NC-170 RESEARCH COMMITTEE ANNUAL MEETING

August 13th – 14th 2020

2019-2020 Officers

Chair: Kristen Morris (morriskd@missouri.edu)
Vice Chair: Charles Freeman (cfreeman@humansci.msstate.edu)
Secretary: Linsey Griffin (lgriffin@umn.edu)
Past Chair: Susan Sokolowski (ssokolow@uoregon.edu)
Administrative Advisor: Elizabeth Bye (ebye@umn.edu)

AGENDA

Thursday August 13th
Location: Zoom Calendar Invite:

Time: Central Standard Time Zone	Topic	Topic Lead(s)
2:05 pm to 2:15 pm	Welcome & Introductions	Kristen Morris
2:15 pm to 2:45 pm	Overview of NC-170 Project NIFA Updates	Missy Bye
2:45 pm to 3:00 pm	New State Reporting Format ***See document on page 3 w/ notations*	Linsey Griffin
3:00 pm to 3:45 pm	State Reports and Introduction of Research Collaboration Interests *See document on page 5-33	Moderated by Lindsey Griffin: Each State Will Report in Alphabetical Order, unless otherwise noted.
3:45 pm – 4:00 pm	Election of New Officers & Annual Meeting Date for 2021 – Discussion on Term of Secretary • *Chair: Charles Freeman* • *Vice Chair: Yingying Wu* • *Secretary: Linsey Griffin* • *Terms of Secretary: New secretary will be on-boarded and will work with current secretary for one year, then will serve a 5-year term that is concurrent with the 5-year proposal/research period. This will enable continuity among members.*	Kristen Morris
4:00 pm – 4:30 pm	Break	
4:30 pm – 5:15 pm	Introduce Breakout Session Format and 5-year plan. Breakout Sessions.	Kristen Morris and Charles Freeman
5:15 pm – 5:30 pm	Breakout Session Reports and 2020 -2021 Meeting Format Discussion	All

	**See Breakout Session Report on page 34* *2021 Formal Meeting Discussion led to the vote to have 3 virtual meetings this year to discuss new ways to collaborate, funding opportunities, and the next 5-year proposal.* • *Next year's annual meeting will be held August 5 & 6 or 12 & 13 in Kansas City if possible* • *90 minute quarterly meetings will be held: 60min admin, 30min collab* • *Meeting 1: NIFA & RFPs (Charles Freeman) Oct 16th, 1-330 CST* • *Meeting 2: RFP part II (Kristen Morris) Feb 12th afternoon, 2-330 CST* • *Meeting 3: Proposal (Linsey) April 16th afternoon, 2-330 CST* • *Meeting 4: Annual (Yingying) August dates tbd* • *Facilities and Equipment: PPT to be sent to participating members to prepare for collaborative proposal*	

Friday August 2nd
Location: Zoom Calendar Invite:

Time: Central Standard Time Zone	Topic	Discussion Lead(s)
	New/Outgoing Officer Meeting for Advancing 5-year Plan	*Dates for Quarterly meetings discussed.*

NC170: Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards

Multistate Research Project: October1, 2017 – September 30, 2022

Period of Report: October 1, 2019 – September 30, 2020

Impact Nugget *A concise statement of advancements, accomplishments and impacts. Please add 1-2 sentences of impact nugget per institution. The information appropriate in this section is the achievements that created tangible outcomes (or products), not research findings.*

New Facilities and Equipment *Include production areas, sensors, instruments, and control systems purchased/installed.*

Unique Project Related Findings *List anything noteworthy and unique learned this year.*

Accomplishment Summaries *Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives. Please use language that the general public can readily comprehend.*

OBJECTIVES:

1. Investigate factors that impact selection, use, care, and maintenance of PPE products and protective clothing, including hand foot, and headwear.
    a. Investigate factors that impact selection, use, care, and maintenance of PPE products and protective clothing, including hand, foot, and headwear: basic and applied anthropometric and ergonomic research; user acceptance and barriers to acceptance in domain areas of fire protection, chemical protection, and health and safety; address decontamination issues that impact maintenance
2. Assess and improve protection and human factor performance of PPE and protective clothing items and systems (including hand, foot, and headwear) through research and product development.
    a. Assess and improve protection and human factor performance of PPE and protective clothing items and systems (including hand, foot, and headwear) through research and product development: assessment of human factor variables in protective clothing; design research and product development in domain areas of fire protection, chemical protection, and health and safety
3. Develop/revise and implement research-based performance guidelines and standards for items and systems of personal protective equipment and protective clothing
    a. Develop/revise and implement research-based performance guidelines and standards for items and systems of personal protective equipment and protective clothing: establish performance guidelines and/or standards for PPE establish sizing and fit guidelines for PPE
4. Develop novel functionality and applications of materials for PPE and health/safety solutions.

