maize and Alfalfa (*Medicago sativa*) roots in the presence of pesticides**

While the impact of pesticides on the composition and metabolic activities of soil microbial communities have been studied,<sup>83-85</sup> the impact of pesticides on bacterial behavior are missing. The Patrick lab has recently investigated the effects of pesticides on *in vitro* swarming motility and biofilm formation, which are both required for plant growth promotion. We found that addition of the organic pesticide Neem oil to both *in vitro* floating biofilm pellicle assays and surface biofilm assays altered biofilm pattern, and at high concentrations, slowed biofilm formation. In addition, we found that both pyrethrin and the organophosphate pesticide malathion inhibited floating pellicle biofilms. All three pesticides significantly reduced biofilm formation in quantitative assays.<sup>86</sup>

In order to better understand the potential effects of pesticides on biofilm formation and the plant growth promoting ability of *B. subtilis*, we will image biofilm formation on the roots of *maize* and *alfalfa* (*Medicago sativa*) in the presence of Neem oil, pyrethrin, and malathion. Dr. Mendis has expertise in culturing *Bacillus* biofilms on seedling roots<sup>87</sup> and will aid in developing protocols for inoculation and growth of *B. subtilis* biofilms. Other labs have successfully used laser-scanning confocal microscopy to track the development of *B. subtilis* biofilms on the roots of *A thaliana* in real time.<sup>72,88,89</sup> We will use confocal microscopy to examine the colonization of fluorescently labeled *B. subtilis* on maize and alfalfa plant roots after treatment with pesticides. Our previous work tested the impact of pesticides applied at the manufacturer's recommended dilution, along with 10-fold and 100-fold dilutions. We will inoculate seedling roots with *B. subtilis* and treat the samples with either no pesticide or one of the three dilutions, and we will monitor biofilm formation intermittently over the course of a week to track biofilm development. Due to the thick nature of the biofilm, the Andor BC43 confocal microscope will allow us to better analyze the mature biofilm. We will also use fluorescent reporters (fused promoters) for the genes for surfactin production (*urfA*), swarming motility (*swrA*), and biofilm matrix production (*sipWtasA*) to determine the expression state of these genes within cells at various positions in the biofilm. Cell counting software in the Imaris software package will allow quantification of fluorescent cells.

**Impact of confocal microscopy:** Confocal microscopy allows for the assessment of both biofilm distribution on the plant root and biofilm thickness, which would otherwise be impossible. The Imaris software package that accompanies the Andor system will allow for cell counting within the biofilm.

**V. Project Title:** Investigating the importance of biofilm formation in legume-rhizobia symbiosis.

**Principle Investigator:** Balapuwaduge Hajeewaka Mendis, Ph.D., Assistant Professor of Biology, Truman State University

**Impacted Students:** 2 Truman undergraduates since 2022.

**Description:** Mendis lab investigates the importance of biofilm formation in legume-rhizobia symbiosis. Exopolysaccharide succinoglycan is critical for the symbiosis of rhizobia bacteria *Sinorhizobium meliloti* 1021 and model legume plant *Medicago truncatula*.<sup>90,91</sup> Recent studies have shown that low molecular weight (LMW) fraction of succinoglycan and succinyl group of succinoglycan of *S. meliloti* are important for infection thread formation and symbiosis.<sup>92,93</sup> However, the mechanism of how succinoglycan facilitate infection thread formation or how bacteria survive inside the infection thread is not understood. *S. meliloti* succinoglycan mutants show varying degrees of symbiotic defects on *M. truncatula*.<sup>92,93</sup> Our hypothesis is that *S. meliloti* succinoglycan facilitate biofilm formation of bacteria and improve initial attachment of bacteria to the host plant root hairs and survival of bacteria inside infection threads. Detailed characterization of biofilm formation of *S. meliloti* succinoglycan mutants and comparing their symbiotic

phenotype will explain what characteristic of succinoglycan facilitate biofilm formation of *S. meliloti* and improve initial attachment and survival of bacteria during symbiosis.

**1) Characterization of biofilm formation of *S. meliloti* succinoglycan mutants *in vitro* and on *M. truncatula* plant roots.**

*S. meliloti* exoY mutants do not make any succinoglycan whereas exoH mutants make succinoglycan without succinyl groups.<sup>93,94</sup> Both exoY and exoH mutants are completely defective in symbiosis with *M. truncatula*. *S. meliloti* exsH and exoK mutants make less LMW succinoglycan compared to wild type. However, only exoK mutants have a slight symbiotic defect in *M. truncatula*.<sup>92</sup> Double and triple mutants exoHK and exoHK:exsH make only high molecular weight succinoglycan without succinyl groups and both mutants are completely defective in symbiosis.<sup>93</sup> We will be analyzing biofilm formation of *S. meliloti* wild type and succinoglycan mutants *in vitro* and on *M. truncatula* root hairs. Biofilms will be stained with LIVE/DEAD® BacLight® viability kit and analyzed with confocal microscopy to quantify biofilm formation and survival of bacteria within the biofilm.

**Impact of confocal microscopy:** Confocal microscopy allows the quantification of biofilm formation and survival of bacteria within the biofilm *in vitro* and on *M. truncatula* plant roots, as well as assessing biofilm thickness and topology.

MRI PI/co-PI	Institution	Department	Research Topic(s)	Number of Current Trainees	Funding	Usage
Stephanie Maiden	TSU	Biology	<i>C. elegans</i> embryonic development	7 undergrads	TSU	Daily
Brett Berke	TSU	Biology	NMJ development in <i>D. melanogaster</i>	6 undergrads	TSU	Daily
Daniela Ostrowski	TSU	Biology	Respiratory dysfunction in rats	9 undergrads	NIH R15; TSU	Daily
Joyce Patrick	TSU	Biology	<i>B. subtilis</i> biofilm formation	5 undergrads	TSU	Weekly
B. Hajee Mendis	TSU	Biology	<i>S. meliloti</i> biofilm formation	2 undergrads	TSU	Weekly
<b>Auxiliary Users</b>						
Shanu Markand	ATSU	Anatomy	Age related macular degeneration	2 masters and 3 DO students	NIH/NEI	Monthly
Keith Elmslie	ATSU	Pharmacology	Receptors involved in generating muscle pain	2 masters and 6 DO students	ATSU	Monthly
Suhail Akhtar	ATSU	Biochemistry	Intestine inflammation	2 masters and 3 DO students	ATSU	Monthly

**Table 1.** Major and minor users of the proposed instrument at Truman State University (TSU) and A.T. Still University (ATSU).

### **Current and Potential Funding Sources**

Mentees of the PI team routinely receive funding for their research projects through Truman's Office of Student Research. Two main competitive programs exist for student-written proposals: GIASR and TruScholars. GIASR funds student research for fall, spring, and summer semesters, while TruScholars funds summer semesters as an 8-week intense/full time research program that includes additional professional development workshops and a research symposium. The faculty themselves have also received funding through the Office of Student Research (Interdisciplinary Research Community Grants), the Office of Academic Affairs, and the Department of Biology. In total, the PI team and their students have received more than \$65,000 in Truman support over the last 7.5 years, which has been sufficient to purchase consumables for student research projects, to pay publication fees, to pay some stipends, and for travel to scientific conferences.

For external funding, projects undertaken by Dr. Ostrowski's students received a collaborative NIH Research Enhancement Award (R15) with the title "Respiratory dysfunction in Alzheimer's disease and its link to oxidative damage within the brainstem" (Proposal No. 1R15AG065927-01; \$385,478; start date: 02-2021). This award supports the material and personnel cost for the project, but does not support new equipment as proposed. Drs. Maiden and Berke have also submitted NIH AREA/R15 proposals that were unfunded but both are planning for resubmissions where confocal microscopy will provide critical preliminary data.

In addition to the NIH R15 program that is geared toward predominantly undergraduate institutions, there are also several NSF funding programs that are suitable for the research described here, including Research in Undergraduate Institutions (RUI) and investigator-initiated proposals to the Division of Molecular and Cellular Biosciences.

### **Results From Prior NSF Support**

Dr. Maiden is a co-PI of a current NSF S-STEM grant (award # 1742289; \$999,914.), "A scaffolded learning community to increase self-efficacy and persistence in STEM", which provides scholarship, academic, and professional support to STEM students within the STEP Scholars program. Because these students are required to have unmet financial need to receive a scholarship, many first generation and other underrepresented students are supported by this program. Through scaffolded courses focused on STEM research, including a student-organized interdisciplinary research seminar, we hope to increase the ability of these students to see themselves as scientists and thus persist to graduation. The grant is in its fifth year (period of support: 2018-2023). A recorded presentation of this project was given at the 2021 S-STEM Virtual Fall Forum and later accompanied by a small group discussion, and a poster was presented at the 2022 S-STEM Symposium in Washington, DC.

### **Dissemination of Results**

According to Truman's Office of Student Research, 31% of our undergraduates participate in research during their collegiate career.<sup>95</sup> The most accessible avenue of dissemination for the majority of these students is Truman's annual Student Research Conference (SRC). With no formal classes held during this one-day event in the spring, SRC 2022 boasted 236 research presentations across oral, poster, and alternative presentation formats. Of those, 34.7% were students in Biology and Biochemistry and Molecular Biology and 6.7% conducted research with the PI and co-PIs of this proposal.<sup>96</sup>

In addition to the SRC, many Biology student researchers present at regional scientific meetings. Numerous Truman undergraduates have given poster presentations and talks about their research at the annual Interdisciplinary Biomedical Research Symposium hosted by ATSU in Kirksville, MO (one student from PI team winning first-place undergraduate poster prize in 2021). Students have also presented at National Conferences on Undergraduate Research, the 2019 Society for Neuroscience meeting (Chicago), the 2017 and 2019 Developmental Biology Symposiums at the University of Minnesota (one student from PI Team winning first-place undergraduate poster prize in 2017), and the 2020 Experimental Biology conference.

In addition, Truman Biology faculty often give invited research talks and travel to larger, national scientific conferences to disseminate the current work from their labs. Drs. Maiden and Berke have given invited talks twice at ATSU and Dr. Patrick once. Dr. Berke has also given a research seminar at Missouri University of Science and Technology, two Society for Neuroscience meetings, and a Gordon Research Conference on "Modulation of Neural Circuits and Behavior". Dr. Patrick was an invited speaker at Illinois Wesleyan University and was the keynote speaker at Indiana University's Annual Microbiology Retreat. Dr. Maiden was an invited virtual speaker at Regis University and routinely attends and presents at the biannual International *C. elegans* Meeting. Dr. Ostrowski was an invited speaker to the 13<sup>th</sup> Göttingen Meeting of the German Neuroscience Society.

Peer-reviewed, published manuscripts are the ultimate goal of faculty conducting research at Truman. The PI and co-PIs of this grant have published several papers with Truman student co-authors. Confocal microscopy was instrumental for Dr. Berke's publication in *Developmental Neurobiology*<sup>40</sup>, and he recently published a behavioral study in *microPublication Biology*.<sup>93</sup> Dr. Berke is also preparing a manuscript for submission to *Impulse*, a premier undergraduate neuroscience journal where he already has one publication.<sup>94</sup> Dr. Maiden has two publications in *microPublication Biology*<sup>95,96</sup> and one in *Developmental Dynamics*.<sup>27</sup> Dr. Patrick has published in *Access Microbiology*<sup>87</sup> and *Transactions of the Missouri Academy of Science*.<sup>97</sup> Dr. Ostrowski has had two recent manuscripts, one in the *Journal of Alzheimer's Disease* and one in *Brain Research*.<sup>60,98</sup> The PI and co-PIs on this grant plan to use all of these tools to further disseminate their research activities to others.

### **Institutional Commitment to Diversity and Inclusion**

Truman is part of a Missouri consortium that was awarded an NSF Louis Stokes Alliance for Minority Participation (MOLSAMP) grant in 2015 with a renewal submitted November 2022. The goal of this funding opportunity is to increase the numbers of baccalaureate and graduate degrees in STEM awarded to historically underrepresented groups. Truman's Center for Diversity and Inclusion supports our community by providing a literal safe space for students, training for faculty (e.g., Safe Zone), and resources for students. Furthermore, last semester our university developed and offered a free online course for faculty and staff: Introduction to Diversity, Equity, and Inclusion. Dr. Patrick has finished this course and other co-PIs on this grant plan to do so in the next year.

