

Supporting rapid, reliable fiber identification through data and standards

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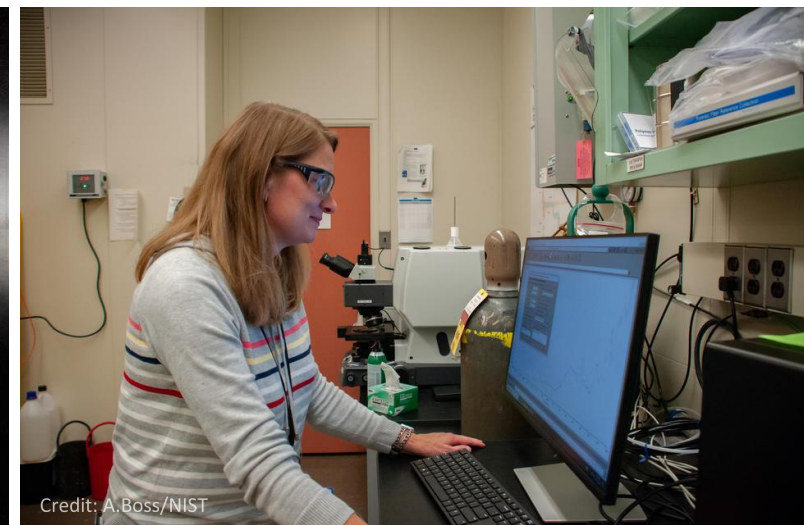


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NIST Mission



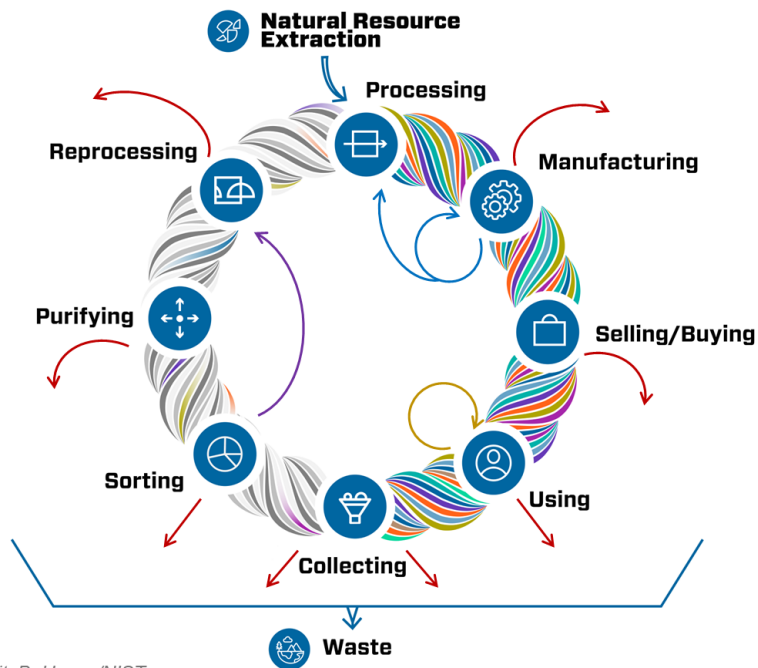
To promote U.S. innovation and industrial competitiveness by advancing **measurement science, standards, and technology** in ways that enhance economic security and improve our quality of life



NIST Circular Economy Program



Leveraging expertise in measurement science, standards, and technology to support stakeholders in addressing circular supply chain challenges



Credit: B. Hayes/NIST

<https://www.nist.gov/circular-economy>

Producing reference materials and data

Supporting documentary standards

Creating tools for data and decision science

Advancing measurement science

CE Textiles Research



Advance
Standards
and
Facilitate
Data
Sharing



Support
Industry
Through
Reliable
Data and
Standards



Improve
Chemical &
Mechanical
Recycling of
Textiles &
Fiber
Reinforced
Composites

