Virtual meeting 2025

NIST Standards Coordination Office Curricula Development Cooperative Agreement Program

Title: Develop, Implement, and Integrate Standard Education Modules in Mechanical, Chemical, and Industrial Management and Technology Curricula (2023)

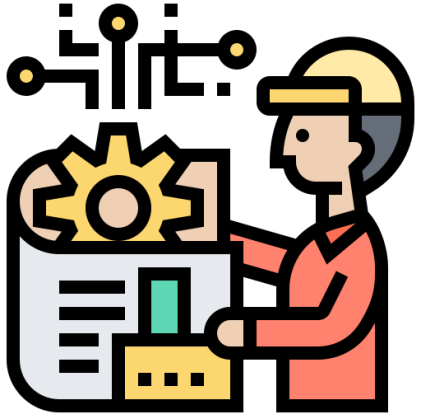
Awardees: Dr. Shah Alam (PI) , Dr. Md Monirul Islam (Co-PI) , Dr. Matthew Alexander (Co-PI)

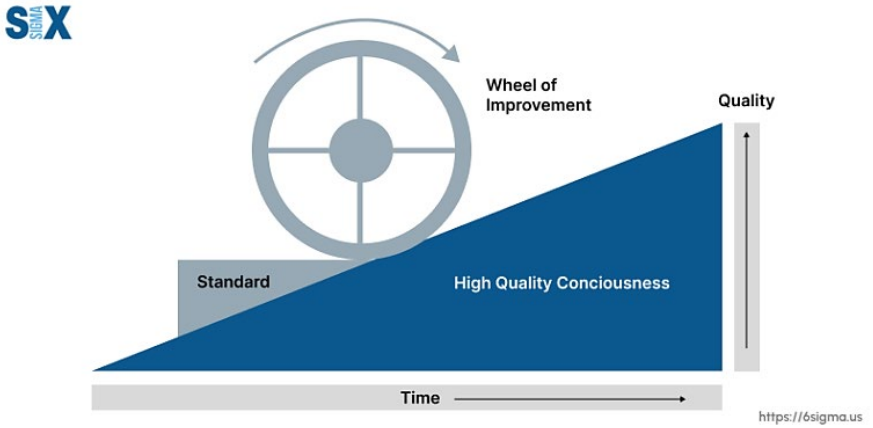
Department of Mechanical and Industrial Engineering, Department of Industrial Management and Technology, and Department of Chemical and Natural Gas Engineering
Frank H. Dotterweich College of Engineering, Texas A&M University-Kingsville

Date: September 10, 2025

Motivation for the Project

- Standardization ensures **uniformity**, **efficiency**, **quality**, **safety**, and **performance**.
- **Consistency** is critical for operational excellence: it **minimizes** performance **variations**, reduces errors, and enhances quality control.
- Process standardization is a **continuous journey**, requiring commitment and ongoing improvement.
- Engineering **graduates** often face challenges when applying standards-based design in practice.