a. Develop novel functionality and applications of materials for PPE and health/safety solutions: research novel materials and technologies that can provide desired functions; research novel textile-integrated sensing techniques; evaluate the performance of the materials for personal protective applications

Published Written Works *Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced*.

Scientific and Outreach Presentations *Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.*

Funds Leveraged

Fatma Baytar

Assistant Professor

Fiber Science and Apparel Design

Cornell University

Research Areas

- 3D virtual product development
- Body & head anthropometry
- Sizing and fit
- Protective apparel design
- Consumer behavior

Collaboration Interest

- 3D virtual fit testing & iterative design of the products
- Head anthropometry

Huiju Park

Associate Professor
Fiber Science and Apparel Design

Cornell University

Research Areas

- Functional apparel design
- Biomechanical motion analysis
- Thermal comfort and protection

Collaboration Interest

- Textile/garment-based sensing
- Design and mobility
- Auxiliary thermal management system

Cornell University

Objectives

1. Objective 1: Investigate factors that impact selection, use, care, and maintenance of PPE products and protective clothing, including hand, foot, and headwear.
2. Objective 2: Assess and improve protection and human factor performance of PPE and protective clothing items and systems (including hand, foot, and headwear) through research and product development.

Accomplishments

· Development and evaluation of size adjustable SCBA harness

· Development of a new effective unisex sizing system of coveralls for pesticide applicators

· Development and evaluation of auxiliary cooling system to be worn underneath coveralls

· Development of educational materials for pesticide applicators with emphasis on non-contaminated doffing, effective ways of handling heat stress, and important safety design features in making purchase decision of coveralls.

Charles Freeman

Associate Professor
Fashion Design and Merchandising

MISSISSIPPI STATE UNIVERSITY™

Research Areas

- Functional design of PPE and use of alternative materials and textiles for PPE.
- Development of new products for occupational health and safety
- Textile material development for protective and functional clothing

Collaboration Interest

- Functional Design/PD
- Occupational Health
- New materials use

Linsey Griffin

Assistant Professor

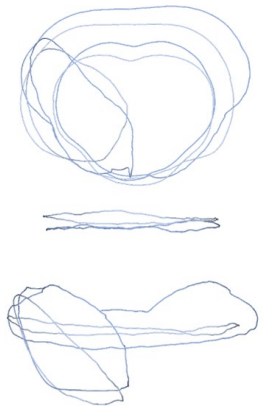
Design

UNIVERSITY OF MINNESOTA

Research Areas

Method Development for Technology

Hand Scanning & Glove Fit



Dynamic Anthropometry

PPE Development

Collaboration Interest

- PPE Sizing & Fit
- Designing for a diverse workforce
- Critical Anthropometry:
  - Head & Face
  - Hand
  - Dynamic Anthropometry
- PPE Development:
  - Respirator Development & Fit
  - Glove Development & Fit

Linsey Griffin
Assistant Professor
Design

UNIVERSITY OF MINNESOTA

NC170 Objectives

- Objective 1
- Objective 2

Accomplishment Summary

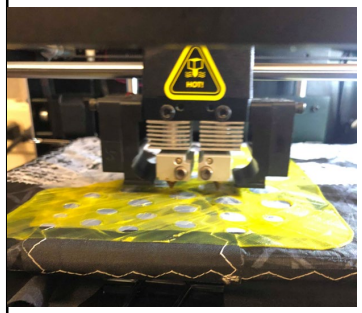
- Developed face mask crisis supply for M Health and UMN (Initial funding 40k; Additional funding pending, 100k for research)
- Developed and tested automatic coding system for measuring hands (in press)
- Cleaned and prepared over 700 participant hand scans for anthropometric assessment (SizeFF and D2D)
- Hand & Glove research w/ Sokolowski