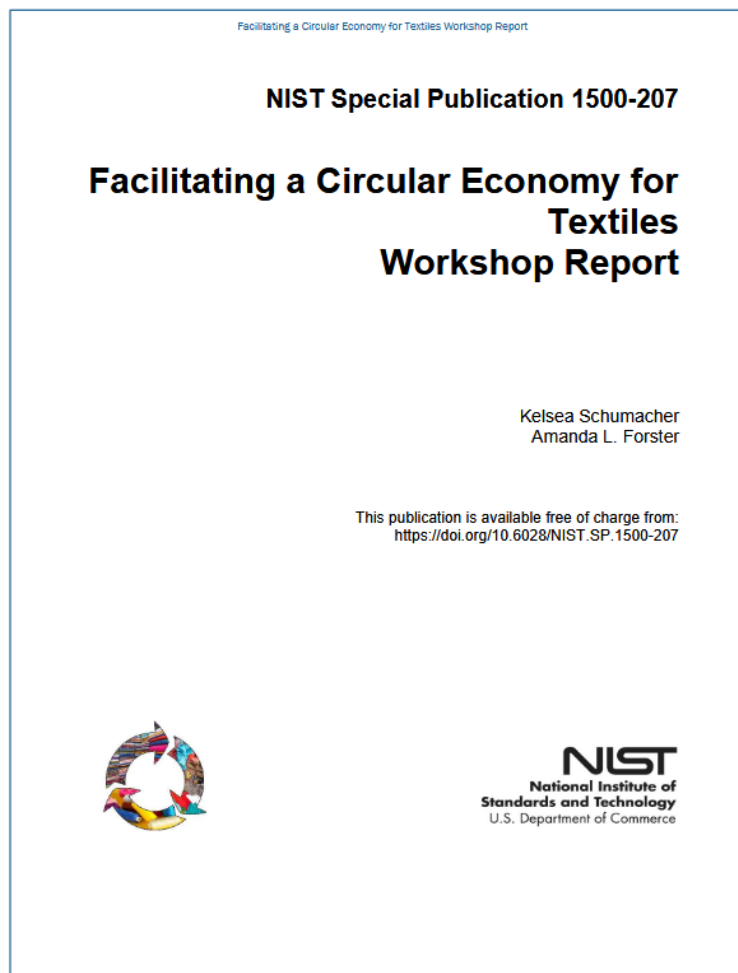


Enable
Rapid
Efficient
Textile
Sorting

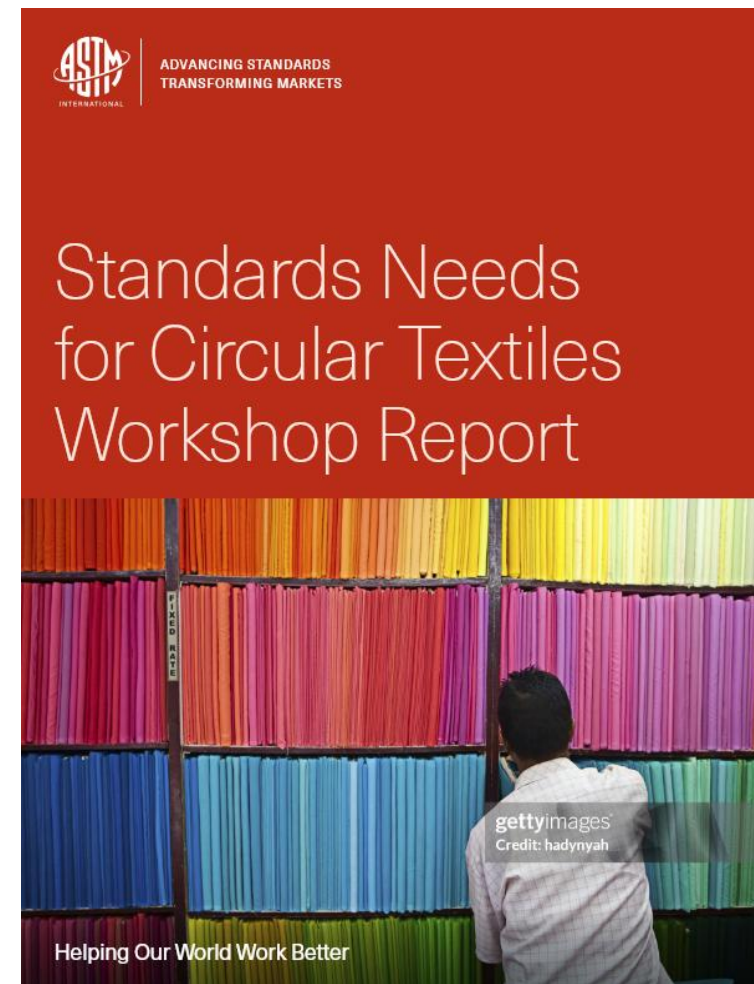
Advancing Textile Circularity through Standards