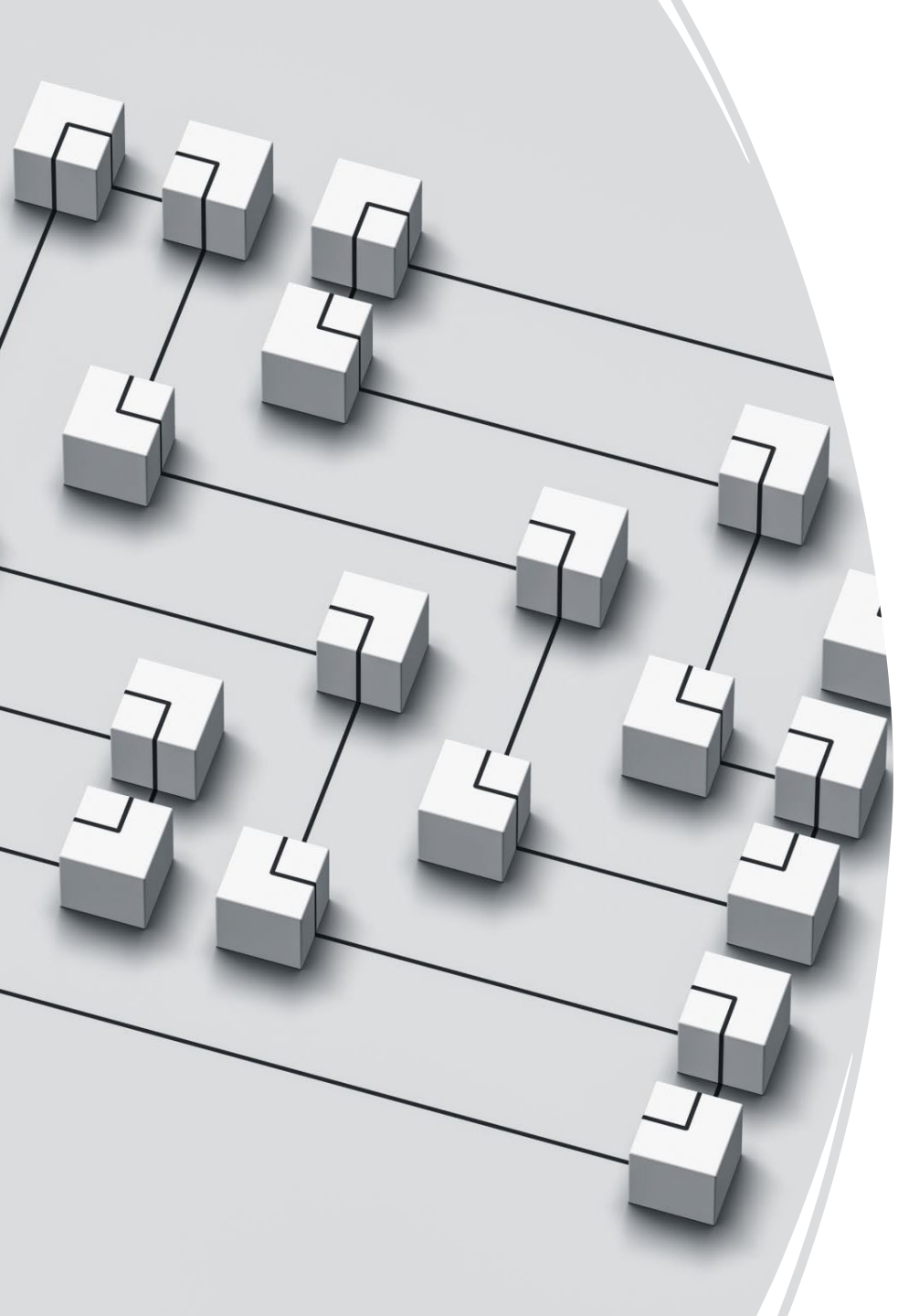


Link: https://www.6sigma.us/business-process-management-articles/process-standardization-for-operational-excellence/

Project Goal and Objectives

- Project Goal
- Improve Mechanical, Chemical, and Industrial Management & Technology curricula by developing course modules that:
  - Integrate standards and standardization knowledge
  - Prepare students to understand the impact and value of standards in engineering

Objective	Description
O1: Familiarize	Introduce students to the standardization process
O2: Guide	Help students identify relevant standards for design, manufacturing, and testing
O3: Educate	Teach students to apply standards in component/system design
O4: Inspire	Encourage future use of standards in professional practice



Scope of Work

- Develop 14 sustainable modules integrated across Mechanical, Chemical, and Industrial Management & Applied Engineering Technology courses.
- Organize 5 webinars on standards and their applications with industry experts.
- Integrate modules into existing courses without disrupting curricula.
- Evaluate effectiveness through assessments.
- Disseminate modules through TAMUK website, professional networks, and conferences (ASEE, ASME, IEEE)