Gozde Goncu-Berk

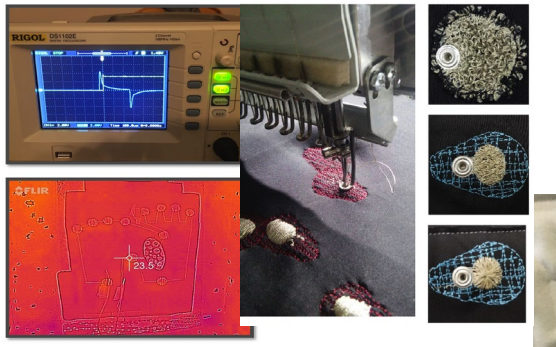
Assistant Professor
Department of Design

UC DAVIS
UNIVERSITY OF CALIFORNIA

Research Areas



Direct 3D printing on textiles



CAD embroidery for e-textile applications

Actuating textiles for healthcare applications

Collaboration Interest

- E-textiles
- Functional wearable product design for health
- Novel applications of 3D printing in functional wearable product design

Juan P. Hinestroza

Associate Professor of Fiber Science
nanotextiles.human.cornell.edu

Cornell University

Research Areas

Fiber functionalization

1. Metal-Organic Frameworks
2. Nanowires
3. Nanoparticles
4. Nanolayers

Fiber-based sensors

1. Toxic Compounds
2. Sweat Analysis

Fiber metrology

1. Electrostatics
2. Mechanical Properties
3. Friction and Lubrication

Collaboration Interest

1. Integration of Fiber Science and Apparel Design

1. Development of fabrics/apparel with embedded fiber-based sensors

1. Active/reactive Protective Clothing against gases and liquid toxic compounds as well as electrical shocks

Shu-Hwa Lin

Department of Family & Consumer Sciences,
Fashion Design & Merchandising

Research Areas

Body scanning & fitting simulation
Functional Designs
- Mask
- PCM for firefighters
- Wearable device ECG

Collaboration Interest

Any functional designs

Hang Liu

Assistant Professor

Apparel, Merchandising, Design and Textiles

WASHINGTON STATE UNIVERSITY

Research Areas

- Nanofiber production and application in smart sensing textiles, biomaterials, and protective garments.
- Textile waste recycling
- 3D Printing in developing functional textiles.

Collaboration Interest

- Functional nanofiber development
- Textile sensing

Dr. Sumit Mandal, Assistant Professor, Oklahoma State University

Areas of Research Interest

- Protective Textiles and Clothing
- Textile Protection and Comfort
- Textile Modeling

Areas of Collaboration Interest

- Thermal Protective Clothing and Equipment - Characterization and Development
- Textile Protective and Comfort Performance Evaluation
- New Textile Test Methods and Materials Development
- Empirical Modeling for Predicting the Protective and Comfort Performance

Dr. Sumit Mandal, Assistant Professor, Oklahoma State University

- Impact Statement/s and/or Objectives you worked under

  1. Developing a Lab on Protective Textiles and Clothing at Oklahoma State University (OSU)

  2. Published Book Chapter and Journal Paper

  3. Presented or Abstract Accepted in International Conference

- Accomplishment Summary

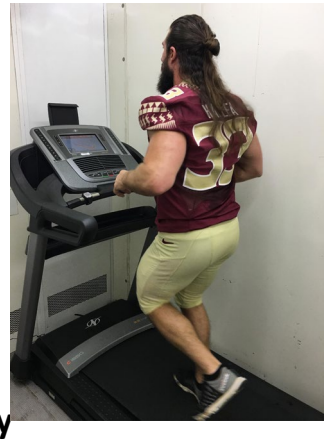
1. Partially developed a lab on Protective Textiles and Clothing at OSU
2. Published 1 Elsevier book chapter (on Thermal characterization of fire protective fabrics) and 1 Textile Research Journal (TRJ) paper (on Characterization and empirical analysis of hot water immersion with compression protective performance of fabrics used in firefighters' clothing)
3. Abstract accepted for presentation in:

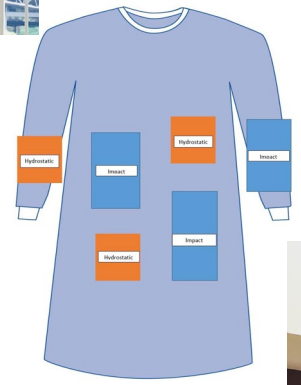
   AATCC International Conference,
   International Textile and Apparel Association Annual Conference,
   Fiber Society Spring Conference,
   9th European Conference on Protective Clothing

Meredith McQuerry, Ph.D.
Assistant Professor

FLORIDA STATE UNIVERSITY
JIM MORAN COLLEGE OF ENTREPRENEURSHIP

Research Areas





FEMA

- **Clothing Comfort Physiology**
- **PPE Laundering/Durability**

Collaboration Interest

- 3D Body Scanning
- Patternmaking/Design for PPE Improvements

Meredith McQuerry, Ph.D.
Assistant Professor

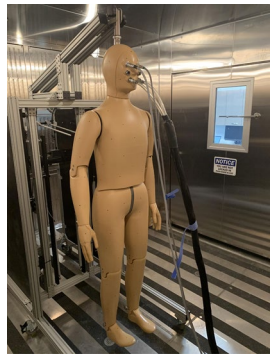
FLORIDA STATE UNIVERSITY
JIM MORAN COLLEGE OF ENTREPRENEURSHIP

- Impact Statement: Design, Comfort, and Mobility Issues for Female Firefighters
- Objectives:
  - #1: Station Wear Selection & Use; Anthropometrics & Ergonomics of Male vs. Female Structural FF PPE; User Acceptance/Barriers to Acceptance of Female FF PPC
  - #2 & #4: Structural FF Design Improvements (Private Partnerships)
  - #3: Wear Trial scale/systems development (COVID Mask Study)

Accomplishment Summary

1. Female Firefighter PPC – Federal Grant
2. ThermaNOLE Manikin Lab
3. Station Wear Publication
4. Male vs. Female Ergonomics/Fit Publication

FEMA

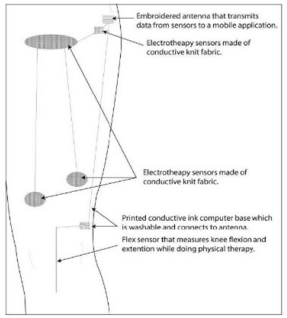


New Member 2019

Dawn Michaelson

Assistant Professor, Apparel Design

Baylor University



Research Interest

- Performance Apparel
  - Sports Apparel
  - Professional Athletes
  - Compression Garments
- Wearables/Smart Apparel
- Apparel Fit/Functionality
- Apparel Quality
  - Seam & textile testing

Collaboration Interest

- Performance Apparel
- Medical Apparel
- Protective Apparel
- Wearable/Smart Garments
- Body Anthropometrics
- Fit & Sizing Issues

Kristen Morris
Assistant Professor
Dept. of Design and Merchandising

COLORADO STATE UNIVERSITY

Research Areas

The central research inquiry for my program of research is:

How can researchers increase *every* apparel user's ability, health, and well-being through the design of apparel products?

I address this question through three strategies:

1. Giving focus to the apparel needs of underserved target markets.
2. Enhancing the functional performance of apparel through the application of innovative technologies;
3. Advancing the apparel design and product development process through user-centered design to address user requirements.

Collaboration Interest

- PPE Development
- Designing for a diverse workforce
  - Clothing sizing and fit, particularly for people with special needs and underrepresented body shape/type;
- 3D visualization (CLO 3D)/ design
- Breast Anthropometry

Kristen Morris

Assistant Professor
Dept. of Design and Merchandising

COLORADO STATE UNIVERSITY

- Impact Statement/s and/or Objectives you worked under
  1. Objective 1: Investigate factors that impact selection, use, care, and maintenance of PPE products and protective clothing, including hand, foot, and headwear.
  2. Objective 2: Assess and improve protection and human factor performance of PPE and protective clothing items and systems (including hand, foot, and headwear) through research and product development.