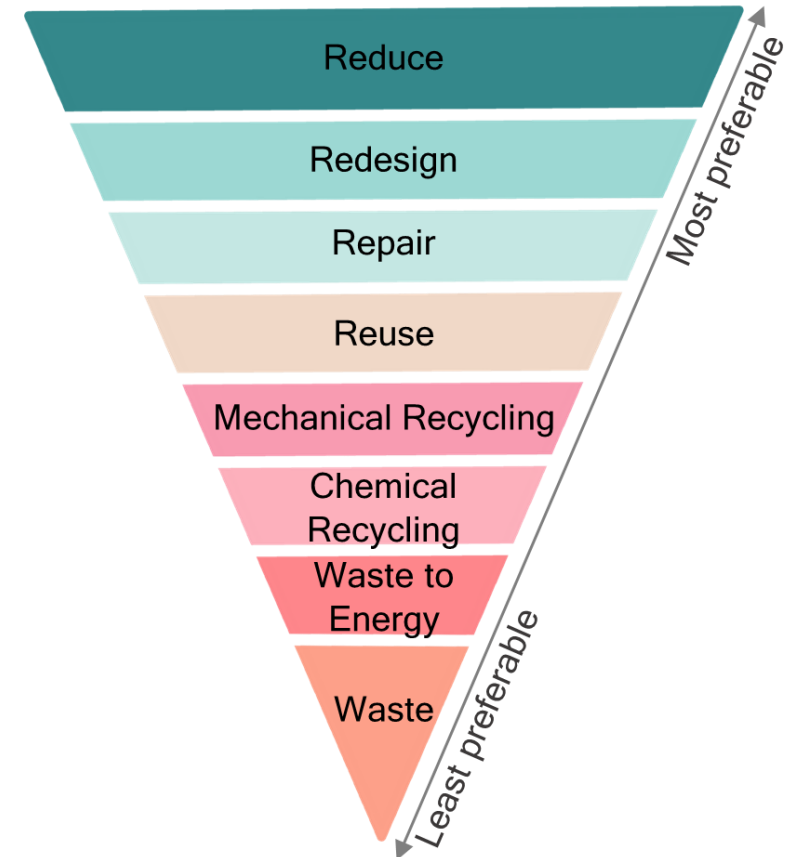
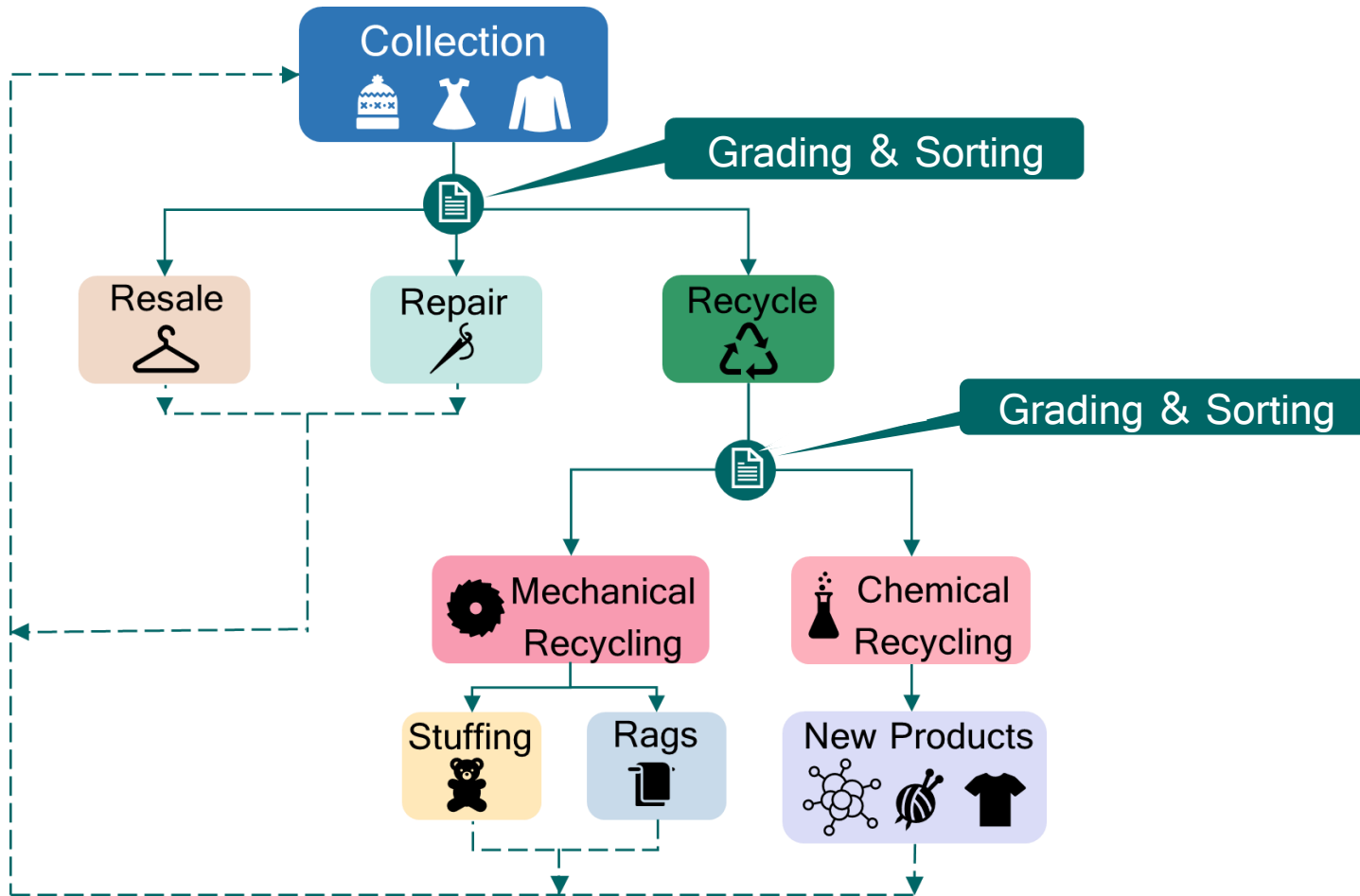
2021