### **DESCRIPTION OF THE RESEARCH INSTRUMENT AND NEEDS**

#### **Confocal microscope**

Funds are requested to purchase an Andor BC43 Benchtop Confocal Microscope, a multipoint confocal that boasts speeds 10x faster than point-scanning systems while still maintaining resolution. The sCMOS detector has an 18.4 mm diagonal field of view, 82% quantum efficiency, and is 4.1 MP (6.5 um pixel, 16-bit) or 2048x2000 pixels. This highly sensitive detector allows for short exposures, and thus reduced photobleaching, and exhibits a high dynamic range to capture weak and bright signals in the same image without saturation. All of this will allow for fast, high-resolution, multidimensional imaging across our different model organisms, as well as a low incidence of photobleaching and phototoxicity during live imaging as evidenced during our recent demonstration. In addition to confocal imaging, the instrument is also capable of brightfield, differential phase contrast, and widefield imaging, as well as combinations of these methods. For example, being able to use both fluorescent confocal and differential phase contrast imaging is advantageous in *C. elegans* embryos for determining the stage of development or which specific cells or tissues may be expressing a fluorophore. The entire confocal microscope is enclosed in a box, so no dark room is required. Its small size and built-in anti-vibration mechanism also means it can fit almost anywhere. In training undergraduate scientists, the software-driven system will reduce mishandling that may damage objectives, light sources, etc. The microscope will be equipped with a variety of objectives, including those that provide lower magnification (2x and 10x/0.45), and those with higher magnification, apochromatic corrected, and high numerical aperture (20x/0.75, 60x/1.4, 100x/1.40). Excitation lines

include 405, 488, 561, and 638 nm, with emission filters for common fluorophores (DAPI, GFP, mCherry, Cy5), as well as a broad-spectrum visible light LED.

### **Software**

The Fusion acquisition software makes the instrument capable of multi-modal, multi-channel, and multi-position imaging, maximizing the amount of data acquired in a single session. Fusion also comes with Clearview-GPU deconvolution to remove haze and further increase resolution, and Fusion can create seamless stitched montages due to the more uniform patented Borealis illumination. This is especially useful with large brain slices and the identification and analysis of specific brain regions like in Dr. Ostrowski's project (Fig. 4B).

To keep the Fusion computer free for acquisition, we will also have a separate Imaris workstation that contains the complete analysis software. The *Imaris for Neuroscientists* package contains several modules that allow for all of the main types of analysis each project needs. The *Core* module includes 3D/4D rendering, which will help with embryological and nucleocytoplasmic analysis or studying biofilm formation. *MeasurementPro* allows you to interact and take measurements from detected objects, which is incredibly useful in counting bacterial cells and neurons, determining changes in intensity (nuclear vs cytoplasmic localization), or determining the surface of a biofilm. Using the surface model will also allow us to segment microtubules in order to calculate their length. *TrackLineage* can handle thousands of objects and time points to measure speed and track length (microtubule dynamics) or area and volume (biofilm formation). The *Coloc* module provides qualitative and quantitative analysis of colocalization even through time, which will be critical in examining the colocalization of MAPs with each other or microtubules. *Filament Tracer* can trace filamentous structures, including neurons and dendritic spines, and with the other modules, it can measure lengths, angles, densities, etc. One of the methods within this module may also allow us to trace non-branching structures like microtubules, but this will depend on the resolution in all three dimensions. *Vantage* allows for further plotting and statistical tests, which can provide more power to our analyses. We believe using software that is designed for the data being acquired will be easier for us and our undergraduate students, increasing productivity and publishability.

## **BROADER IMPACTS**

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### **Impact on Current Faculty Research**

Until July 2019 when the spinning disk motor on our confocal microscope failed, the PI and co-PIs of this grant had direct and daily access to a fluorescent confocal microscope. Without a replacement, the sudden breakdown of this instrument has meant that many on-going, confocal-based research projects have had to be shelved or relinquished to collaborators that have the necessary tools. Last semester, we found someone to repair the spinning-disk motor, but our green laser is now dead. Even when the old confocal was working properly (Fig. 1A), the low resolution made it difficult to obtain preliminary data for grants or publication-quality data. Nearby ATSU has an older laser-scanning confocal microscope that they allow us to use for free but it has been unsuitable for live imaging of GFP in *C. elegans* embryos or adults due to the lack of sensitivity and speed. For other uses, Truman faculty have to work around ATSU scientists and coordinate with the facility director, which can limit the amount of available time for imaging. The nearest microscopy core facility is at the University of Missouri – Columbia, 90 miles from Truman. A round trip for a 2-hour imaging session would take at least 5 hours, and at the cheapest hourly rate (\$35 per hour) would cost a minimum of \$9,000 per year not including travel (258 hours of imaging time per year based on recent work). At \$0.50 per mile for travel reimbursement, the number of trips required would cost an additional \$11,610 per year. The time commitment and cost of this option cannot be supported by Truman institutional funds, and gathering the necessary preliminary data to acquire external grant funds to support this option will be severely hampered without a functional confocal microscope on site.

### **Impact on Undergraduate Research Training**

Research labs of Truman Biology faculty are populated by undergraduate scientists. These students often have independent research projects that give them additional experiences beyond learning technical



skills. Truman undergraduates participate at all stages of the scientific process; generating hypotheses, collecting and analyzing data, troubleshooting, and dissemination (see “Dissemination of Results” section). Many students even write research proposals to apply for internal funding through Truman’s Office of Student Research and aid in drafting manuscripts. The robust critical thinking and analytical skills that students gain from conducting independent research makes them more competitive in subsequent careers. Of all graduating Biology seniors from 2013-2018, 44.4% were placed in a graduate program. Of the Biology majors that applied to medical school between 2012-2018, 56% were accepted into an MD or DO program. In a recent alumni survey deployed by the Biology Department, the top three responses for “What experiences as a Truman Biology major best prepared you for your current position?” were “Reading scientific papers” (88.9%), “Lab courses” (63%), and “Conducting independent research” (51.9%). Being able to offer this type of high-impact, often transformative experience is incredibly important to our undergraduates. Between the PI and co-PIs of this proposal, five different model organisms are represented and 146 Truman students (65% women) have already been trained in research since 2015. Previous undergraduates have given over 66 internal research presentations, 11 external research presentations, and are co-authors on 9 peer-reviewed manuscripts. With a new confocal microscope applied to the above research projects, we can continue to offer a diverse array of scholarly experiences to our undergraduates.

### **Impact on Classroom Education**

The Truman Biology Department prides itself on offering a laboratory component with every core and core elective course in the major, as well as with the majority of upper-level electives. Historically, every Biology major has had the opportunity to work with confocal microscopy, albeit briefly. The proposed instrument will allow us to continue that tradition as well as to develop new lab curricula. Our old confocal was not as amenable to student use because it was fairly temperamental, not intuitive to use, and housed in a room that could only fit 5 people at a time. We strongly believe this system is better for classroom use because it does not need a dark room, is largely software-driven, and is capable of multiple imaging modalities. Below are examples of how confocal microscopy has been used in our courses, with additional elective courses being impacted upon funding of this proposal (e.g., Advanced Cell Biology, Cell Signaling, Cell Physiology).

#### **I. BIOL 330 Cell Biology**

**Instructors:** Drs. Stephanie Maiden, Daniela Ostrowski, and John Ma

**Impacted students:** 100 per year (maximum 24 students per lab section)

This course is not only popular as a core elective within the Biology major but also as an elective among non-majors (e.g., chemistry, health science). Many of these students are sophomores with limited laboratory experience, so the goal is to expose them to a variety of common techniques used to study cell biology. As part of the lab curriculum, students spend two weeks completing a fluorescent cell staining module. In the first week, students fix cancer cells (e.g., HeLa) and stain for microtubules, F-actin, and DNA. In the second week, students visualize their prepared slides via fluorescent confocal microscopy. After imaging, students further analyze their data in ImageJ. In the future, this course would like to expand this lab module, possibly with live imaging, and give students a chance to use the instrument themselves. Fluorescent confocal microscopy has become a fundamental tool in cell biology, and student experience in this technique will better prepare them for careers in research and industry.

#### **II. BIOL 362 Embryology and Developmental Biology**

**Instructor:** Dr. Stephanie Maiden

**Impacted students:** 24 students every other year (maximum 24 students per lab section)

This course is offered as an upper-level elective focusing on the molecular mechanisms that drive embryonic development in sea urchins, frogs, nematodes, fruit flies, and chicks. The laboratory curriculum gives students experience in basic embryological techniques as well as in more advanced developmental biology methods. Fluorescent confocal microscopy is the focus of one lab activity where students mount

and image live *C. elegans* containing various transgenes. Some of these transgenes fluorescently label different populations of neurons in adults, cell-cell adhesion proteins in the epidermis of the embryo, germline markers in the gonad, etc., which gives students a sense of the power of fluorescent microscopy across many life stages. Being able to use confocal microscopy is invaluable in demonstrating the spatial organization that exists in an intact 3D animal and further promotes the utility of this tool in developmental biology. In the future, this lab module will be expanded to include imaging of *Drosophila* transgenic embryos and fluorescent staining of *Drosophila* imaginal discs.

#### **Impact on Recruitment of New Faculty and Collaborators**

Drs. Maiden and Berke were certainly attracted to the Biology Department at Truman because there was free use of a fluorescent confocal microscope on site. For both PIs, that instrument was absolutely critical in establishing and maintaining an active research lab at a predominantly undergraduate institution without major external grant support. There are two ongoing tenure-track faculty searches in Biology (plant biologist) and Chemistry (biochemistry) at Truman. Any new faculty in cell, development, and molecular biology research will likely need similar instrumentation as fluorescent confocal microscopy has become a fundamental tool in these fields. The four different imaging modalities will also accommodate a wide variety of projects, which will be helpful in recruiting new faculty as users. There are currently three minor users of the instrument from ATSU (Table 1). Because of the multifunctional nature of the Andor confocal system, there is great potential for recruiting additional ATSU users to foster scholarly activity between the two institutions.

#### **Impact on Broadening Participation in STEM**

Truman was one of the top ten public schools listed as a “Best Buy” by the 2022 “Fiske Guide to Colleges” due to its outstanding educational value.<sup>99</sup> Truman was also ranked No. 9 in the top “50 Most Affordable In-State Public Universities” from AffordableColleges.com, the only Missouri school to make the top 10.<sup>100</sup> Part of this is due to Truman’s generous financial aid packages; 97% of students receive scholarships and 50% of students graduate with no loan debt.<sup>1</sup> Because of its affordability and excellent education, Truman attracts many first-generation college students and those with low socioeconomic status. Several programs provide additional academic and financial support to these same students: the NSF-funded STEP Scholars program, the U.S. Department of Education-funded Ronald E. McNair program, and the MOLSAMP program. All of these programs aid in student retention and persistence to graduation, as does the mentoring by faculty during independent research projects. The PI team of this grant have trained several research students participating in these programs (5 STEP Scholars, 5 McNair Scholars, and 2 MOLSAMP Scholars) and are committed to continuing those efforts. Between the lab-intensive courses and participation in undergraduate research, the Truman Biology Department provides underrepresented students the skills and confidence to pursue a variety of STEM opportunities, including internships, REUs, and graduate programs.

#### **Impact on Local Community**

Truman is located in Kirksville, MO, a small city of roughly 17,000 people surrounded by even smaller rural towns. Being the largest four-year university for 90 miles, Truman acts as a hub for educational programs for these communities. One such program, the Joseph Baldwin Academy (JBA), provides ~400 students in grades 7-9 the opportunity to live on campus over the summer and take a three-week course from a Truman faculty member.<sup>101</sup> Students attending Dr. Brett Berke’s JBA Neuroscience course will study fixed and live samples, learn about fluorescent confocal microscopy, and understand its importance to scientific knowledge. Additionally, through the Regional Professional Development Center on campus, Truman has hosted grant-funded professional development workshops for K-12 teachers. Typically, ~20 teachers spend the day at Truman learning about a particular technology and career skill focused on the Next Generation Science Standards, and leave with the knowledge and materials necessary to implement the curriculum in their classrooms. In the spring, the teachers reflect on the curriculum implementation, and learn more about careers from experts in the field. Similar content to the JBA course will be incorporated into a teacher professional development workshop model where complementary classroom activities would



include analyzing confocal images virtually.<sup>102</sup> Through these activities, we will increase community awareness of this type of technology and its role in understanding human health and disease.

## **MANAGEMENT PLAN**

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### **Facility Description**

The new fluorescent confocal microscope will be maintained in a dedicated room of Magruder Hall at Truman State University. The 1,575 square-foot *Integrated Microscopy Suite* has ample space for both the instrument, acquisition computer, and separate Imaris software workstation. The large central space these would be housed in can easily fit 20 students in comparison to only 5 students in the separate dark room for the old confocal. This room also has its own heating and cooling system to allow for precise environmental control. The suite also contains dedicated rooms for a scanning electron microscope, a transmission electron microscope, the old confocal microscope, and light microscopy.

### **Operation and Maintenance**

Dr. Stephanie Maiden will be the initial point of contact for the instrument with regard to new users and maintenance issues. The PI and co-PIs will share the load of training new users external to their independent labs (likely less than five hours per semester for each) but training for individuals from specific labs will be done by their respective PI. Hands-on, research-specific training will be supplemented with detailed protocols, online training videos, and quizzes, both for the acquisition and analysis software. The Biology Department Chair has offered a \$3500 summer stipend for each year of the award to fund a faculty member while they create these documents and videos and train new users. While the goal is to train undergraduate students to the point of independence, unmonitored use will only be allowed for those that demonstrate the utmost care, proper technique, and score 100% on quizzes. With proper care and use, the instrument should be easily maintained by the PI and co-PIs of this grant who have extensive experience with fluorescent confocal microscopy. Three years of service is included in the proposed budget, which will cover all parts, labor, help desk, technical support, and preventative maintenance. The School of Science and Mathematics at Truman has also agreed to maintain a service contract on this instrument after the award period ends.