Implemented course modules

Discipline	Level	Targeted Codes / Standards	Course Number
Mechanical Engineering	Junior	1. ASME Boiler and Pressure Vessel Code, Section VIII, Div. 2. 2. ASME Boiler and Pressure Vessel Code, Section II, part D.	MEEN 3350
		3. API 2C Specification for Offshore Pedestal Mounted Cranes.	MEEN 3360
	Senior	4. ANSI/AISC 303-16 Code of Standards Practice for Steel Buildings and Bridges 5. Steel Construction Manual, American Institute of Steel Construction.	MEEN 4351
	Graduate	6. ASTM test method for tensile properties of fiber-resin composites (D3039) 7. ASTM test method for flexural properties of fiber-resin composites (D7264)	MEEN 5316
		8. DNV-GL Rule for classification -Submarine	MEEN 5314
Chemical Engineering	Junior	9. ASTM B543 Heat exchanger tubing	CHEN 3310
	Senior	10. NFPA 36-17 Solvent Extraction Plants 11. ASTM E3027 Sustainable Chemicals Selection	CHEN 4317
		12. ASTM C1274 Ceramic Materials Surface Area Determination	CHEN 4373
		13. ASTM E2535 Safe Handling of Engineered Nanoparticles 14. NFPA 53-16 Oxygen Enriched Atmospheres	CHEN 4341
Industrial Management and Applied Engineering Technology	Sophomore	15. IEEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines 16. IEEE 2030.9-2019: IEEE Recommended Practice for the Planning and Design of the Microgrid	ITEN 2330
	Junior	17. IEEE Std 1562™-2021: IEEE Recommended Practice for Sizing of Stand-Alone Photovoltaic (PV) Systems 18. NFPA 170 Standard for Fire Safety and Emergency Symbols	ITEN 3313
	Graduate	19. ISO 28000:2022 Security and resilience - Security management systems Requirements 20. GS1-128 (formerly known as EAN-128 or UCC-128): Linear Barcode Symbology Specification	IMEN 5350
		21. ISO 45001:2018 Occupational health and safety management systems 22. ISO/IEC 31010:2019 Risk management — Risk assessment techniques	IMEN 5340

What makes a Module?

- What standards and standardization are.
- Importance and applications of standards.
- Development and modification process of standards.
- Major engineering standards (ASME, IEEE, ASTM, ISO, NFPA, etc.).
- Standard databases and search methods.
- Includes real-world examples (e.g., accidents due to noncompliance, design of pressure vessels, layout of chemical plants).
- Integrated webinars with industry experts; recorded content embedded in module

Students' Learning Outcomes and Evaluations

- **Assessment Aspects**
  - Students' ability to **identify the correct standard** for a specific design
  - Students' **understanding of the standardization process**
  - Students' ability to **apply appropriate standards** to components
  - Students' **interest in using standards** in their future career
  - Students' **familiarity with a variety of standards**
- **Assessment Instruments**
  - **Homework & Project Assignments** – measure application of standards
  - **Quizzes & Exams** – test comprehension and accuracy
  - **Pre- & Post-Course Surveys** – capture growth in awareness, interest, and familiarity