2023



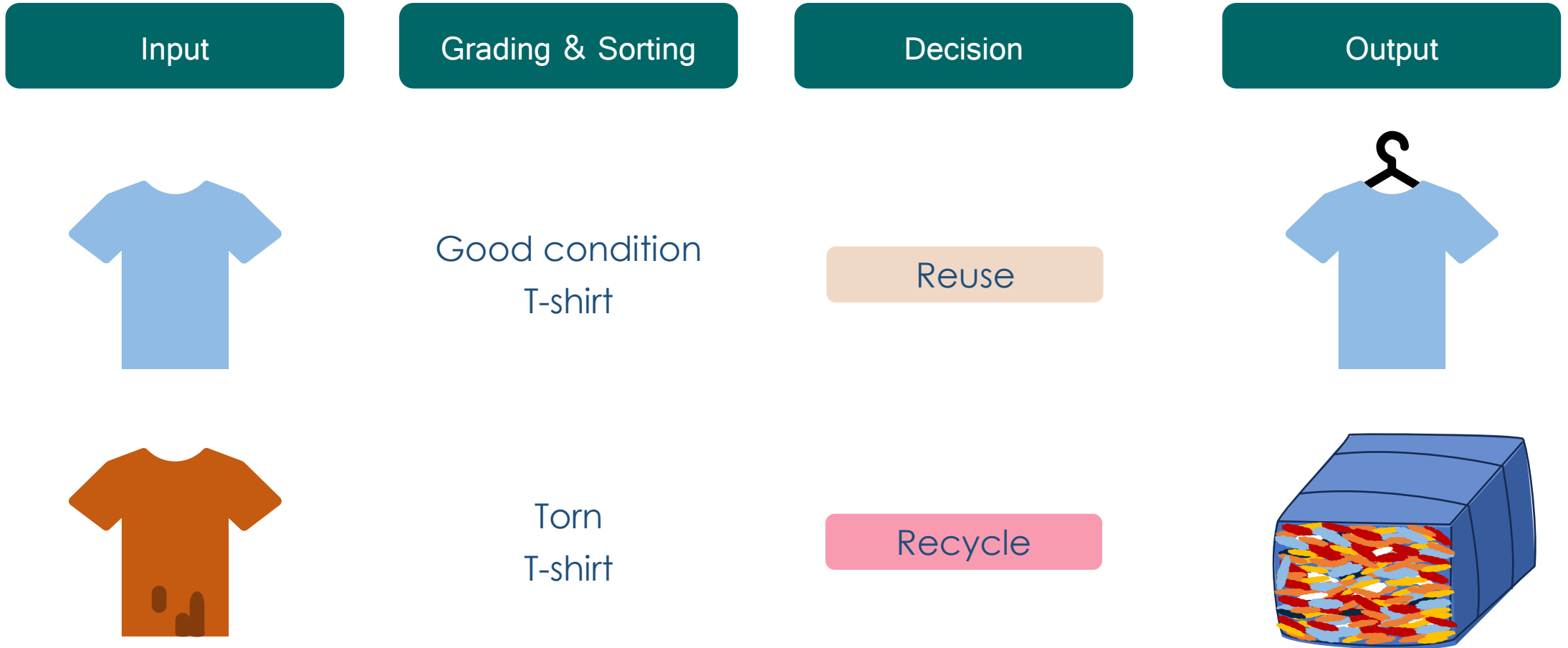
Textile Recovery System



Credit: A.Forster & K.Schumacher/NIST

No harmonized sorting standards or criteria currently exist.

Textile Grading & Sorting

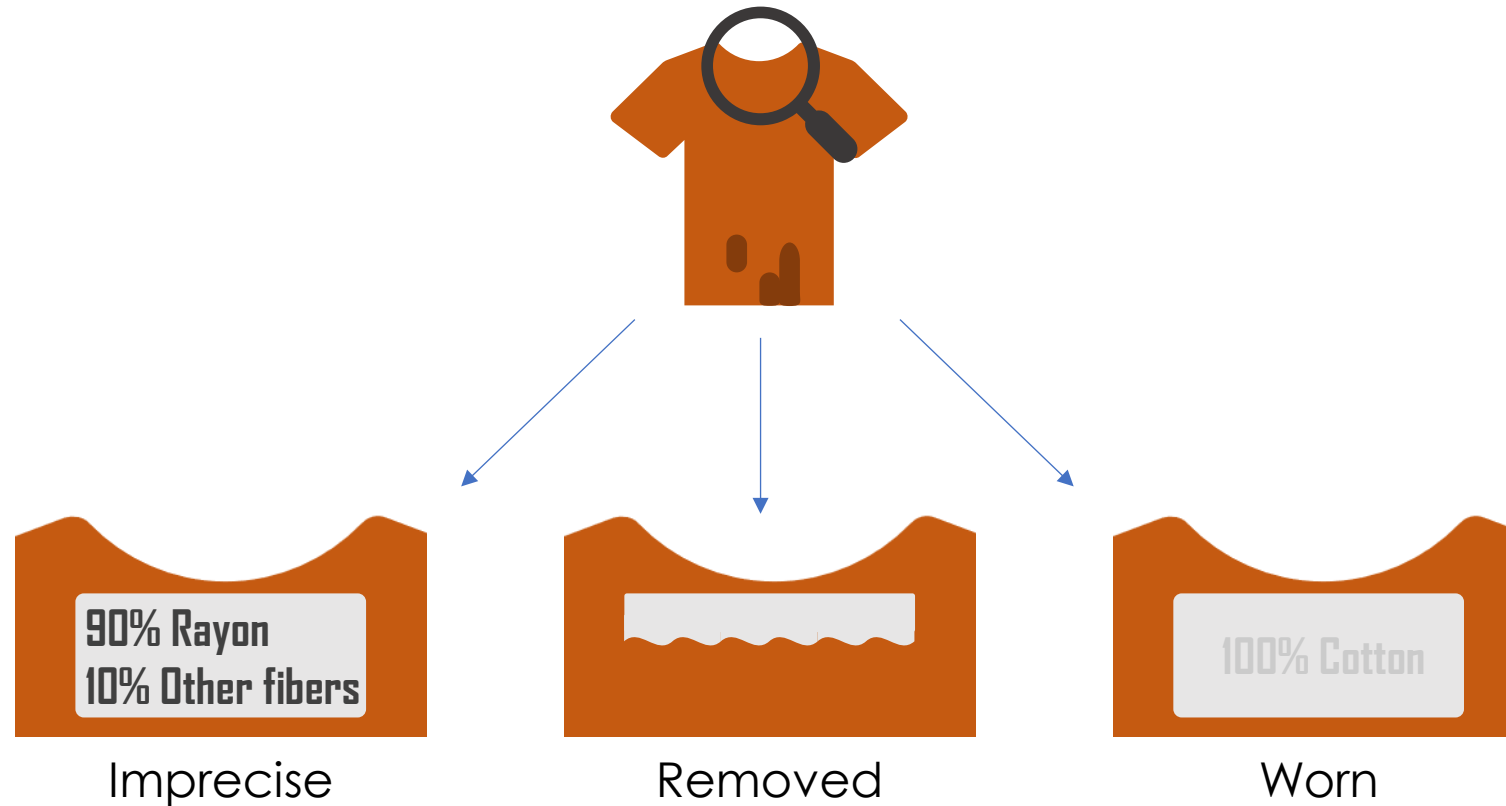


Grading for reuse involves a visual inspection of each garment.