### **Usage**

Anticipated usage of this instrument is expected to be at least 6-fold higher relative to recent usage of our old system. The old system clocked an average of 79 hours each fall and spring semester (158 hours total) and an average of 100 hours each summer, bringing the total to 258 hours per year averaged over four-years (~5 hours/week). Projects in Dr. Maiden's lab have reached a point where fluorescent confocal microscopy is the logical and necessary next step, increasing the weekly load by at least 10 hours. Both Dr. Ostrowski's and Dr. Mendis' positions changed from non-tenure-track to tenure-track in Fall 2021 and Fall 2022, respectively, decreasing their teaching loads while increasing their research loads. Dr. Ostrowski estimates increasing her confocal time to 10 hours/week. Drs. Patrick and Mendis will also be new users of the confocal microscope (~7.5 hours/week) and Dr. Berke anticipates an increase of 6 hours/week over routine imaging. In total, this would increase time on the confocal by a minimum of 33.5 hours/week. To better accommodate the increased usage and users from ATSU, we plan to use Skedda, a free online booking and management tool. Skedda allows five administrators to control hours of operation and who is authorized to book the instrument. For external users, specific days or times for booking will be determined each semester based on Truman faculty availability in order to prioritize their use of the instrument. If necessary, we will also implement a policy where those conducting live imaging need to sign-up at least a week in advance for priority. Skedda will also provide usage data that we can use to assess the number of students using the instrument and which PIs/projects have the heaviest use. In addition, Truman students needing work study or scholarship hours will be employed to manage physical access to the instrument during open hours, and can even be trained to help with basic microscope functions. Use of the new instrument will be free to all users, and additional ATSU research faculty may be recruited if their imaging needs include speed and sensitivity.

Truman State University

Truman SU - Maiden - BC43

Ref: RSINQ1043-02

Quotation Date: 6/22/2023

Valid Until: 10/22/2023



Proposal prepared by

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**Prepared by:** Ryan Robinson

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Dear Stephanie,

As requested, please find a quote for a BC43 with the following objective

10x/0.45 Dry  
20x/0.8 Dry  
60x/1.42 Oil  
100x/1.45 Oil

All the Best,

*Ryan E Robinson, Ph.D.*

Andor Technology

## Truman SU - Maiden - BC43

### Andor Benchtop Confocal Microscope - BC43

1	1	INS-BTCF	<p><b>BC43 Benchtop Confocal Microscope</b></p> <p>Andor BC 43 Benchtop Confocal Microscope. Including 2x objective and joystick for motorized sample positioning. Equipped with: Brightfield and Differential Phase Contrast transmitted white light illumination, widefield epifluorescence for low-light imaging and patented Borealis™-illuminated multipoint confocal for fast high-contrast 2D &amp; 3D imaging. Includes built-in vibration management, dual function Focus Seek and Lock™. Excitation lines 405nm, 488nm, 561nm &amp; 638nm, and emission filters for commonly used fluorophores such as DAPI, GFP, mCherry, CY5. 4.1 MP (6.5µm pixel, 16-bit) sCMOS camera up to 82% QE. 18.4 mm field of view. Workstation: 6 Core, 18M Cache, 3.3GHz up to 4.8GHz; 64GB RAM; 512GB SSD Boot drive; 8GB Graphics card, 2TB Data storage; Windows 10 operating system. Software: Fusion BC43 acquisition software for multi-dimensional experiments in 2D, 3D, time series, multi-field, multi-well and large area montage with image stitching. Renders 3D images in real-time as a volume. Includes ClearView GPU™ for enhanced resolution images with reduced sample background. Imaris for BC43 for high-quality snapshots, movie creation, isosurface reconstructions, 2D point-to-point measurement and Imaris Arena for image management. Imaris license supplied on the PC, but can be moved. Imaris Measurement Pro also included for use on another suitable designated PC. Price includes 12 months full warranty, software updates and access to support desk.</p>	US\$181,980
2	1	BC43-IQ	<p><b>BC43 Confocal Onsite Installation</b></p> <p>Onsite installation of the Andor BC43 Benchtop Confocal, including familiarisation training.</p>	US\$0
3	1	CAB-MAINS-CAN-USA-2M	<p><b>Mains Cable Canada/USA 2m IEC C13 Black</b></p> <p>Mains cable for US and Canada</p>	US\$11

### Additional Data Storage

4	1	INS-PC-DRV-4TB	<p><b>4TB Hard Drive for BC43</b></p> <p>BC43 extra data storage (HDD). 4TB hard drive will add capacity to the existing 2TB drive included with the BC43. Up to two drives can be added.</p>	US\$273
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### Benchtop Microscope Objectives

5	1	INS-OBJ-10D-045	<p><b>10X Plan Apo LD Air Object 0.45NA 4.0WD</b></p> <p>10x Plan Apochromat Lambda D objective with 0.45 numerical aperture. Working distance of 4mm.</p>	US\$3,360
6	1	INS-OBJ-20D-080	<p><b>20X Plan Apo LD Air Object 0.8NA 0.8WD</b></p> <p>20x Plan Apochromat Lambda D objective with 0.8 numerical aperture. Working distance of 0.8mm.</p>	US\$3,843
7	1	INS-OBJ-60D-142-O	<p><b>60X Plan Apo LD Oil Object 1.42NA 0.15WD</b></p> <p>60x Plan Apochromat Lambda D oil immersion objective with 1.42 numerical aperture.</p>	US\$8,810



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RSINQ1043-02 6/22/2023

Valid until: 10/22/2023

**Truman SU - Maiden - BC43**

Working distance of 0.15mm.

8	1	INS-OBJ-100D-145-O	100x Plan Apo LD Object 1.45NA 0.13mmWD 100x Plan Achromat Lambda D oil immersion Objective with 1.45 numerical aperture. Working distance of 0.13mm.	US\$8,862
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**System Warranty**

9	1	XS-REV2-000	BC43 Platinum Service Contract - First Year Microscopy 12 Month Warranty Included.	US\$0
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10	1	BC43-PLAT-24MTHS	All Parts & Labour, Software UPg, PM Priority Help Desk, All Parts, Labour, Software Upgrades. 1 X Annual Preventative Maintenance. Excludes Consumables	US\$23,551
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**Shipping**

11	1	CAR	CARRIAGE CHARGE	US\$1,142
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**Imaris for Neuroscientists**

12	1	BPI-UPGRADE	Imaris Core Upgrade to Imaris for Neuroscientists Package This package upgrades will add 5 Imaris modules to the Imaris Core + MeasurementPro license included with the Andor BC43 Confocal system. These modules include: ImarisColoc, Imaris Vantage, Imaris TrackLineage, Imaris XT, Imaris Filament Tracer modules. All include 1 year of maintenance for online training, technical support and version updates.  Includes discount for academic research.	US\$29,400
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13	1	BPI-MAINTENANCE-MUL TI	2 additional years of Imaris maintenance 2 additional years of maintenance coverage for the Imaris for Neuroscientists package for a total of 3 years coverage (1st year is included in license purchase). Includes multi-year discount.	US\$11,348
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14	1	BPI-HARDWARE	Imaris 4D Analysis Workstation This Imaris analysis workstation is configured with the following specifications which are ideal for the reconstruction, visualization and modelling of large 2D/3D/4D microscope images for Cell & Developmental Biology as well as Neuroscience Research. CPU: AMD Threadripper Pro 3.9GHz (16 Core) RAM: 256GB GPU: NVIDIA GeForce RTX 3070 Ti(8GB) Primary HD: 1TB M.2 PCIe SSD Secondary HD: 2TB M.2 PCIe SSD	US\$12,800
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RSINQ1043-02 6/22/2023

Valid until: 10/22/2023

**Truman SU - Maiden - BC43**

QTY	PART #	DESCRIPTION	UNIT PRICE
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Tertiary HD: 8TB SATA3 SSD  
 Windows 10  
 Warranty: Lifetime Labor and Tech Support, 1 Year Parts  
 27" Monitor, keyboard & mouse  
 Shipping & handling included  
 INT REF: 000243064

List Price	US\$285,380
Discount	-US\$1,898
<b>PURCHASE PRICE</b>	<b>US\$283,481</b>

Price does not include tax; if tax exempt, please forward your certificate to [usadmin@andor.com](mailto:usadmin@andor.com)



INVESTOR IN PEOPLE



**ANDOR**

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RSINQ1043-02 6/22/2023

Valid until: 10/22/2023

Please contact me if I can be of further assistance.

This Quotation is made upon and subject to (i) any terms and conditions specified herein, (ii) the attached Andor Technology Inc. Terms and Conditions of Quotation and Sale for Goods and Services and (iii) if applicable, the terms of the relevant Service Plan attached herewith; all of which shall govern any contract entered into between Andor Technology Inc. and a purchaser to the exclusion of any other terms and conditions subject to which any order may be made or purported to be made by a purchaser.



INVESTOR IN PEOPLE

**ITEM K.3  
Engineering Services - HVAC Repair/Replacement Project**

**DESCRIPTION AND BACKGROUND**

Several facilities need heating and cooling upgrades to replace old systems and provide adequate ventilation. HVAC systems in three major buildings are 35 – 45 years old and subject to failure. Cooling towers and chillers would be replaced, as well as air handling units. This project would also provide operational cost-savings via more efficient HVAC units, including replacing obsolete campus central heating plant equipment. As a first step, HVAC improvement engineering design services are necessary.

Qualifications were requested from three engineering firms with expertise in mechanical systems that had previous experience with Truman's systems. Proposals were reviewed by a committee that included Physical Plant and Campus Planning representatives. Based on the quality of recent work at Truman and the proposed engineering team, it is recommended that Henderson Engineers of Lenexa, Kansas, be selected for this project.

**RECOMMENDED ACTION**

BE IT RESOLVED that the proposal from Henderson Engineers to provide engineering services for the HVAC Repair/Replacement Project, with the fees and work for such services to be within the guidelines of the proposal, be approved; and

BE IT FURTHER RESOLVED that the President of the University, or her designee, be authorized to execute a contract with the firm for the project; and

BE IT FURTHER RESOLVED that a copy of the proposal be included as an exhibit with the minutes of this meeting.

Moved by \_\_\_\_\_  
Seconded by \_\_\_\_\_

Vote:	Aye	Nay
Burkemper	_____	_____
Christofferson	_____	_____
Cozette	_____	_____
Dameron	_____	_____
Gingrich	_____	_____
Lovegreen	_____	_____
Miller	_____	_____

**ATTACHMENT**

Henderson Engineers Proposal



# HVAC REPAIR/ REPLACEMENT

Truman State University

September 26, 2023





Henderson Companies | Employee Owned



September 26, 2023

Lori Shook, AUID  
Campus Planning  
Truman State University  
100 E Normal, MC100  
Kirksville, MO 63501

Dear Ms. Shook:

We understand a campus is a community where students live, learn, work, and play — so there's little room for delays and disruption. Henderson Engineers' diverse project experience and prior on-call work will make us a valuable partner. We have found that the most successful approach to higher education projects is to see our firm as an extension of our client's campus services department. We set out to know your facilities and infrastructure as well as the staff responsible for them. From academic and administrative buildings to student unions and university arenas, we'll work hard to ensure your project has the right infrastructure to support the world-changers of tomorrow.

We're passionate about what we do every day because we can see the positive impacts in our community. In addition, we believe the following qualifications set us apart:

**WE HAVE A QUALITY MINDSET** Quality is one lens through which we approach our vision to "be the firm that builds a better world." We work toward our vision through quality relationships with people, service to others, and engineering on our projects. Our quality control process is applied to every project, regardless of its size. With this process at hand, we continually monitor our project's budget, schedule, and client expectations.

**OPEN COMMUNICATION THROUGHOUT DESIGN AND CONSTRUCTION PROCESS** Our success is the product of listening, learning, and growing together. We value honest feedback and the opportunity to discuss any lessons learned and associated action items.

**WE CARE ABOUT THE LIFE OF BUILDING** It's in our nature to seek the most innovative and efficient solutions for our clients and to constantly try to improve our process. Our technical development team is led by our chief technical officer and consists of four pillars (sustainability, BIM/VDC, quality, and innovation), each with their own dedicated directors and staff. This robust structure gives us a vehicle to rapidly implement changes to our design process and quickly incorporate best practice guidelines.