- Accomplishment Summary
  1. Objective 1: **Manuscript under review** based on interviews of 35 female firefighters about how ill-fitting turnout coats and pants negatively impact female firefighter's ability to perform their work.
     a. McKinney, E., Morris, K., Wu, Y., Griffin, L., Sokolowski, S., Carufel, R., & Park, J. (under 3rd review - Aug. 2020). Firewomen's fit problems with their coats and pants: Impact on mobility and safety. WORK: A Journal of Prevention, Assessment, and Rehabilitation.
  2. Objective 1: **Collected 97 survey responses from both male and female firefighters in Mid-Missouri.** Data has not been processed for this set yet.
  3. Objective 2: Under this goal, MO c**ollected 3D hand, foot, and body scans from 54 firefighters in the Mid-Missouri** region using structure sensor technology. There were 16 women and 38 men in this sample. These scans contribute to the larger goal to collect a representative sample of anthropometric data of firefighters across the United States.
  4. ALL DATA COLLECTED relate to Objective 1 & 2 establish a foundation to provide suggestions on how to improve the sizing and fit of PPE for improved safety and mobility.

Susan L. Sokolowski
Founding Director + Associate Professor
Sports Product Design: University of Oregon

Research Areas

Underserved PPE users + product fit/sizing

Product innovation process

Machine + deep learning

Performance product material + design applications

Collaboration Interest

Any PPE research that will influence new fit/sizing/design

Large 3D scanning anthropometric data collection efforts

Large funding opportunities (over 1 mil)

Susan L. Sokolowski
Founding Director + Associate Professor
Sports Product Design: University of Oregon

Objectives Worked Under for 2020

2. Assess and improve protection and human factor performance of PPE and protective clothing items and systems (including hand, foot, and headwear) through research and product development.

Accomplishment Summary

_Participated in new 3D + qualitative data collection effort for hands (w/Griffin). Co-published initial results.
_Investigated methods of capturing functional hand grips/positions for glove/tool design (with UO grad students). Published.
_Developed innovation framework for glove/tool innovation. Published.
_Developed new method to draft glove patterns from anthropometric data (w/ Griffin). In press.
_Developed new method to build ½ scale dynamically positioned mannequins (w/ UO grad student). Published.
_Comparative study of workwear gloves (w/ Griffin). In Press.
_Published healthy aging and mobility needs for industrial design and built environments (NIH + Innovation Magazine).
_Developed processes to analyze glove fit versus hand scans (w/ Griffin). Published.

Gang Sun, Professor
Biological and Agricultural Engineering, UC Davis

Research areas

- Biological and chemical protective textile materials
- Textile and material chemistry for protective functions
- Applications of biocidal materials in personal protective equipment and food safety operations
- Personal use and highly sensitive sensors for toxic chemicals and biological agents

Major achievements

- Chlorine rechargeable biocidal materials for protective clothing, food contact surfaces, and water purifications
- Daylight-induced biocidal technologies for biological applications
- High-throughput fabrication process of thermoplastic nanofibers
- Highly sensitive paper-like colorimetric sensors for vaporous pesticides

Yingying Wu
Assistant Professor
Fashion Design

KANSAS STATE UNIVERSITY

Research Areas

Functional Clothing Design

- Protective clothing design
- Design for people with special needs
- Design for older population and people with special body type/shape;

Clothing size & fit

Three Dimensional (3D) Virtual Apparel Design

- 3D Virtual Design and Fitting in Apparel Product Development
- 3D virtual Apparel Product Presentation

Consumer Behaviors Investigation using Eye-tracking technology

Collaboration Interest

- Clothing Sizing and Fit, particularly for people with special needs and underrepresented body shape/type;
- Head Anthropometry
- 3D virtual design

Chunhui Xiang

Assistant Professor
Apparel, Merchandising, and Design

IOWA STATE UNIVERSITY

Research Areas

- Environment-friendly, fully biodegradable and renewable ‘Green’ nanocomposites
- Nanomaterials used in high performance textiles
- Textile material development for protective and functional clothing

Collaboration Interest

- Functional textiles
- Protection and comfort
- Product development

Mary Ruppert-Stroescu, Associate Professor, Washington University in St. Louis

Areas of Research Interest

- **Conductive textiles**
- **Biometric sensing systems**
- **PPE**
- **3D design visualization and scanning**

Areas of Collaboration Interest

- **Conductive textiles**
- **Biometric sensing systems**
- **PPE**

Mary Ruppert-Stroescu, Associate Professor, Washington University in St. Louis

Research areas

- Conductive textiles
- Fittering textiles for masking
- Vapor sensing
- Biometric measuring with textiles