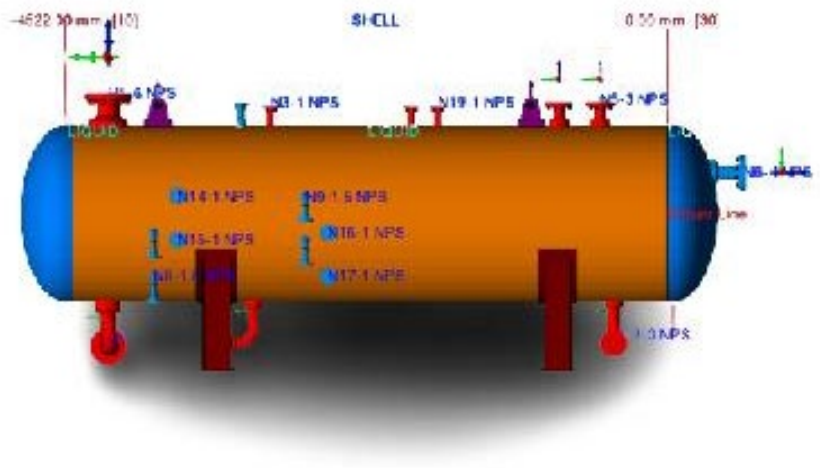
Evaluation Metric

CRITERIA (INSTRUMENT)	UNSATISFACTORY (1)	DEVELOPING (2)	SATISFACTORY (3)	EXEMPLARY (4)	SCORE
Identify proper standard for a particular design problem (homework and course project)	Not identify the proper standard	Identified partial correct standard	Identified near correct standard	Identified proper standard	
Students' comprehension on standardization process (quiz)	Wrong answer	Partial correct answer	Near correct answer	Full answer with example	
Student's familiarity with various standards (quiz and exam)	Wrong answer	Partial correct answer	Near correct answer	Full answer with example	
Student's interest on using standards in future career (Survey)	No interest	Partial interest	Strong interest	Very strong interest	
Use of standard properly (homework and course project)	Not use standard	Somehow used standard	Satisfactory used standard	Excellent used standard	
				Average Score	

Project Timeline and Tasks

- **Year 1: September 2023 – August 2024**
  Goal: Develop 14 modules and integrate 6 modules into courses
  - **Task 1.1:** Collect standards & develop 6 modules – by Dec 2023
  - **Task 1.2:** Organize 5 webinars & implement 5 modules – by May 2024
  - **Task 1.3:** Develop 5 additional modules – by May 2024
  - **Task 1.4:** Develop 5 additional modules – by Sept 2024
  - **Task 1.5:** Collect data for evaluation – by Aug 2024
- **Year 2: September 2024 – August 2025**
  Goal: Integrate 8 modules into 8 courses
  - **Task 2.1:** Integrate 5 modules – by Dec 2024
  - **Task 2.2:** Integrate 5 modules – by May 2025
  - **Task 2.3:** Collect evaluation data – by May 2025
  - **Task 2.4:** Final reporting, assessment & dissemination (TAMUK site, NIST site, conferences) – by Aug 2025

Example Standard 1: Design a pressure vessel according to ASME boiler and pressure vessel code



1. Code Selection

- **ASME VIII (Division 2): Construction of Pressure Vessel Codes**

2. Material Selection

- Based on Appendix B requirements
- **SA-106 B** for Head, Shell, Nozzle, PG, Drain, Inlet, Outlet

3. Design Temperature

- Max: **300°F**
- MDMT = lowest expected service temperature

4. Corrosion Allowance

- **1.5 mm** allowance for air receivers (condensation expected)

5. Shell Design

- Thickness based on circumferential & longitudinal stress formulas
- Uses allowable stress (S) & weld joint efficiency (E)

6. Closure & Head Design

- Ellipsoidal, torispherical, hemispherical per UG-16 & UG-22
- Required thickness ≥ hemispherical equivalent

7. Ellipsoidal Head Design

- Required thickness ≈ **57.4 – 59.7 mm**

8. Nozzle & Reinforcement

- Openings circular/elliptical
- Flow-rate based dimensions: **Inlet = 100 mm, Outlet = 80 mm**