**WE MAKE BUILDINGS WORK** It is no secret lead times for equipment are getting longer and it's putting projects in a tough position to meet owner expectations on schedule and cost. The field expertise of our sister company, Henderson Building Solutions, helps our engineering team develop comprehensive and accurate picture of project cost. Estimates begin with a solid understanding of the scope, current conditions, and an idea of how the project will be constructed. Fortunately, this is something we are ready to face head-on and we are prepared to meet with the University at the earliest possible stage to discuss expectations on both design and construction schedule and costs.

Please do not hesitate to contact me directly at (913) 742-5419 if you have any questions or if we can provide additional information. Thank you for considering Henderson Engineers and we look forward to your response.

Sincerely,

Danny McGrail, PE  
Project Director | Associate  
danny.mcgrail@hendersonengineers.com

# FIRM PROFILE

Henderson Engineers is a national building systems design firm. The systems we design help bring buildings to life by providing air and water flow, lighting, power, and technology integration.

## WE SEE THINGS A LITTLE DIFFERENTLY

We know our work is about more than buildings. It's about the people, experiences, and potential inside. At the core of every project, you'll find us — working with integrity, intelligence, and care. We're as passionate about people as we are about our work, and that unique focus ensures we can meet our clients' needs. Even better, it helps us enhance the experience for the people who use the spaces we help create.

## WE DO THINGS A LITTLE DIFFERENTLY

We are committed to the life of each building. Our view is that no project is ever truly finished, because the building lives on. That means we stay an engaged partner even after the books are closed. When you work with us, your project becomes our project; there's always a solution and we'll work tirelessly to find it. Our technical accuracy, attention to detail, and knowledge of where the industry is headed help drive us to make every project the very best it can be.

Because good design on paper requires great building partners to bring it to life, you'll find construction management and commissioning services from Henderson Building Solutions under our same roof. Together, we're changing the engineering and construction industries and redefining how buildings come to life.

## FOUNDED

1970

## SERVICES

- Acoustics
- Architectural Lighting
- Audio-Video
- Broadcast Services
- Code Consulting
- Commissioning
- Construction Management
- Electrical
- Energy Audit
- Fire & Life Safety
- Mechanical
- Plumbing
- Refrigeration
- Retro-Commissioning
- Security
- Sustainability
- Telecom

## WE ARE HENDERSON



# 1,000+

EMPLOYEES NATIONWIDE

# 250+

PROFESSIONAL ENGINEERS



MEP 2040 COMMITMENT

**HENDERSON WILL BE NET ZERO CARBON ACROSS OUR BUSINESS BY 2040.**

# SPECIALIZED SERVICES

HENDERSON ENGINEERS

## ACOUSTICS

- Architectural Acoustics
- Environmental & Community Noise Control
- Existing Facility Acoustical Assessment
- Expert Testimony
- Industrial & Noise Control
- Noise & Vibration Control
- Sound Isolation

## ARCHITECTURAL LIGHTING

- Computer Generated Lighting Modeling
- Controls Design
- Daylighting Design
- Design Concept Development
- Design Consultation
- Interior, Exterior Facade, & Site Lighting Design
- Lighting Mockups
- Master Plans
- On-Site Aiming & Focusing
- Owner Training
- Peer Reviews

## AUDIO-VIDEO

- Audio-Video Systems Design
- Digital Signage System Design
- Existing System Assessments
- Master Planning & Programming
- Public Address System Design
- Sound Masking System Design
- Systems Commissioning
- Television Distribution (IPTV) System Design

## BROADCAST SERVICES

- Broadcast System Commissioning
- Broadcast Systems for Internet Users & Audiences
- Mobile Production Design
- Post-Production (Edit Suite) Design
- Sports Complex Broadcast Design
- Television Studio Design
- Venue Broadcast Control Room Design
- Venue Broadcast Pre-Wire

## CODE CONSULTING

- Alternate Materials & Methods
- Code Compliance Assessments
- Fire & Life Safety System Commissioning
- Fire & Smoke Modeling
- Joint Commission Statement of Conditions
- Life Safety Surveys
- Performance-Based Design
- Smoke Control Design & Analysis
- Special Inspections
- Third Party & Independent Review

## ELECTRICAL

- Arc Flash Studies
- Emergency Egress Illumination
- Emergency & Standby Power Generation
- Fault Current & Overcurrent Coordination Studies
- Grounding Design
- Lighting Systems & Controls Design
- Lightning Protection
- Medium Voltage Design
- Power Systems Design & Distribution
- Solar & Wind Power Design

## FIRE & LIFE SAFETY

- Clean Agent Systems
- High-Piled Storage Analysis
- Fire Alarm Design
- Fire Pumps
- Fire Sprinkler Design
- Mass-Notification Systems Design
- Smoke Control Analysis & Design
- Standpipe Design
- Water Supply Analysis
- Water Storage Tanks

# SPECIALIZED SERVICES

HENDERSON ENGINEERS

## MECHANICAL

- Alternate Fuel Sources
- Clean Rooms & Laboratory Design
- District Steam & Chilled Water Systems
- Heating & Chilled Water Systems
- Heating, Ventilation, & Air Conditioning
- Humidification Control
- Indoor Air Quality
- Temperature & Controls
- Utilities

## PLUMBING

- Compressed Air Design
- Medical Gas Systems
- Natural Gas Systems
- Potable Water Service
- Sanitary & Storm Systems
- Service Water Heating
- Sustainable Plumbing Solutions

## REFRIGERATION

- Age & Condition Designs
- Energy Efficiency Analysis
- Energy Management Construction Drawings
- Heat Reclaim Analysis
- Prime consulting for Equipment Replacement
- Refrigerant Analysis (HFC, HFO, Natural)
- Refrigeration Commissioning
- Refrigeration Construction Drawings
- Refrigeration Electrical Design

## SECURITY

- Electronic Security System Engineering
- Life Safety Code Compliance Evaluations
- Operational Planning for Building Security
- Security Systems Commissioning
- System Assessments (Installation & Operation)
- System Expansion
- System Fault Tolerance Evaluations
- System Planning
- System Retrofit & Modernization

## SMART BUILDING SYSTEMS

- Controls Master Planning and Audits
- Infrastructure Audits
- Levels of Integration Assessment
- Network Controls Consulting
- Peer Review
- Smart Building Systems Consulting
- Smart Building Plan Development

## SUSTAINABILITY

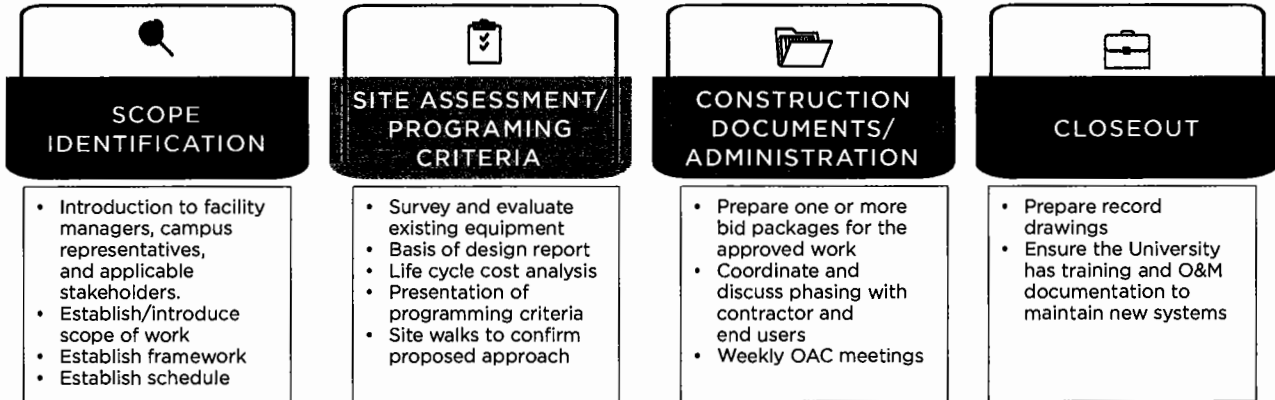
- Carbon Consulting
- Daylight Simulation
- Energy & Water Benchmarking
- Energy Code Compliance
- Energy Modeling
- Envelope Analysis
- LEED & Well Consulting
- Life Cycle Cost Analysis
- Sustainability Master Planning
- Tax-Incentives & Rebate Analysis

## TELECOM

- Consulting for Network Electronics, Servers, Storage, & Operating Systems
- Consulting for Telephony Systems
- Distributed Antenna System Design
- Infrastructure Audits
- Network Consulting
- Outside Plant Design
- Premise Infrastructure Design
- Productivity Software
- Technology Master Planning & Audits
- Telecom Infrastructure Design
- Wi-Fi Configuration Planning

# OUR APPROACH

## OVERVIEW



From our initial kick-off to final construction documents, our team can clearly relay information and options so as to allow the University to visualize and make decisions on the direction of the project. We are flexible to accommodate design adjustments and to find solutions that meet your goals.

### SCOPE IDENTIFICATION

Upon notice to proceed, our first step would be scope identification. The initial kick-off meeting would be to introduce ourselves and include facility managers, campus representatives, and applicable stakeholders. The goal is to establish these items below:

- Establish/introduce point of contacts (POCs)
- Establish/introduce scope of work
- Confirm communication channels, project goals, basis of design requirements and discuss any anticipated challenges that are apparent from review of the surveys and reports or prior experience.
- Establish framework and responsibilities for execution at the consultant and contractor level.
- Establish survey schedule

### SITE ASSESSMENT (PROGRAMMING)

Following scope identification, we will conduct a building condition assessment to become familiar with the building.

We will survey and evaluate the existing equipment, associated building systems, and programming. After our site surveying, we will work with the University and our equipment vendors on developing a basis of design report for consideration. This basis of design will not only highlight baseline like-for-like equipment replacement options, but also equipment enhancements like enhanced

filtration media, infection control strategies, and UV lighting for the University to evaluate and approve prior to proceeding into construction documents.

Henderson Engineers can also present life cycle cost analysis as part of the equipment selection process. This analysis will also include a review of the University's energy usage, an electrical load study, and a utility grid synchronization study to help the University determine how they can further enhance their building system operations. We understand these considerations are cost effective items that can provide significant value to the University over time and is why we see the value on delivering this during the site assessment phase.

### PROGRAMMING CRITERIA

Based upon our observations from the reports, surveys, and our own field observations, we shall prepare and present our understanding of the project needs, goals and objectives and presentation of programming criteria that will include an executive summary, drawings and schedules, and an estimate of probable cost. Ultimately, we look to detail the depth and breadth of the scope at hand and use this confirming step to validate the final project scope and direction.

To the extent that there are different options to be considered, we'd look to present those to you within a virtual meeting at the presentation of the programming criteria documents. This will be the first of several milestone reviews where we will be looking for buy-in from project stakeholders.

We will perform site walks as needed to confirm approach to custom design locations and proposed equipment room configurations. We have found that discussions with end users is far more effective when there is something to review and comment upon. Visualization is critical.

# OUR APPROACH

CONTINUED

## CONSTRUCTION DOCUMENTS

The construction documents phase is where ideas get flushed out. We take in any comments or conditions of approval received from the University regarding the project scoping, building systems, and overall approach in the schematic design phase and incorporate that feedback into the work moving forward. The documents produced are clear, thorough, and well-coordinated for a smooth construction process.