Major achievements

- Felted electrode
- EKG shirt V5

Anugrah Shaw
Professor
University of Maryland Eastern Shore

Areas of Research Interest

- PPE for Pesticide Applicators
- Standards Development
- Decontamination of PPE

Areas of Collaboration Interest

- Face protection
- Head protection
- Decontamination studies
- Educational materials for outreach

Anugrah Shaw
Professor
University of Maryland Eastern Shore

- Impact Statement/s and/or Objectives you worked under
- Objective 1 – Decontamination of fabrics contaminated with pesticides
- Objective 3 – ISO standards for PPE for pesticide operators
- Impact – ISO standards included in FAO guidelines

- Accomplishment Summary

1. Laboratory study conducted on contamination and decontamination of fabrics with pesticides.
2. Interlaboratory studies and revision of pipette test
3. Leveraging resources/research to initiate international partnerships to address health and safety of pesticide applicators

Shu-Hwa Lin

Department of Family & Consumer Sciences,
Fashion Design & Merchandising

Research Areas

Body scanning & fitting simulation
Functional Designs
- Mask design & evaluation
- PCM for firefighters
- Wearable device ECG

Collaboration Interest

Any functional designs
- Mask
- PCM design
- Wearable ECG applications

Shu-Hwa Lin

Department of Family & Consumer Sciences,
Fashion Design & Merchandising

Impact Statement/

Objective 2: Assess and improve protection and human factor performance of PPE and protective clothing (including hand, foot, and headwear) through research and product development

- Accomplishment Summary
  1. Body scanning & fitting simulation
  2. Wearable device ECG for firefighter

NC-170 Team Brainstorm
August 13, 2020

Participants
Susan
Charles
Huiju
Gang
Dawn
Anugrah
Gozde

Questions to Answer
1. What are our common collaboration areas and synergies (derived from slides)?
   - **Underserved populations**
     - Children
     - Women
     - Allergy prone
     - Medical personnel
     - Migrant workers

   - **Health and safety (food safety/processing, agriculture, fishing, health care)**
     - PPE (e.g. masks, footwear, apparel)
       - Sizing and fit
       - Human Physiology + perception
       - Product Development
       - Functional product design
       - Applied materials research
     - Sensors
       - Sizing and fit
       - Human Physiology + perception
       - Product Development
       - Functional product design
       - Applied materials research

NC-170 should be a problem-solving research group.
What are the key problems?

2. **What are exciting, potential end-to-end opportunities for this team? End to end – research to chemistry, to fiber/yarn, fabric, finish, pattern, product to production.**

   - Challenges is that the research is sequential – then some folks need to wait
   - Sensors is a better idea, because there is some work already accomplished
   - Quarterly mtg presentation of everyone's work
   - Where are the roadblocks? (ex: fiber extrusion)
   - What is the materials/fiber folks presented 1st?
   - Writing grants together
   - Need funding sources (career award NSF)
   - Raw material -new material – breathable/biodegradable/sustainable
   - Finishes – anti-microbrial
   - Fabric – structure and breathe-ability
   - Sizing-Fit – 3D tools
   - Design -
   - Decantamination/disposal – donning/doffing

3. **Are there any new areas/research zones of work that folks are interested that they would like to pursue as part of the NC-170 effort?**
   - Sensors
   - Bio-degradable/bio-design
   - 3D CAD design (future of this space)
   - Collaborations between materials + design
   - Other disciplines/experiences where our work can translate to
   - Socially related issues (ex: migrant workers, health disparities)
   - Collaborations with outsiders (e.g., body, clothing, fire engineer to understand the hazards)
   - Focus on daily use versus the “on-stage” performance
   -

4. **Funding opportunities?**

- Other disciplines/experiences where our work can translate to
- Socially related issues (ex: migrant workers, health disparities)
- Local government/state (food safety)
- FEMA
- DHS
- NSF
- HHS
- DOD
- EPA
- Foundations (Gates)
- NIOSH!
- AFRI (NIFA) (be cautious and check in with Anugrah for history/feedback for pesticides). How do we get our area to one of the priority areas? Does our 5-year proposal somehow connect to their priorities? Textile/apparel is not a current focus.

Next Step – to find actual funding calls to see how we align.