Textile Grading & Sorting



Sorting for recycling requires fiber content info for each garment.

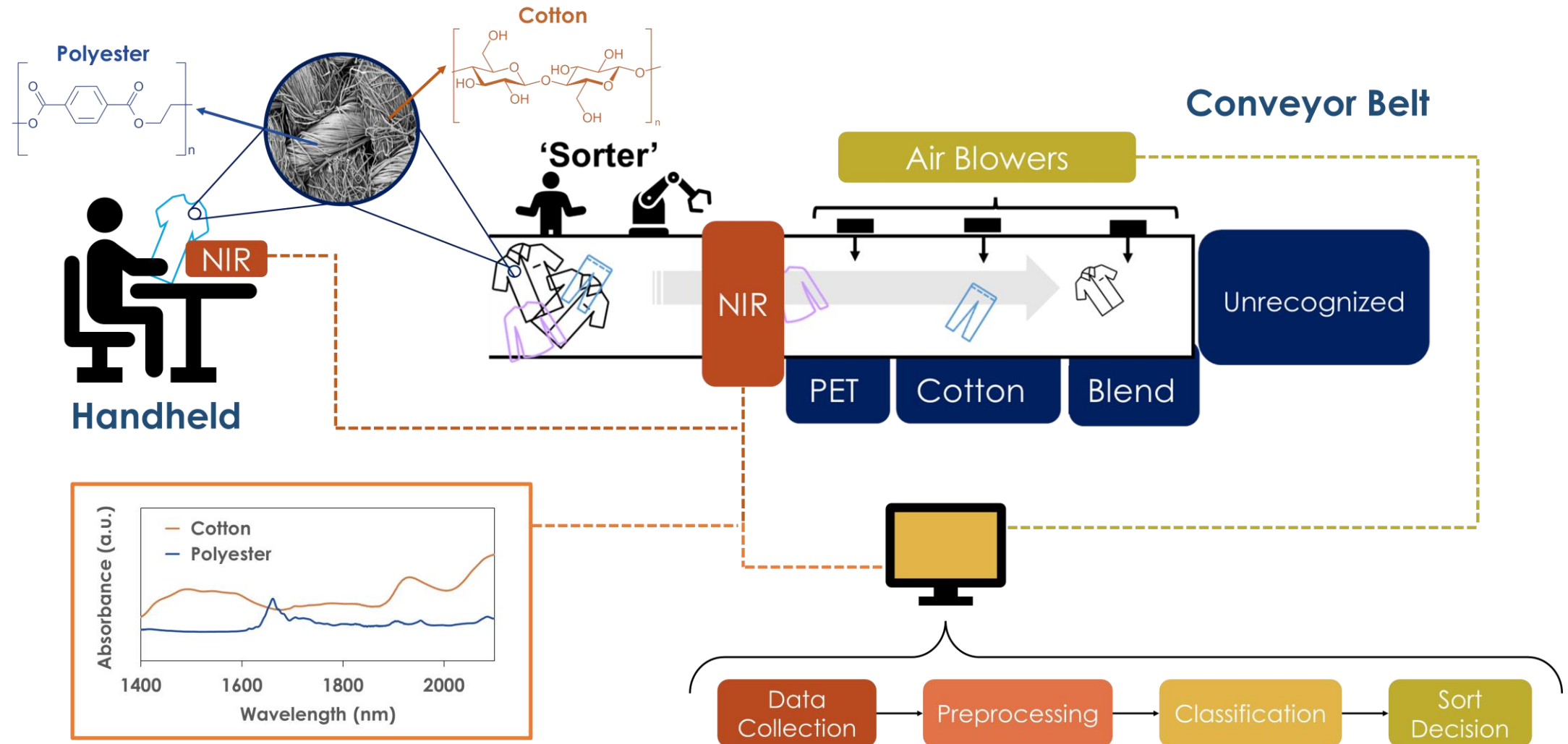


Sorters cannot rely on care labels alone for fiber identification.

Textile sorting via Near Infrared (NIR)



NIR spectroscopy paired with AI/ML models can identify fiber content.



Challenges in Textile Recovery



Textile Produced

Ideal Sort



NIR analysis is not straightforward, and AI/ML algorithms work well with high-dimensional data. However, models can predict **incorrect, incomplete, or inconclusive** fiber compositions.

Inaccurate fiber classification can lead to problems in downstream processing steps:

- Unrecognized elastane can **entangle** in and **clog** shredding equipment
- Unidentified components can **reduce** expected yield and **contaminate** recovered products

How do we prevent misrecognitions?

NIR-SORT dataset



Need: High quality measurements of **known composition** and **real-world** fabrics.