## CONSTRUCTION ADMINISTRATION

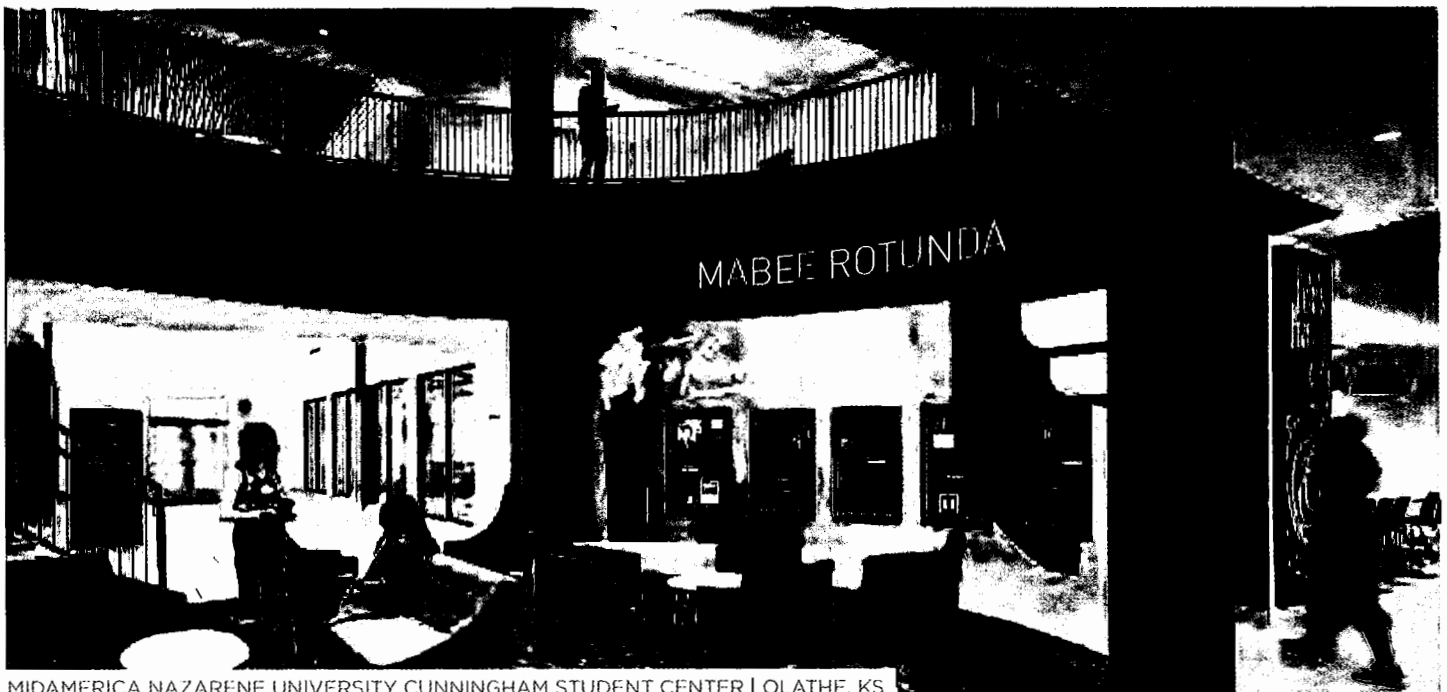
Upon approval of our 100% CD documentation by the University, Henderson Engineers will support the bid efforts. We will perform an initial bid walk with the invited contractors for each project package, respond to bidder questions as they present themselves, and support the University in review of bids. This is all in an effort that will culminate in an awarded contractor, who will be directed to quickly mobilize their construction teams to the project sites. Henderson will host weekly owner, architect, contractor (OAC) meetings with the awarded contractor, the University, and appropriate stakeholders to help inform the University on how project construction is progressing.

This structure helps build accountability across the project team while promoting a single team mentality--we are one team working towards a common goal and it is our responsibility to deliver on that for the University.

## CLOSEOUT

Upon completion of the project, we will prepare record drawings for the University. We will also ensure the University has the appropriate training and O&M documentation necessary for them to maintain their new systems within their operational expertise and guidelines. The closeout package will include these documents as well as any appropriate warranties the University has elected to activate upon substantial completion.

Of course, the closeout phase does not represent the conclusion of the University's services with Henderson. Our core goal is to be your building partner for the life of the building, so Henderson will be available far beyond project closeout to support the University on any needs or questions they may have on any of their new building systems.



MIDAMERICA NAZARENE UNIVERSITY CUNNINGHAM STUDENT CENTER | OLATHE, KS

# ORGANIZATIONAL CHART

TRUMAN STATE UNIVERSITY

PROJECT DIRECTOR



**DANNY MCGRAIL**  
PE  
PRACTICE DIRECTOR

PROJECT MANAGER



**DAV BETTENHAUSEN**  
PE  
PRACTICE MANAGER

LEAD MECHANICAL ENGINEER



**MATT SWABACK**  
PE  
PRACTICE MANAGER

LEAD ELECTRICAL ENGINEER



**JOHN PLACKEMEIER**  
PE  
ELECTRICAL ENGINEER

PRINCIPAL ARCHITECT



**STEVE CRAMER**  
AIA, LEED AP, NCARB  
PGAV ARCHITECTS

PROJECT ARCHITECT



**TIM OVERSTREET**  
RA, LEED AP  
PGAV ARCHITECTS





# DANNY MCGRAIL

PE, LEED AP BD+C  
PROJECT DIRECTOR

Danny is known for his ambition and work ethic. He began his career as a mechanical engineer focused on higher education and science and technology projects. An advocate for quality with a keen eye for detail, Danny takes the time to fully understand how the end users will interact with their space and then develops the engineering systems to meet their current and future needs.

As the project director, he will oversee the project and will be a resource to project team throughout the duration of the project. He uses his passion for innovative environments and his experience in master planning and lab planning to develop the framework for scientific discovery and innovative research.



## EDUCATION

Bachelor of Engineering  
Kansas State University

## REGISTRATION

Professional Engineer: KS  
LEED AP BD+C

## EXPERIENCE

Total: 13 Years  
Firm: 7 Years

## PROJECT EXPERIENCE

**Kirk Building Renovation**  
Truman State University | Kirksville, MO

**Pershing Hall Renovation**  
Truman State University | Kirksville, MO

**University House Improvements**  
Pittsburg State University | Pittsburg, KS

**Weede Fieldhouse HVAC Upgrades**  
Pittsburg State University | Pittsburg, KS

**On-Call Engineering**  
Pittsburg State University | Pittsburg, KS

**HEERF Ventilation Improvements**  
University of Arkansas | Fayetteville, AR

**Jayhawk Welcome Center**  
University of Kansas | Lawrence, KS

**McCain Auditorium Addition**  
Kansas State University | Manhattan, KS

**Templin Hall Renovation**  
University of Kansas | Lawrence, KS

**Elliott Student Union Addition & Renovation**  
University of Central Missouri | Warrensburg, MO

**Henrion Hall Renovation**  
Wichita State University | Wichita, KS

**WRAP Building**  
Arizona State University | Tempe, AZ



# DAV BETTENHAUSEN

PE  
PROJECT MANAGER

Dav has extensive electrical systems design experience and is well versed on construction phases to accommodate any higher education project. As a proactive advocate, he is a key player in bringing about the success of projects. His passions revolve around power distribution and lighting design systems which he hopes leave a lasting impact on the community and people who enjoy these buildings.

As a project manager, he has successfully completed several projects for municipalities, colleges and universities, and knows what it takes to get the job done, and done right.



## EDUCATION

Bachelor of Architectural Engineering  
University of Kansas

## REGISTRATION

Professional Engineer: KS

## EXPERIENCE

Total: 17 Years  
Firm: 8 Years

## PROJECT EXPERIENCE

**Kirk Building Renovation**  
Truman State University | Kirksville, MO

**Pershing Hall Renovation**  
Truman State University | Kirksville, MO

**McCain Auditorium Addition**  
Kansas State University | Manhattan, KS

**Jayhawk Welcome Center**  
University of Kansas | Lawrence, KS

**University House Improvements**  
Pittsburg State University | Pittsburg, KS

**Ellis Dining Hall Renovation**  
University of Central Missouri | Warrensburg, MO

**Templin Hall Renovation**  
University of Kansas | Lawrence, KS

**Teasdale State Office Building - HVAC Modifications**  
Raytown, MO

**McPherson School of Nursing Simulation Hospital Addition**  
Pittsburg State University | Pittsburg, KS

**Carver & Busby Greenhouses**  
Lincoln University | Jefferson City, MO

**Master Plan**  
Kansas City Kansas Community College | Kansas City, KS



# MATT SWABACK

PE

LEAD MECHANICAL ENGINEER

Matt grew up with an interest in floor plans and building design. As his analytical and mathematical skills became apparent the older he got, he decided to pursue an architectural engineering degree. Not long after graduation, Matt started his career as an engineer with Henderson in 2015.

Matt's favorite part of the job is being creative and unique in the solutions he comes up with and seeing all that hard work pay off to bring a project to life. Even though HVAC and mechanical design is not readily apparent to building users, Matt knows just how important it is in keeping people comfortable and safe.



## EDUCATION

Master of Architectural Engineering  
University of Kansas

Bachelor of Architectural Engineering  
University of Kansas

## REGISTRATION

Professional Engineer: KS

## EXPERIENCE

Total: 8 Years

Firm: 8 Years

## PROJECT EXPERIENCE

**Weede Fieldhouse HVAC Upgrades**  
Pittsburg State University | Pittsburg, KS

**Jayhawk Welcome Center**  
University of Kansas | Lawrence, KS

**Darnaby Elementary School HVAC & Lighting Replacement**  
Union Public Schools ISD 9 | Tulsa, OK

**Elliott Student Union Addition & Renovation**  
University of Central Missouri | Warrensburg, MO

**AWSOM**  
Bentonville, AR

**McPherson School of Nursing Simulation Hospital Addition**  
Pittsburg State University | Pittsburg, KS

**On-Call Engineering**  
Pittsburg State University | Pittsburg, KS

**1021 Food Hall Study**  
University of Arkansas | Fayetteville, AR

**University House Improvements**  
Pittsburg State University | Pittsburg, KS

**Seaton Hall School of Architecture, Planning, & Design**  
Kansas State University | Manhattan, KS



# JOHN PLACKEMEIER

PE

LEAD ELECTRICAL ENGINEER

With a passion for solving complicated design problems and seeing plans become reality, John is a trusted electrical engineer. He has worked on a wide range of projects including several city- and county-owned facilities and takes a cost-effective approach to his designs while also keeping energy usage and sustainability at the forefront.

John approaches the design process with a holistic lens. He knows that by collaborating with the entire design team the best design solution can be achieved. Adaptable and willing to learn, he makes a great teammate on any project.



## EDUCATION

Bachelor of Architectural Engineering  
University of Miami  
Bachelor of Civil Engineering  
University of Miami

## REGISTRATION

Professional Engineer: TX

## EXPERIENCE

Total: 11 Years  
Firm: 5 Years

## PROJECT EXPERIENCE

**HEERF Ventilation Improvements**  
University of Arkansas | Fayetteville, AR

**Ellis Dining Hall Renovation**  
University of Central Missouri | Warrensburg, MO

**Templin Hall Renovation**  
University of Kansas | Lawrence, KS

**Mechanical & Electrical Upgrades**  
Pleasant Hill R-3 SD | Pleasant Hill, MO

**Support Services Building HVAC**  
Liberty Public Schools 53 | Liberty, MO

**Lawrence High School**  
Lawrence Public Schools USD 497 | Lawrence, KS

**AWSOM**  
Bentonville, AR

**Nanoscale Material Science & Engineering Building  
Laboratory Upgrades**  
University of Arkansas | Fayetteville, AR

**Barbara Marshall Residence Hall & Wylie Dining Center**  
Kansas City Art Institute | Kansas City, MO

**Student Center Renovation & Addition**  
Graceland University | Lamoni, IA

**Engineering Technology Renovation**  
Metropolitan Community College | Kansas City, MO



# STEVE CRAMER

AIA, LEED AP, NCARB  
PRINCIPAL ARCHITECT

A vice president of PGAV, Steve has 20 years of comprehensive architectural experience, including the planning and design of 21C teaching and learning environments for colleges and universities. Many of these projects have involved the renovation, expansion, and transformation of existing campus buildings and the modernization of building systems and infrastructure serving those buildings to meet modern needs. Steve has successfully designed several technically complex projects on all four UM system campuses, and at Truman State University and Kansas State University, among others.

## PGAVARCHITECTS

### EDUCATION

Bachelor of Architecture  
University of Kansas

### REGISTRATION

Licensed Architect  
LEED Accredited Professional  
NCARB Certification

### EXPERIENCE

Total: 22 Years  
Firm: 18 Years

### PROJECT EXPERIENCE

**Kirk Building Renovation**  
Truman State University | Kirksville, MO

**Pershing Hall North Renovation**  
Truman State University | Kirksville, MO

**Pickler Library Modernization**  
Truman State University | Kirksville, MO

**Baldwin Hall Renovation**  
Truman State University | Kirksville, MO

**McClain Hall Elevator Replacement**  
Truman State University | Kirksville, MO

**Bloch School of Management Renovation and Additions**  
University of Missouri-Kansas City | Kansas City, MO

**Miller Nichols Library Transformation**  
University of Missouri-Kansas City | Kansas City, MO

**Plaster Free Enterprise and Research Center Programming and Bridging Architect**  
University of Missouri-Kansas City | Kansas City, MO

**Spencer Hall & School of Biological and Chemical Sciences Renovation**  
University of Missouri-Kansas City | Kansas City, MO

**Medical School Building Master Plan and Renovations**  
University of Missouri | Columbia, MO

**1st Floor, 7th Floor, and Morgue Renovations**  
University of Missouri | Columbia, MO



# TIM OVERSTREET

RA, LEED AP  
PROJECT ARCHITECT

Tim's architectural abilities range from conceptual design to construction administration for a wide range of building types, including academic, civic, and institutional. He has a strong background in virtual modeling, and leverages BIM extensively in the design and construction administration process. As the project progresses, he will ensure design concepts and client goals are carried through in the details.

Tim excels at clear client communication and design abilities that demonstrate a strong understanding of the realities of the built environment. Tim has served as Project Architect on several projects on the Truman State campus in Kirksville, including the ongoing renovation of the historic Kirk Building.