9. Prototype Modeling

- 3D model created in **SolidWorks**

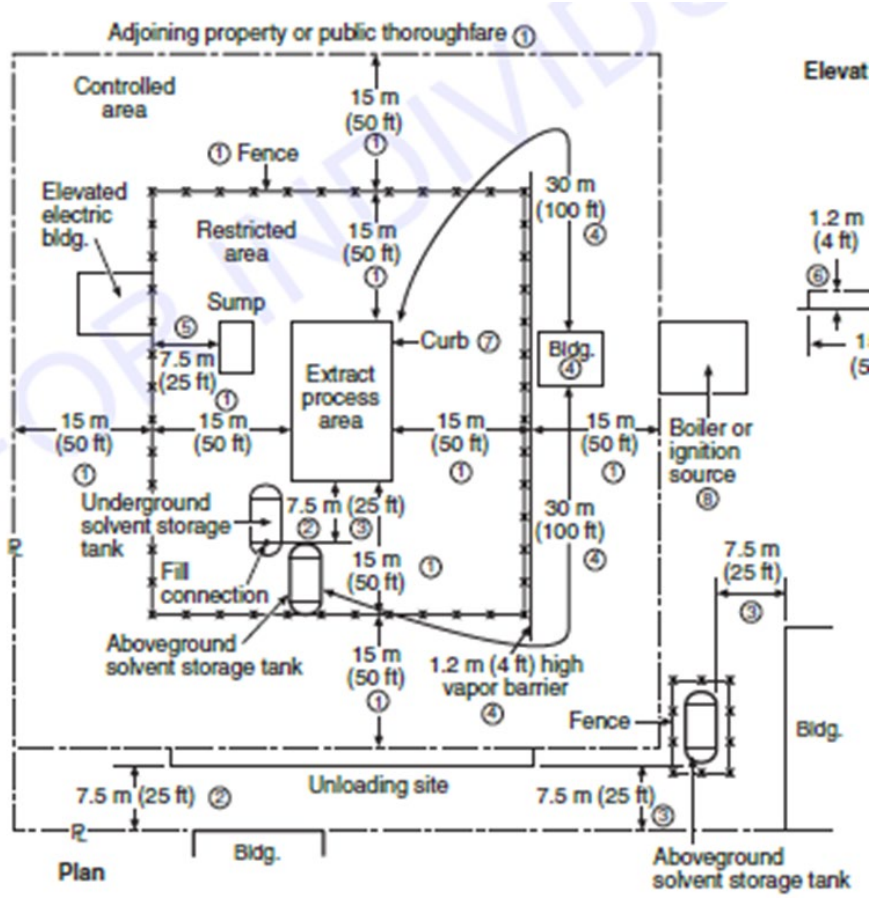
10. Simulation & Analysis

- Finite element analysis (FEA)
- Compare von Mises stresses with allowable stress (S)

10. Modification & Finalization

- Adjust thickness or material grade if stress > allowable
- Finalize optimized design

Example Standard 2: NFPA 36-17 Standard for Solvent Extraction Plants



1. Code Selection

- **NFPA 36 provides code for safety of solvent extraction plants using hexane and similar solvents**

2. Objectives

- Fire prevention
- Structure design requirements
- Hazardous materials handling
- Emergency response

3. Siting

- Extraction process using flammable solvents should be located in the open or specially designed buildings.

4. Fencing / Access

- Industrial fencing shall be installed at least 15 m from the extraction equipment.
- The area from 15 to 30 m from the unit shall be controlled with posted signs.
- Basements and tunnels shall be prohibited within 30 m.

5. Design and Construction

- Building containing extraction equipment must be open air.
- Must be constructed of fire-resistant and non-combustible materials.

6. Drainage and Spill Control

- Must design site drainage so as to prevent the introduction of any released solvent into sewer or storm sewer system.

7. Ignition Source

- Ignition sources not allowed in the extraction building or within 30 m of extraction process unit
- Heating or steam tracing equipment shall not exceed 120 C temperature.

Example Standard 3: IEEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines

1. Pre-Job Planning & Setup

- Safety briefing, equipment check
- Calculate MAD (e.g., 5 m @ 500 kV)
- Verify tool insulation distance (e.g., 6 m @ 500 kV)

2. Installation of Protective Equipment

- Apply temporary grounding on de-energized sections
- Use cover-up equipment for adjacent energized parts

3. Aerial Work & Barehand Procedures

- Access line via helicopter or insulated aerial device
- Workers bonded to line potential using gloving/barehand techniques