- NIR spectra for fiber sorting and RGB images for color sorting
- Sorting system development and validation

FAIR dataset, annotated and ready to be ingested for ML and AI workflows :

Near InfraRed Spectra of Origin-defined and Real-world Textiles (NIR-SORT)



data.nist.gov
(PDR)



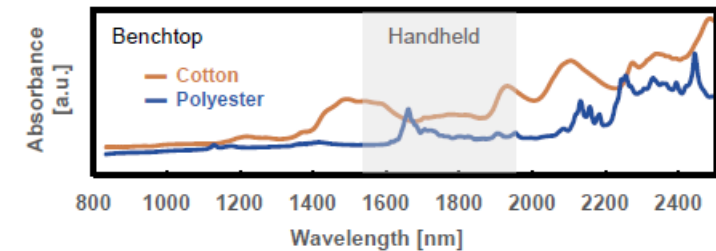
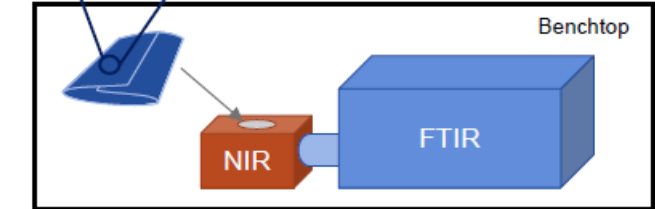
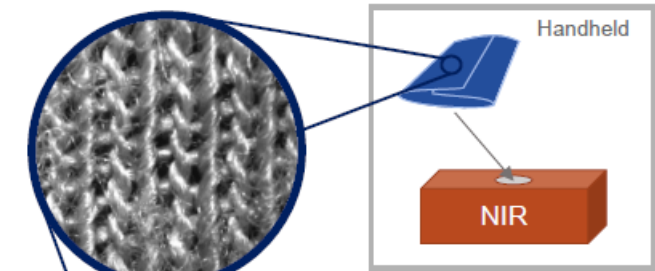
Materials Data
Facility (MDF)



Project
details



Data
descriptor



Benchtop vs handheld

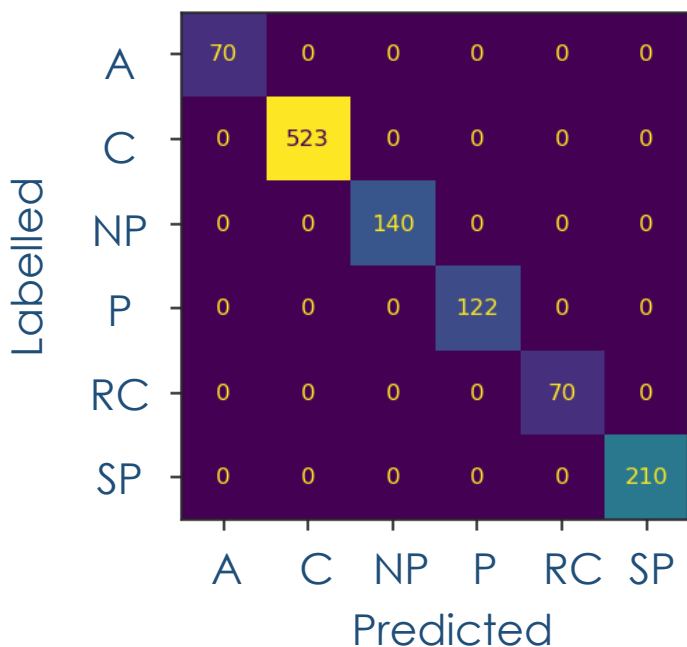
Full NIR range vs typical range in the field

Insights from NIR-SORT



Representative training data is critical. Both training data and model construction choices affect misrecognition.

Properly trained



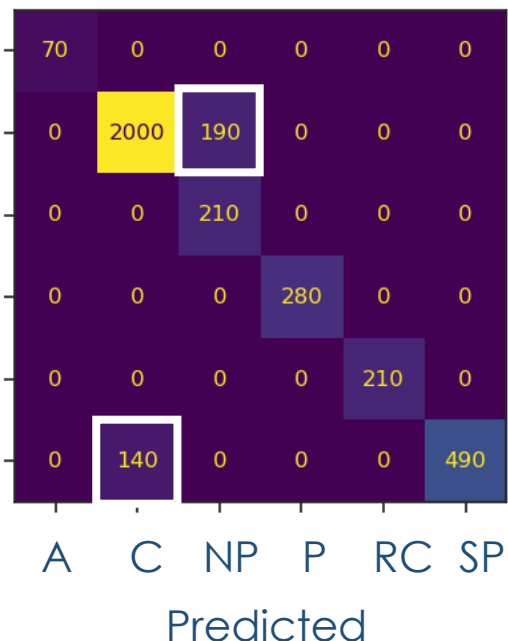
KEY:

A: Acrylic

C: Cotton

NP: Natural Polyamide

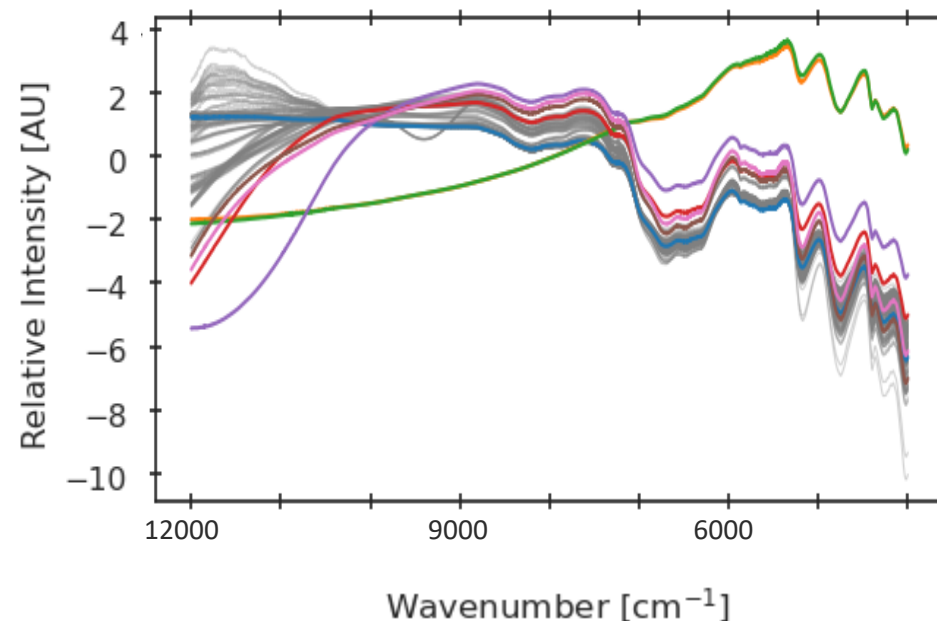
Gaps in training



P: Polyester

RC: Regenerated Cellulose

SP: Synthetic Polyamide



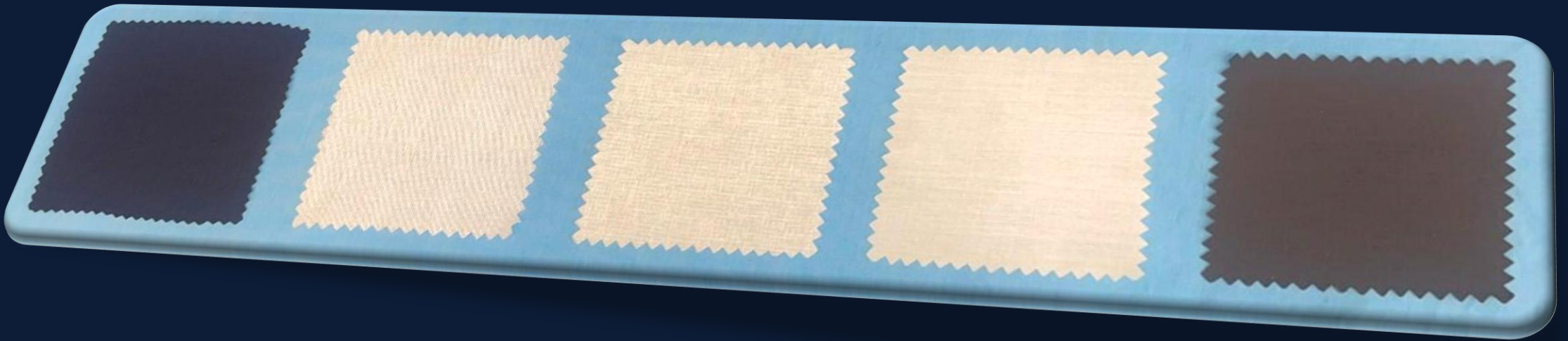
KEY:

Grey = Recognized

Color = Misrecognized

RGTM 10279

Textiles for Feedstock Identification



Research Grade Test Materials



Goal: Provide known composition **physical test materials** backed with rigorous data.