## PGA V ARCHITECTS

### EDUCATION

Master of Architecture  
University of Kansas  
Bachelor of Architecture  
University of Kansas

### REGISTRATION

Licensed Architect  
LEED Accredited Professional

### EXPERIENCE

Total: 15 Years  
Firm: 4 Years

### PROJECT EXPERIENCE

**Kirk Building Renovation**  
Truman State University | Kirksville, MO

**Pershing Hall North Renovation**  
Truman State University | Kirksville, MO

**Pickler Library Modernization**  
Truman State University | Kirksville, MO

**Baldwin Hall Renovation**  
Truman State University | Kirksville, MO

**McClain Hall Elevator Replacement**  
Truman State University | Kirksville, MO

**Bloch School of Management Renovation and Additions**  
University of Missouri-Kansas City | Kansas City, MO

**Cunningham Student Center**  
MidAmerica Nazarene University | Olathe, KS

**High Density Library Depository Expansion**  
University of Missouri | Columbia, MO

**Fischli-Wills Center for Student Success**  
Fort Hays State University | Hays, KS

**Forsyth Library Renovation**  
Fort Hays State University | Hays, KS

**Parks and Recreation Maintenance Center**  
City of Leawood, Kansas | Leawood, KS

**Thompson Hall Fume Hood Replacement**  
Kansas State University | Manhattan, KS

# ACADEMIC ENVIRONMENTS

SELECT HIGHER EDUCATION PROJECT EXPERIENCE



## ON-CALL EXPERIENCE

**University of Arkansas**  
Fayetteville, AR

**University of Central Arkansas**  
Conway, AR

**Los Angeles Community College District**  
Los Angeles, CA

**University of Southern California**  
Los Angeles, CA

**Kansas State University**  
Manhattan, KS

**Pittsburg State University**  
Pittsburg, KS

**University of Kansas**  
Lawrence, KS

**University of Kansas Medical Center**  
Kansas City, KS

**Wichita State University**  
Wichita, KS

**Metropolitan Community College**  
Kansas City, MO

**Northwest Missouri State University**  
Maryville, MO

**University of Central Missouri**  
Warrensburg, MO

**University of Missouri**  
Columbia, MO

## EXPERIENCE WITH PGAV ARCHITECTS

**EPA KC Lab Renovation**  
Easterly Government Properties | Kansas City, KS  
*Henderson Engineers Led Project*

**Nanoscale Material Science & Engineering Building  
Laboratory Upgrades**  
University of Arkansas | Fayetteville, AR  
*Henderson Engineers Led Project*

**Kirk Building Renovation**  
Truman State University | Kirksville, MO

**Pershing Hall Renovation**  
Truman State University | Kirksville, MO

**University House Improvements**  
Pittsburg State University | Pittsburg, KS

# KIRK BUILDING RENOVATION

TRUMAN STATE UNIVERSITY | KIRKSVILLE, MO



**SIZE**  
15,600 SF

**COST**  
\$16,400,000

**COMPLETION DATE**  
Ongoing

**SERVICES**  
Electrical  
Fire & Life Safety  
Mechanical  
Plumbing

The historic Kirk Building is a central feature of the Truman State University Quad and is one of the oldest and most significant structures on campus. The first level consisted of classrooms and offices and the upper two levels are dedicated to a full-size gymnasium with concrete risers on three sides and a stage at one end. As the campus has grown, this functionality has been duplicated with a new field house and dedicated auditorium spaces. The Kirk Building has sat largely unused for nearly 30 years, and lacks modern mechanical, electrical, and plumbing systems.

The renovation project will transform Kirk into a student success center which houses academic advising, student health clinic, counseling services, a writing center, and a career center. The program also features the Forum: a 250 seat lecture space repurposing the historic stage and proscenium for campus and community gatherings.

All mechanical, electrical, and plumbing system systems will be new from the respective service entrances and fire sprinklers are added to protect the structure. The building is being removed from the campus steam system and new VRF heat pump based HVAC systems will be installed to improve energy efficiency.

# PERSHING HALL RENOVATION

TRUMAN STATE UNIVERSITY | KIRKSVILLE, MO



**SIZE**  
30,000 SF

**COST**  
\$3,500,000

**COMPLETION DATE**  
2022

**SERVICES**  
Acoustics  
Electrical  
Fire & Life Safety  
Mechanical  
Plumbing

Pershing Hall houses the university's Athletics and Allied Health Departments as well as the university's largest arena. The original central structure was built in 1957 and over the years the building added a north wing (1967), south wing (1977), and natatorium (1976). Our renovation work focused on the Health Sciences portions of levels 1 and 2. Spaces include nursing simulation, classrooms, men's and women's locker rooms, restrooms, the athletic training room, dance studio, lobby spaces, a pressbox, and separate administrative and office spaces for athletics.

Infrastructure upgrades were needed due to the useful life of existing systems. Henderson Engineers performed an HVAC analysis for the replacement of the obsolete HVAC systems. We presented HVAC options to the University based on their feedback and requirements. Ultimately a VRF with DOAS HVAC was selected. Hydronic perimeter heat was maintained. Design also included replacement of electrical service, replacement of fire alarm system, installation of fire sprinkler system, and restroom upgrades to meet ADA and code requirements. We worked closely with the design team and University stakeholders to stay within the budget and plan for appropriate phasing. Despite the lack of existing complete and accurate as-builts, Henderson delivered new building systems design within the limited floor to floor height.



# WEEDE FIELDHOUSE HVAC UPGRADES

PITTSBURG STATE UNIVERSITY | PITTSBURG, KS



**SIZE**  
103,000 SF

**COST**  
\$1,600,000

**COMPLETION DATE**  
2022

**SERVICES**  
Electrical  
Mechanical  
Plumbing

*Henderson served as the prime consultant on this project*

Henderson Engineers worked with the university to provide HVAC upgrades to the main university fieldhouse. Originally constructed in 1969, the fieldhouse contains the main competition court for basketball and volleyball and houses the university commencement ceremony. The project provided three grade mounted, high efficiency direct expansion, gas heated rooftop units. The units are connected to large double-wall ductwork distributed across the three courts. Each court has a high volume, low speed (HVLS) fan to assist in destratification and increase thermal comfort through increased air velocity. The new RTUs each have CO2 and humidity sensors for humidity control and ventilation reset. The fieldhouse was previously only heated and ventilated.

Prior to the project, the design team provided a study to determine the most appropriate system type and provide a cost estimate. The final project cost was in-line with the study's cost estimate.

# TEASDALE STATE OFFICE BUILDING HVAC MODIFICATIONS

RAYTOWN, MO



**SIZE**  
2,300 SF

**COST**  
\$500,000

**COMPLETION DATE**  
Est. 2024

**SERVICES**  
Electrical  
Mechanical  
Plumbing

*Henderson served as the prime consultant on this project*

The main dual duct air handler for the building was original to the initial construction in 1973. After various refurbishments and renovations, there were still issues with the HVAC system that caused the facility to operate inefficiently. A commissioning report conducted by the facilities management staff uncovered air handler deficiencies and problems maintaining the building's static pressure.

Henderson Engineers designed HVAC improvements, particularly regarding thermal comfort, reliability, and building pressurization. We designed a new fan array and specified replacement coils to improve the efficiency and thermal performance of the air handler. We designed new outside air and floor isolation dampers to improve the control of building pressurization, and connected all new equipment to the modern Building Automation System. Henderson also designed a new heating hot water system for this air handler, replacing one old boiler with three smaller high efficiency units improving both energy performance and reliability.

# ON-CALL ENGINEERING SERVICES

NORTHWEST MISSOURI STATE UNIVERSITY | MARYVILLE, MO



**SIZE**  
Varies by Project

**COST**  
Up to \$1,200,000

**COMPLETION DATE**  
2018

**SERVICES**  
Electrical  
Fire & Life Safety  
Mechanical  
Plumbing

Henderson Engineers has been the prime consultant for numerous on-call type projects at Northwest Missouri State University since 2014. Some projects completed include a renovation to their dining services area, electrical and fire system upgrades to Martindale Hall, an electrical upgrade to the fine arts facility, and chiller plant upgrades. The electrical upgrades of the Fine Arts facility included electrical main distribution, wiring, and low voltage systems. The project consisted of two phases.

During phase I, our team worked with the university to define scope of work, schedule, and budget with phase II focusing on developing the design, bid documents, and construction administration services. For the University's chiller plant upgrades, our team provided mechanical design services to interconnect four existing cooling towers. During the construction package phase, we evaluated the tower flowrates, make-up water, pressure drop and plumbing; developed photo diagrams for the installation of the interconnection piping and a one-line diagram and control drawings for contractor installation; and provided overall project supervision. During construction administration, our team provided RFI responses, shop drawing reviews, and a final review of the piping installation.

# OLIVE DELUCE FINE ARTS BUILDING ACOUSTICAL STUDY & ELECTRICAL UPGRADE

NORTHWEST MISSOURI STATE UNIVERSITY | MARYVILLE, MO



**SIZE**  
93,000 SF

**COST**  
\$1,525,000

**COMPLETION DATE**  
2019

**SERVICES**  
Acoustics  
Electrical

Henderson Engineers provided the electrical upgrades, which included the electrical main distribution, electrical wiring, electrical devices, and low voltage systems. Completed in two phases, the first phase consisted of a scoping development process completed by our team to define the specific scope of work, schedule, and budget. The second phase included the development of design, bid document preparation, bid assistance, and construction administration services. Henderson also provided an acoustical study for view of historical acoustic concerns for the facility along with recommendations for improvement.

When the initial bids resulted in costs two thirds of the university's budget and state funding, the team quickly identified some additional scope (i.e. lighting upgrades throughout the facility) and issued another construction package to increase the scope to align with the budget.

# HEERF VENTILATION IMPROVEMENTS

UNIVERSITY OF ARKANSAS | FAYETTEVILLE, AR



## SIZE

Old Main  
100,000 SF  
Business Building  
77,000 SF  
Plant Sciences Buildings  
162,000 SF  
Bell Engineering Center  
230,000 SF

## COST

\$7,600,000

## COMPLETION DATE

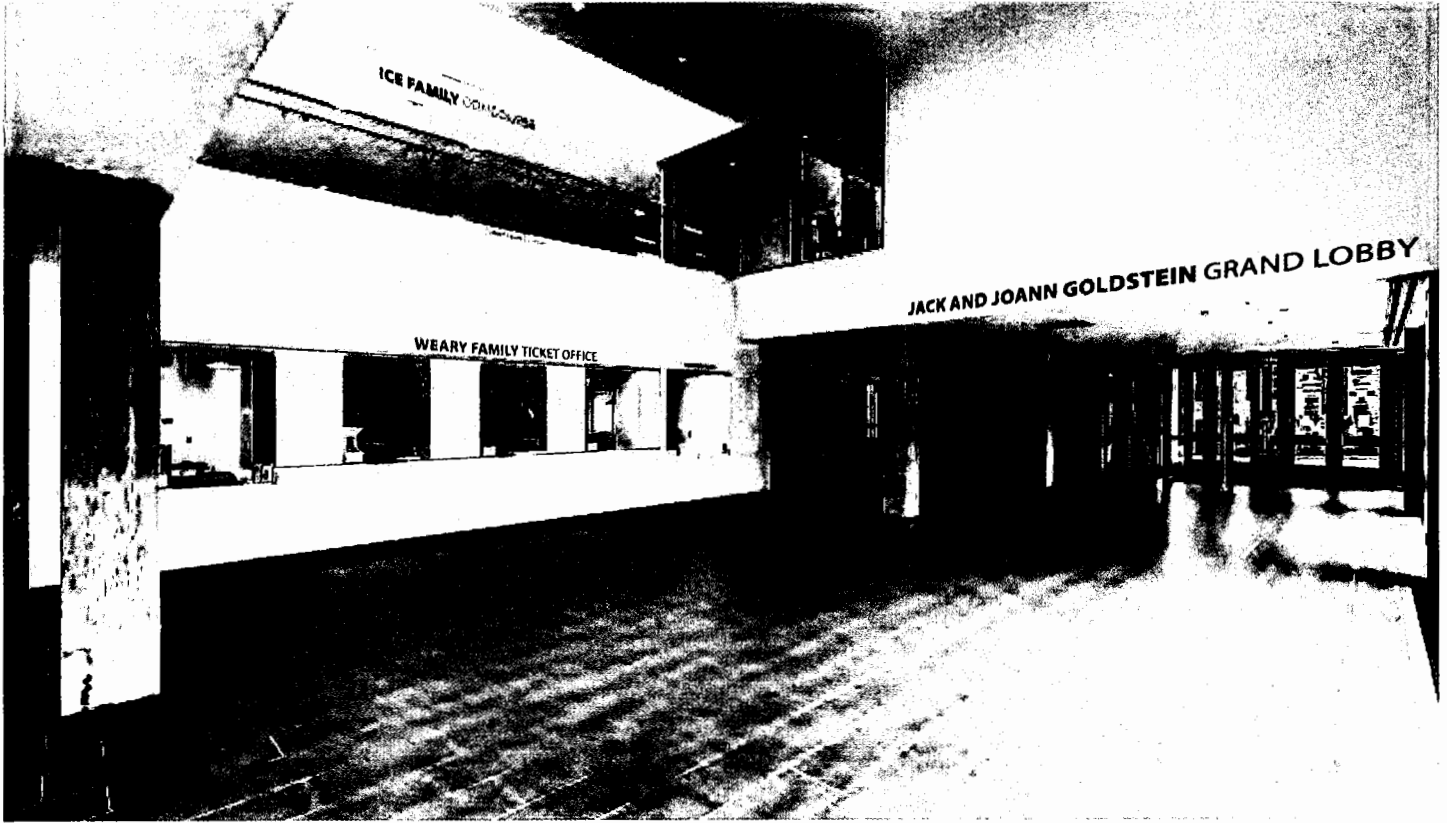
Ongoing

## SERVICES

Electrical  
Mechanical  
Plumbing

The University of Arkansas is being allocated HEERF III funds to upgrade and replace their air handling units (AHU) in classroom buildings. The project prioritized ventilation improvements in four large classroom buildings due to their high use and the fact that they have the oldest mechanical units. The buildings include Old Main, the Business Building, the Plant Sciences Building, and the Bell Engineering Center. Collectively, there are 13 existing AHUs located throughout the buildings.