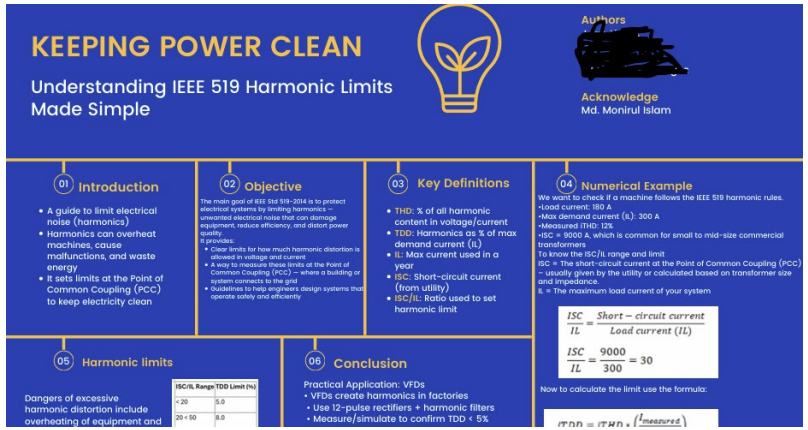
4. Monitoring During Maintenance

- Track leakage & capacitive currents (safe < 1 mA leakage)
- Ensure sparkover ratings exceed possible surges

5. Post-Job Procedures

- Remove grounding & cover-up equipment
- Document MAD, parameters, incidents, and lessons learned

- **Illustrative Example: 500 kV Transmission Line Maintenance**
  - **Setup:** MAD = 5 m; insulated tools = 6 m; grounding rated 40 kA
  - **Access:** Workers lifted by helicopter, bonded at line potential, gloves rated 500 kV
  - **Monitoring:** Leakage current = 0.8 mA; capacitive current = 15 mA; surge = 600 kV (tools rated 700 kV)
  - **Post-Job:** Safe removal of equipment; final report with surge and current data
- **Critical factors that can change the measurement**
- Work Techniques: Aerial Work, Barehand Work, Helicopter Work, etc.
- Protective Measures: Cover-up Equipment, Insulated Tools/Device
- Electrical Currents: Conduction Current, Capacitive Current, Leakage Current