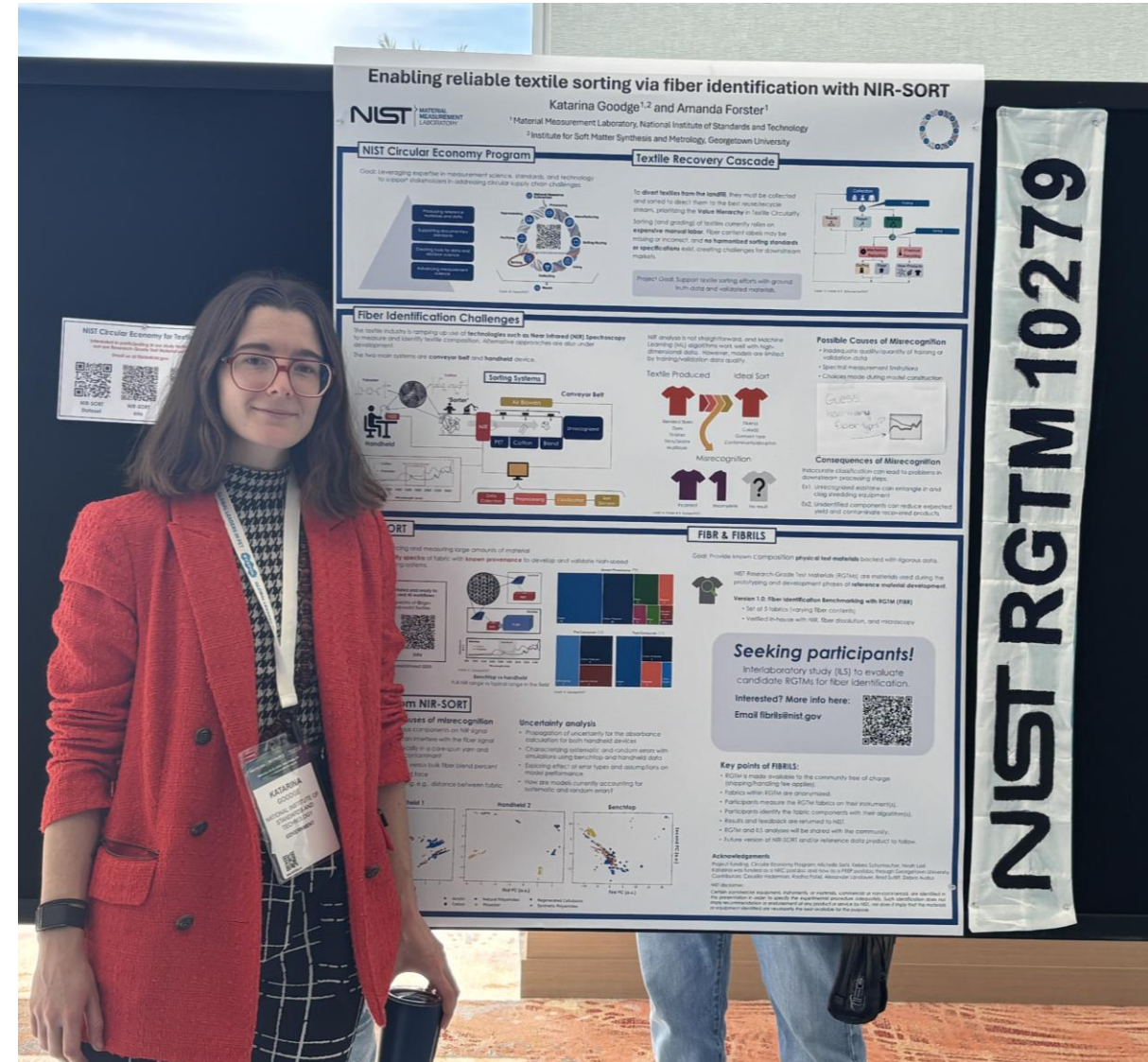
NIST Research-Grade Test Materials (RGTM) are materials used during the prototyping and development phases of **reference material development**.

FIBR: Fiber Identification Benchmarking with RGTM

- Set of 5 fabrics (varying fiber contents)
- Verified in-house with NIR, fiber dissolution, and microscopy

FIBRILS: FIBR Interlaboratory study (ILS)

- Comparison study to evaluate candidate RGTM for fiber identification
- Currently seeking participants!
- Email: fibrils@nist.gov



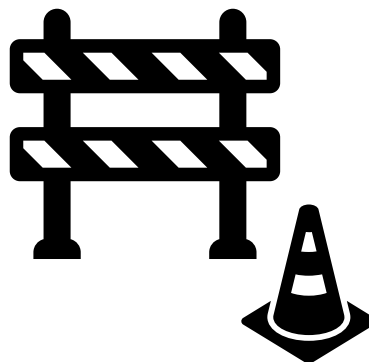
Supporting Industry Through Reliable Data and Standards



NIR-SORT dataset

NIR-SORT 2.0 is available!

Plans for NIR-SORT 3.0
release by end of 2026



Insights from NIR-SORT

Paper coming soon!

Investigating mechanisms
for fiber misclassifications



FIBR RGTM & FIBRILS

Seeking participants!

Join by July 30, return
results by September 30

Thank you to our many supporters and collaborators:

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Rebecca Geppert, Refiberd

Brad Sutliff, NYDOT

Charlotte Wentz, Coastal Carolina University

Please reach out with questions or input,
we'd love to hear from you.

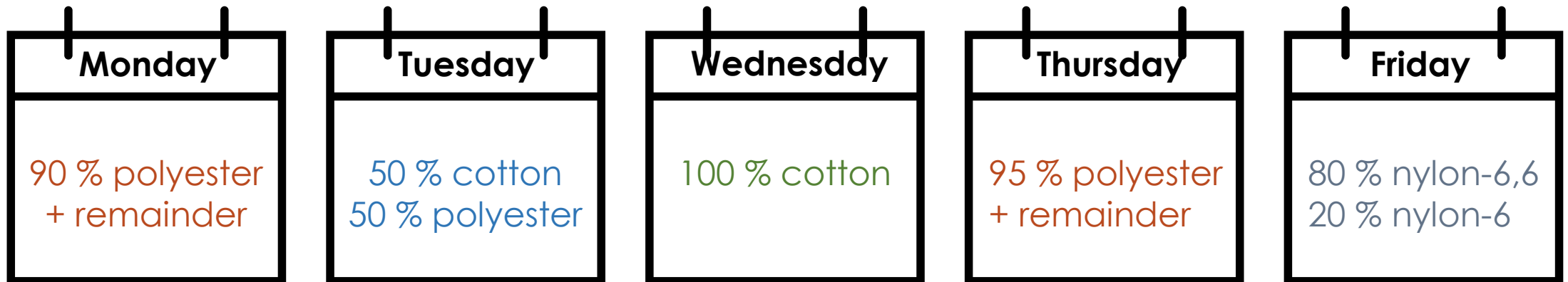
Katarina Goodge: katarina.goodge@nist.gov

How do standards enable textile CE?



Ex1. Bale specifications can support industry scale up.

Without: Sorters are at the whim of their customers (Recyclers).



How do standards enable textile CE?



Ex1. Bale specifications can support industry scale up.

With: Sorters can build inventory and lower costs.