Henderson Engineers designed the mechanical upgrades to focus on increased ventilation rates, filtration improvements, energy reduction, redundancy of systems, ease of maintenance, and reduced maintenance, replacement of pneumatic controls with direct digital controls, and indoor air quality improvements.



## MCCAIN AUDITORIUM ADDITION

KANSAS STATE UNIVERSITY | MANHATTAN, KS



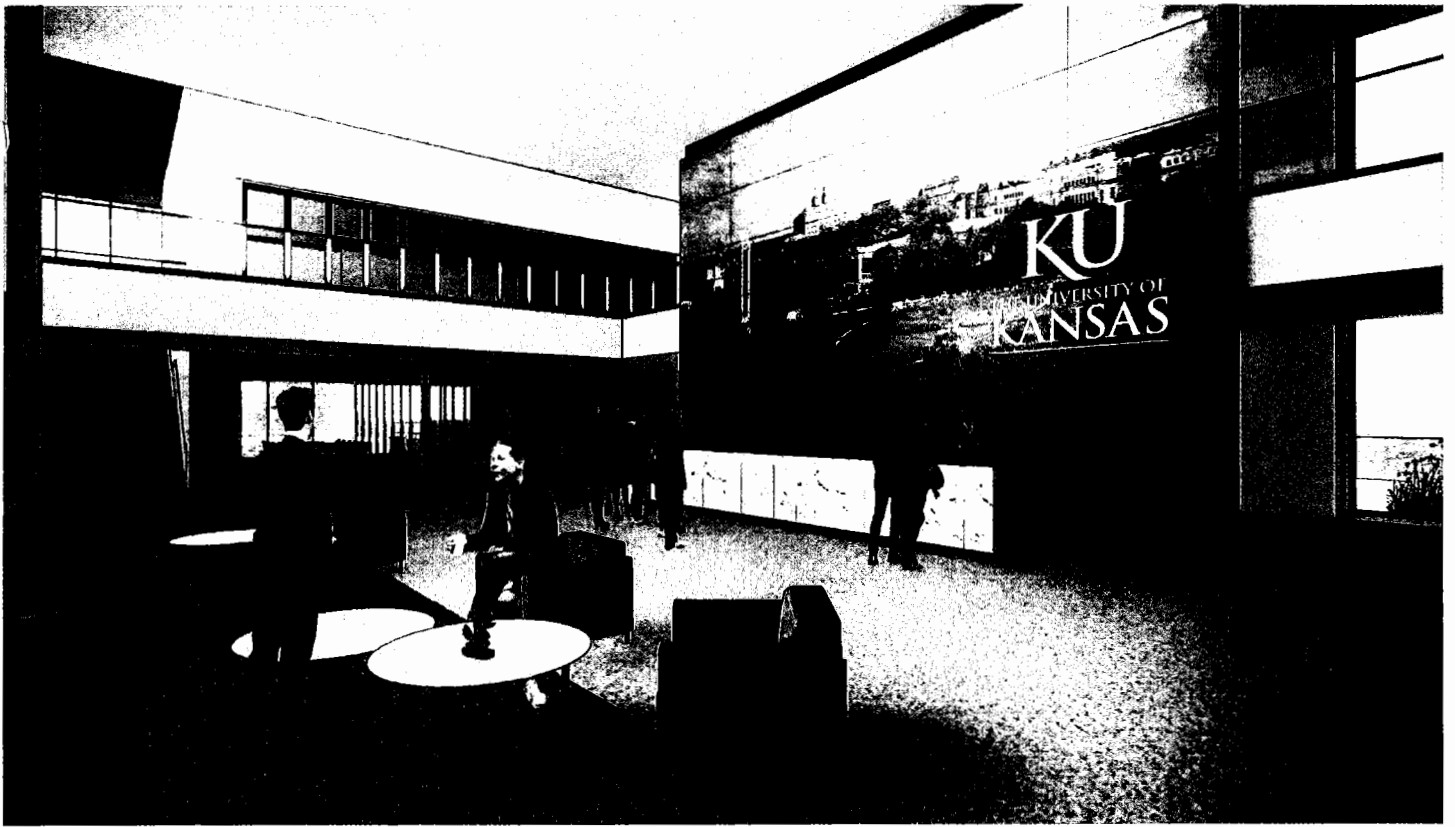
**SIZE**  
20,000 SF

**COST**  
\$6,000,000

**COMPLETION DATE**  
2020

**SERVICES**  
Acoustics  
Electrical  
Fire & Life Safety  
Mechanical  
Plumbing

Originally built in the 1970's, McCain Auditorium continues to be a high-valued venue for Kansas State University and surrounding community. The expansion added a larger lobby area, a bigger box office, two concession stands, and a multi-use space for community events, donor lounge, and collaborative arts education. The restrooms were also expanded and renovated. The addition created visual connections to the quad and new exterior courtyard. Henderson Engineers' design included new mechanical, electrical, plumbing, and fire protection systems along with recommendations for noise control and acoustics.



# JAYHAWK WELCOME CENTER

UNIVERSITY OF KANSAS | LAWRENCE, KS



**SIZE**  
63,555 SF

**COST**  
\$30,000,000

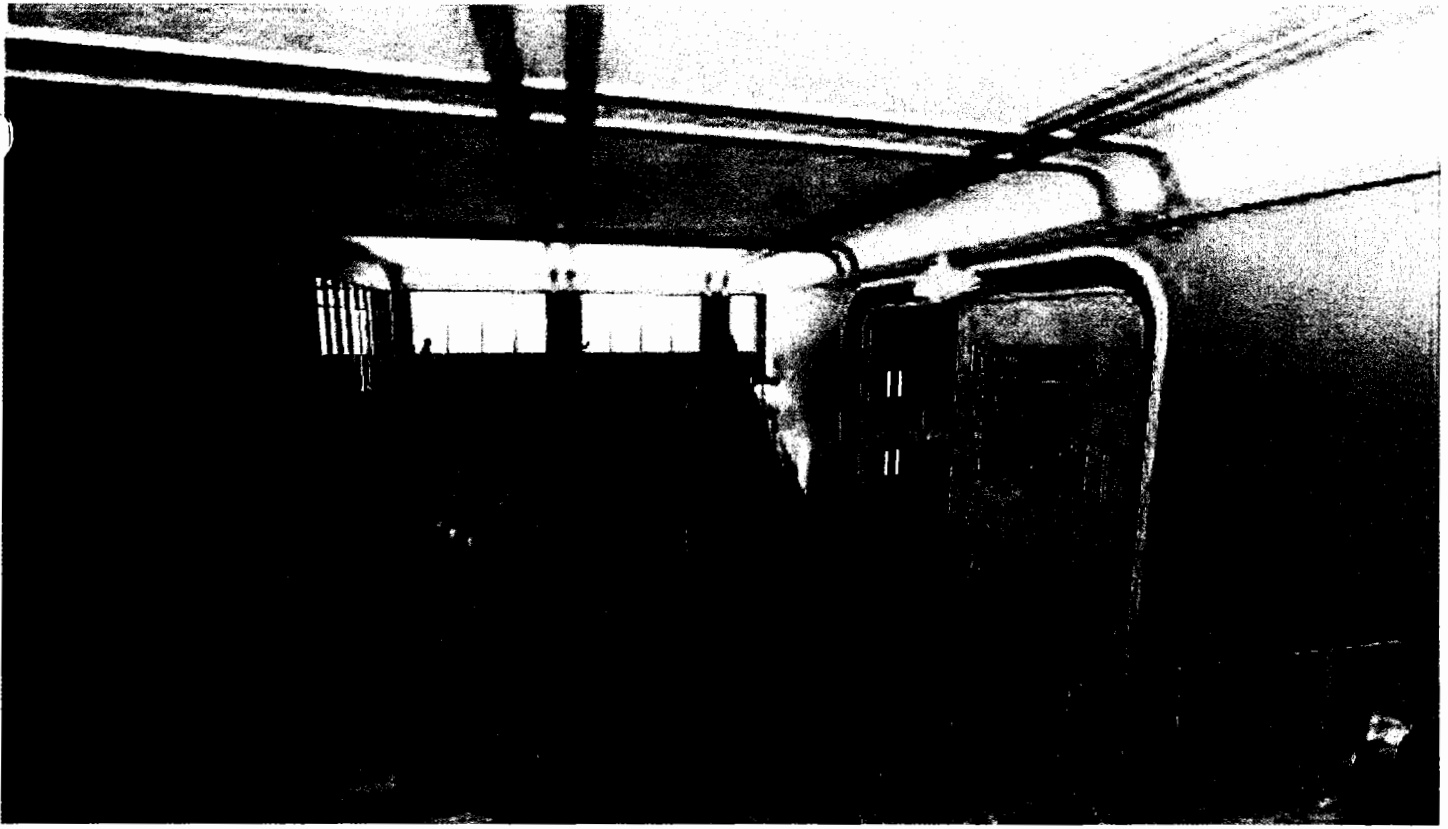
**COMPLETION DATE**  
2023

**SERVICES**  
Acoustics  
Electrical  
Fire & Life Safety  
Mechanical  
Plumbing  
Security  
Telecom

The Jayhawk Welcome Center Addition and Renovation at University of Kansas is set to further enrich the Jayhawk experience for current students and alumni alike. The Welcome Center will serve as a new “front door” to the university’s Lawrence-based campus.

Located immediately north of the existing Adams Alumni Center, the two-story Welcome Center addition houses a welcome vestibule, prefunction space, and a partitionable multi-purpose room with the capacity for up to 300 guests.

There were major renovations to the Adams Alumni Center on the first two floors with minor renovations to the third. Connecting the two centers is a two-story bridge filled with interactive exhibits and hospitality spaces. Special coordination was required for new air handling units located in the basement of the Alumni Center. They will distribute air to the Alumni and Welcome Centers. Our team also provided the electrical and lighting framework and conditioning to support a floor to ceiling LED video board in the main lobby of the welcome center. Throughout the facilities, there are multiple static and digital displays for wayfinding, announcements, and various graphics.



## **KIRK BUILDING RENOVATION**

TRUMAN STATE UNIVERSITY | KIRKSVILLE, MO

### **PGAVARCHITECTS**

**SIZE**  
15,600 SF

**COST**  
\$16,400,000

**COMPLETION DATE**  
Ongoing

Truman State University is renovating the historic Kirk Building to house a new Student Success Center to enhance student support services.

The new Student Success Center will employ a collaborative service model in which individual student service departments will work in coordination to meet students' needs throughout their college career. The Student Success Center is comprised of: the Career Center; Tutoring Services; the Student Health Center; Counseling Services; Student Access and Disability Services; the Center for Academic Excellence; the Communication Lab; and the Writing Center. Additional goals for the project include supporting new student recruitment by creating a positive first impression of the University; creating operational efficiencies for staff and a streamlined student experience by bringing these services which are currently distributed across campus together in a single facility; achieving parity among programs/groups, some of whom currently occupy inferior spaces to others; and aligning the historic structure of the building with Truman State's brand.

In addition to housing the Student Success Center, the updated facility will provide resources to the community, including workforce development outreach, rural telehealth counseling, and academic outreach workshops. The Lifelong Learning Skills (SKILLS) Center will build upon the services of the departments in the Student Success Center, making key services available to the local community.



# BLOCH HERITAGE HALL RENOVATION AND ADDITIONS

UNIVERSITY OF MISSOURI-KANSAS CITY | KANSAS CITY, MO

## PGAVARCHITECTS

### SIZE

52,000 SF Renovation  
10,500 GSF Addition

### COST

\$13,926,122

### COMPLETION DATE

2022

The Bloch School is a nationally preeminent school of management focused on entrepreneurial leadership and innovative business education. PGAV was commissioned to transform the aging 1987 Bloch Heritage Hall (the original home of the Bloch School) and the historic 1909 Shields Mansion by modernizing learning environments and reimagining student services delivery. PGAV developed and implemented a renovation program and facilities master plan which has maximized existing space utilization, modernized 12 heavily used classrooms and class labs, and new consolidated spaces for one-stop student services.