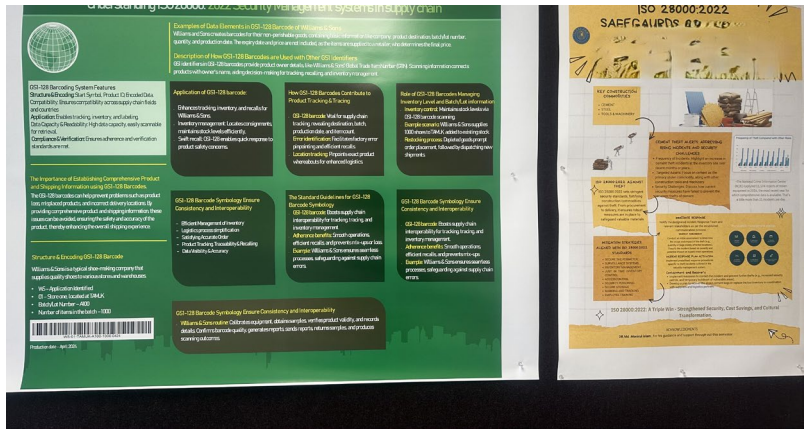
Publication in Progress

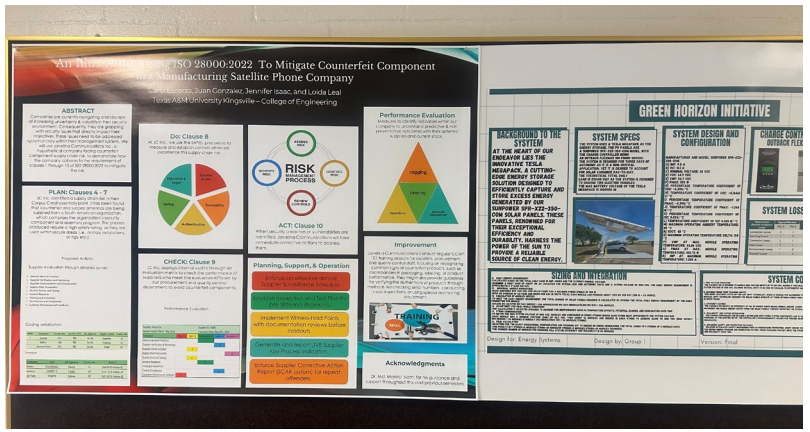
Seminars were given by the following industry representatives a
experts
Brian McFall (Army Corps of Engineers – Coastal & Hydraulics Labo
TLE: Developing the International Guidelines for Application of Natural
sed Features (NNBF)

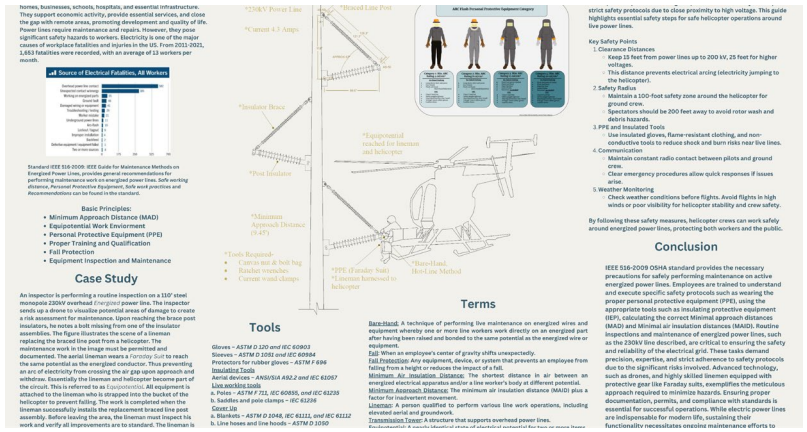
. Mark Roetzel (CDS Muery Engineers) TITLE: Effective Use of Plans
Design Definition

. Richard M. Berry (CDS Muery) TITLE: Standards and Codes in Co

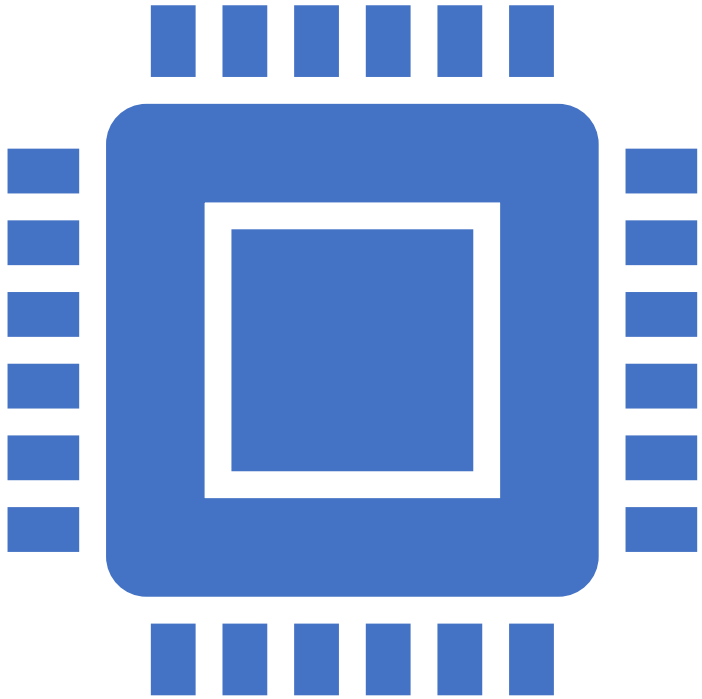
Matthew Alexander (TAMUK) TITLE: Application of Engineering Sta
vironmental Engineering Design







Highlights from Accomplishments



“Standards are the silent architects of innovation.” – ISO

Thank you NIST!