The project included three strategic building additions: a new stair and elevator tower to create a stronger west entrance; a new technology-enabled active learning classroom to enhance instructional capabilities; and a new east addition providing expanded space for student services and faculty offices, while enhancing the Bloch School's main entrance. The completed project also addressed \$6.5M in deferred building systems maintenance.

Relevant features include:

- Modernized classrooms and updated instructional technology
- New 72-seat active learning classroom
- Consolidated undergraduate admissions and advising center
- Launchpad Scholarship Center
- Business career center and interview rooms

**CORPORATE HQ**

**BENTONVILLE**

**DALLAS**

**DENVER**

**HOUSTON**

**KANSAS CITY**

**LAS VEGAS**

**LOS ANGELES**

**NASHVILLE**

**NEW YORK**

**PHILADELPHIA**

**PHOENIX**

**TAMPA**

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October 04, 2023

Lori Shook  
Truman State  
100 E Normal, MC100  
Kirksville, MO 63501

RE: Truman State University HVAC Improvements

Dear Lori:

Henderson is honored to have been recommended for the Truman State University HVAC Improvements projects. Henderson will provide basic mechanical, electrical, plumbing design services along with any necessary architectural, civil and structural design services through select design partners. Henderson proposes using a basic service fee per the UM Architectural & Engineering Fee Guidelines Project Type VI which range between 11.2% and 9% for projects between \$500,000 and \$6,000,000. While project estimates are not set, Henderson will provide a conceptual project estimate to assist in establishing a fee and scope.

<https://collaborate.umsystem.edu/sites/fpd/public/docs/Architectural%20and%20Engineering%20Basic%20Services%20Fee%20Estimating%20Guidelines%20v4.pdf>

Sincerely,

Henderson Engineers

A handwritten signature in cursive script that reads 'Dany McGrail'.

Dany McGrail  
Director

## Architectural and Engineering Basic Services Fee Estimating Guidelines

Basic Services is the design work customary on a typical project to take an established building program, site, and budget, and then develop the architectural design, engineer the building systems, produce construction documents, and perform construction administration for a single phase project. Basic Services include the design services customary on every project such as architectural, structural, civil, mechanical, and electrical engineering services. Basic Services are described in the Standard Consulting Agreement.

The following method estimates the Basic Services fees using the Amount Available for Construction (AAC) from the established project budget. The fees are expressed as percentage of AAC for six (6) projects types with differing levels of complexity for both New Construction and Renovation. The Project Types are:

**Project Type I – Considerably Less than Average Complexity:** Farm Structures, shop & Maintenance, Service, Warehouses, Storage Facilities, Parking Structures.

**Project Type II – Less Than Average Complexity:** Student Housing, Office Buildings, Complex Parking Structures.

**Project Type III – Average Complexity:** Classroom Facilities, General Teaching Spaces, Medical Offices, Clinics, Gymnasias.

**Project Type IV – More Than Average Complexity:** Complex University Buildings, Engineering Laboratories, University Libraries, Dining Facilities, Theaters, Arenas, Auditoriums, Medical Schools.

**Project Type V – Considerably More than Average Complexity:** Science and Medical Research Buildings, Hospitals, Museums.

**Project Type VI – Engineering Projects:** Campus/Building Chilled Water, Steam, Fire Protection, or Hot Water Systems; Campus/Building Electrical Distribution Systems; Building Replacement Mechanical or Electrical Systems; Building or Campus Generator Systems; Campus Fire Alarm or Security Systems; Outdoor Lighting or Sports Lighting; Retrofit Building Fire Protection Systems; Campus Voice/Data Systems. Power & steam generating capacity projects are not included. The fees for projects at Power Plants, projects involving high voltage electrical distribution, projects involving steam distribution over 15 psi or new major chiller plants shall be determined by current market conditions.

To use the chart, find the row corresponding to the project's AAC, then find the column best describing the project type. The intersection of the row and column is the percentage of the AAC that is a reasonable estimate of a Basic Services Fee for that project. Fees are then stated as a Lump Sum Amount. When the project AAC is greater than \$30,000,000, contact UM Facilities Planning & Development.

The application of these tables is dependent on understanding the size and complexity of the project. It is assumed the project scope of work and budget has been developed to a level where this method can be used to produce an estimate of a reasonable and customary fee.

Consultant Fees to prepare Design/Build proposal documents are estimated using the Basic Services curves and then factored for the level of bridging documents required. For example bridging through Design Development would be factored by 35%. Services for proposal package preparation, responding to questions during the proposal phase, proposal evaluation services, and construction administration support are then added as not to exceed fees estimated based of the level of effort anticipated.

Not included in the Basic Services Fee are amounts to cover Additional Services or approved Reimbursable Expenses. These costs should be added to the Total Project Budget and should be estimated based on the projected scope of work.

Additional Services are those required to augment the Basic Services that are not customary on every project. The need for Additional Services is dependent on the individual project and will change from project to project. Some of these services will not be identified until the project is underway. However, it is preferable for needed additional services to be identified when requesting services for design.

#### Additional Services

Additional Services include, but are not limited to those listed below. It is desirable that these be identified with the basic services fees and approved at the same time.

#### Pre-Design Phase

- Feasibility Studies/Analysis
- Assistance with Grant and Funding Applications
- Facility Programming
- Master Planning
- Soils Investigations/Reports/Geotechnical Services
- Surveys-Topographic/Boundary/Vegetation Improvements/Utilities
- Existing Facilities Analyses
- Measured Drawings of Existing Facilities
- Environmental Assessments
- Storm Water Management Permitting
- Environmental/Site Permitting
- Traffic Analyses
- Hazardous Materials Consultation/ Surveys

## Design Phase

- Additional Project Meetings [in Excess of Biweekly]
- Accelerated Design Schedules
- Engagement of a Signature Design Architect
- Engagement of Specialty Expert Consultants for consultation on design parameters, such as Food Service, Historic Preservation, Theater, Acoustical, Audio/Visual, Landscape, Life Safety, Laboratory, Way-finding graphics, Interior Design, Furnishings, & Artwork
- Coordination with Consultants Engaged Directly by the Owner
- Site Specific Seismic Studies
- LEED Process Support and Documentation
- Electrical Fault Current Studies
- Load Studies (Mechanical or Electrical)
- Reliability Analysis (Mechanical or Electrical)
- Value Analyses / Life Cycle Cost Analyses (beyond that required under basic services)
- Computer Modeled Energy Analyses (other than required by University Energy Standards)
- Renderings/Models/Videos
- Owner directed Changes to Scope, Size, or Complexity
- Documents Prepared for Multiple Component Construction Packages
- Documents Prepared for Separate Proposal Packages Requested by the Owner
- Environmental Work (Hazardous Waste Consultant Hired by Design Professional)

## Construction Phase

- Comprehensive CPM Scheduling
- Phased Construction Observation
- Prequalification of Contractors/ Subcontractors Services
- Commissioning
- Commissioning Support
- Full Time Construction Inspection Provided by the Design Professional
- Program Management Services
- Designing Replacement Work for Damaged Work
- Post Occupancy Observations/Evaluations

**ARCHITECTURAL & ENGINEERING BASIC SERVICES FEE PERCENTAGE NEGOTIATION GUIDELINES**

Amount Available for Construction (\$)	TYPE I Considerably less than average complexity		TYPE II Less than average complexity		TYPE III Average Complexity		TYPE IV More than average complexity		TYPE V Considerably more than average complexity		TYPE VI Engineering Projects	
	New %	Reno. %	New %	Reno. %	New %	Reno. %	New %	Reno. %	New %	Reno. %	New %	Reno. %
500,000	6.4	8.0	7.2	9	8	10	8.8	11	9.6	12	9	<del>11.2</del>
750,000	6.1	7.6	6.8	8.6	7.6	9.5	8.4	10.5	9.1	11.4	8.5	<del>10.6</del>
1,000,000	5.8	7.3	6.6	8.2	7.3	9.1	8	10	8.8	11	8.2	<del>10.2</del>
1,250,000	5.7	7.1	6.4	8	7.1	8.9	7.8	9.8	8.5	10.7	8	<del>10</del>
1,500,000	5.6	7.0	6.3	7.9	7	8.8	7.7	9.7	8.4	10.5	7.9	<del>9.8</del>
1,750,000	5.5	6.9	6.2	7.8	6.9	8.7	7.6	9.5	8.3	10.4	7.8	<del>9.7</del>
2,000,000	5.5	6.9	6.2	7.7	6.9	8.6	7.5	9.4	8.2	10.3	7.7	<del>9.6</del>
2,250,000	5.4	6.8	6.1	7.7	6.8	8.5	7.5	9.4	8.2	10.2	7.6	<del>9.5</del>
2,500,000	5.4	6.7	6.1	7.6	6.7	8.4	7.4	9.3	8.1	10.1	7.5	<del>9.4</del>
2,750,000	5.3	6.7	6	7.5	6.7	8.4	7.3	9.2	8.0	10	7.5	<del>9.4</del>
3,000,000	5.3	6.6	6	7.4	6.6	8.3	7.3	9.1	7.9	9.9	7.4	<del>9.3</del>
3,500,000	5.3	6.6	5.9	7.4	6.6	8.2	7.2	9	7.9	9.9	7.4	<del>9.2</del>
4,000,000	5.2	6.5	5.9	7.4	6.5	8.2	7.2	9	7.8	9.8	7.3	<del>9.2</del>
4,500,000	5.2	6.5	5.9	7.3	6.5	8.1	7.2	8.9	7.8	9.8	7.3	<del>9.1</del>
5,000,000	5.2	6.5	5.8	7.3	6.5	8.1	7.1	8.9	7.8	9.7	7.2	<del>9</del>
6,000,000	5.1	6.4	5.8	7.2	6.4	8	7.1	8.8	7.7	9.6	7.2	<del>9</del>
7,000,000	5.1	6.4	5.7	7.2	6.4	8	7	8.8	7.7	9.6	7.1	8.9
8,000,000	5.1	6.3	5.7	7.1	6.3	7.9	7	8.7	7.6	9.5	7.1	8.9
9,000,000	5.0	6.3	5.7	7.1	6.3	7.9	6.9	8.7	7.6	9.5	7.1	8.8
10,000,000	5.0	6.3	5.6	7	6.3	7.8	6.9	8.6	7.5	9.4	7	8.8
11,000,000	5.0	6.2	5.6	7	6.2	7.8	6.8	8.6	7.5	9.3	7	8.7
12,000,000	4.9	6.2	5.6	7	6.2	7.7	6.8	8.5	7.4	9.3	6.9	8.7
13,000,000	4.9	6.1	5.5	6.9	6.1	7.7	6.8	8.4	7.4	9.2	6.9	8.6
14,000,000	4.9	6.1	5.5	6.9	6.1	7.6	6.7	8.4	7.3	9.2	6.8	8.5
15,000,000	4.8	6.1	5.5	6.8	6.1	7.6	6.7	8.3	7.3	9.1	6.8	8.5
16,000,000	4.8	6.0	5.4	6.8	6	7.5	6.6	8.3	7.2	9	6.7	8.4
17,000,000	4.8	6.0	5.4	6.7	6	7.5	6.6	8.2	7.2	9	6.7	8.4
18,000,000	4.8	5.9	5.3	6.7	5.9	7.4	6.5	8.2	7.1	8.9	6.7	8.3
19,000,000	4.7	5.9	5.3	6.6	5.9	7.4	6.5	8.1	7.1	8.9	6.6	8.3
20,000,000	4.7	5.9	5.3	6.6	5.9	7.3	6.4	8.1	7.0	8.8	6.6	8.2
21,000,000	4.7	5.8	5.2	6.5	5.8	7.3	6.4	8	7.0	8.7	6.5	8.1
22,000,000	4.6	5.8	5.2	6.5	5.8	7.2	6.4	7.9	6.9	8.7	6.5	8.1
23,000,000	4.6	5.7	5.2	6.5	5.7	7.2	6.3	7.9	6.9	8.6	6.4	8
24,000,000	4.6	5.7	5.1	6.4	5.7	7.1	6.3	7.8	6.8	8.6	6.4	8
25,000,000	4.5	5.7	5.1	6.4	5.7	7.1	6.2	7.8	6.8	8.5	6.3	7.9
26,000,000	4.5	5.6	5.1	6.3	5.6	7	6.2	7.7	6.7	8.4	6.3	7.9
27,000,000	4.5	5.6	5	6.3	5.6	7	6.1	7.7	6.7	8.4	6.2	7.8
28,000,000	4.4	5.5	5	6.2	5.5	6.9	6.1	7.6	6.6	8.3	6.2	7.8
29,000,000	4.4	5.5	5	6.2	5.5	6.9	6.1	7.6	6.6	8.3	6.2	7.7
30,000,000	4.4	5.5	4.9	6.1	5.5	6.8	6.0	7.5	6.6	8.2	6.1	7.6