

Exponent®
Engineering & Scientific Consulting

Tymon Nieduzak, Ph.D.

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Professional Profile

Tymon Nieduzak, Ph.D., has developed his expertise in data science and engineering mechanics and is specializing in battery safety, structural health monitoring, applied machine learning, and finite element modeling for complex engineered systems. He helps clients in the automotive, aerospace, energy storage, and civil infrastructure sectors assess risk, investigate failures, and evaluate system reliability by combining experimental and computational methods across advanced sensing, experimental mechanics, and data analytics. His work enables clients to understand complex technical challenges, make informed engineering decisions, and evaluate the performance and reliability of a wide range of products and infrastructure.

Areas of expertise include:

- Battery safety and thermal runaway
- Sensor fusion and embedded sensing
- Structural health and condition monitoring
- Vibration, modal, and computer vision/optical analysis
- Machine learning and anomaly detection
- Finite element and heat-transfer modeling
- Composite materials and experimental mechanics
- Engineering data analytics and predictive modeling

Industries Served

- Automotive
- Electric Vehicles
- Energy Storage
- Aerospace
- Wind Energy
- Utilities
- Civil Infrastructure
- Advanced Materials/Composites
- Manufacturing

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- Sensing Technologies

Dr. Nieduzak helps clients transform sensor measurements, laboratory observations, and engineering data into clear, defensible findings that support product evaluation, risk assessment, reliability analysis, technical due diligence, and failure investigations. His approach combines test planning, instrumentation, data analytics, engineering modeling, and machine learning to evaluate system behavior and identify potential performance or safety concerns. He applies these capabilities to product development, condition monitoring, experimental validation, and investigations that require distinguishing normal variability from emerging damage or abnormal system behavior.

For battery and energy-storage systems, Dr. Nieduzak develops sensing, monitoring, and data-analysis approaches that help identify early indicators of battery degradation, abnormal behavior, and fire risk. He integrates information from multiple sensing technologies to evaluate battery condition and assess thermal, chemical, and structural response. His work includes transformer-based autoencoders for battery anomaly detection, finite element heat-transfer modeling, and experimental validation of monitoring strategies and safety-critical systems. This experience supports battery safety evaluations, thermal runaway investigations, monitoring-strategy development, sensor selection, reliability assessments, and the evaluation of emerging battery technologies.

Dr. Nieduzak also evaluates how loading, fatigue, temperature, damage, and manufacturing processes influence the performance and reliability of structures and materials. His work encompasses multifunctional fiber-reinforced polymer composites, embedded sensing technologies, impact and fatigue testing, full-field deformation measurements, and damage detection. He combines conventional instrumentation with computer vision, three-dimensional digital image correlation, optical motion magnification, vibration testing, and modal analysis to assess structural condition across laboratory, component, and field environments. These methods help clients evaluate structural integrity, identify potential failure mechanisms, prioritize maintenance decisions, and assess long-term reliability.

His data-analysis experience includes time-series analysis, sensor fusion, anomaly detection, classical machine learning, deep learning, and computer vision using Python, MATLAB, Java, and C++. He has developed and applied machine learning models, including long short-term memory (LSTM) and transformer architectures, for engineering data analysis, predictive modeling, and pattern recognition. He applies these techniques to identify emerging risks, evaluate asset performance, detect anomalies, and extract actionable insights from complex engineering datasets. Throughout his work, he emphasizes traceable assumptions, data quality, experimental validation, and physical interpretation to ensure that analytical findings remain clear, defensible, and relevant to engineering decision-making.

Before joining Exponent, Dr. Nieduzak conducted research on intelligent composite systems, battery monitoring, wind-energy infrastructure, optical diagnostics, and plasma-processing technologies across both Columbia University and the University of Massachusetts, Lowell. He collaborated on multidisciplinary academic, industrial, and government-sponsored programs and helped advance sensing, monitoring, and predictive-analysis capabilities for a variety of engineering applications. He has mentored and instructed undergraduate and graduate researchers and communicated technical findings through peer-reviewed publications, technical conferences, program reviews, and industry-facing presentations. He has served and continues to serve in instructional and research appointments at Columbia University, most recently as a Professional Instructional Assistant and lecturer.

Academic Credentials & Professional Honors

Ph.D., Engineering Mechanics, Columbia University, 2026

M.S., Mechanical Engineering, University of Massachusetts, Lowell, 2023

B.S., Mechanical Engineering, University of Massachusetts, Lowell, 2021

First Place Best Paper Award, Society of Plastics Engineers, Automotive Composites Conference &

Exhibition, 2025

First Place Best Graduate Poster Award, Society of Plastics Engineers, Automotive Composites Conference & Exhibition, 2025

Best Researcher Award, Global Composite Awards, 2025

Best Student Paper Award, American Society of Mechanical Engineers, SMASIS, 2024

Dean's Medal for Outstanding Academic Achievement, University of Massachusetts Lowell, 2022 and 2023

Student Research & Community Engagement Symposium Winner, University of Massachusetts Lowell, 2022 and 2023

Craig Douglas Award for excellence in undergraduate research, University of Massachusetts Lowell, 2022

Academic Appointments

Professional Instructional Assistant, Columbia University 2026-Present

Graduate Research Assistant and Co-Instructor, Columbia University 2023-2026

Graduate Research Assistant, University of Massachusetts Lowell 2022-2023

Prior Experience

Ph.D. Researcher, Columbia University, SMaRT Laboratory, 2023-2026

Graduate Researcher, University of Massachusetts Lowell, SDASL and WindSTAR, 2021-2023

Technician, Entegris Inc., 2020-2022

Undergraduate Researcher, University of Massachusetts Lowell, REng|Lab, 2019-2021

Mechanical Engineering Research Assistant, University of Massachusetts Lowell, REng|Lab, Summers 2017 and 2018

Professional Affiliations

Session Chair, SPIE Nondestructive Characterization and Monitoring Conference, 2026

American Society of Mechanical Engineers (ASME)

Society for Experimental Mechanics (SEM)

SPIE

Society of Plastics Engineers (SPE)

Pi Tau Sigma

Tau Beta Pi

Chi Epsilon

Publications

Nieduzak TB, Haller HK, Narayanan D, Feng MQ. Unsupervised transformer-based autoencoder for early lithium-ion battery anomaly detection using multimodal gas and temperature sensing. Available at SSRN 7044633 2026; Submitted.

Nieduzak TB. Multimodal embedded sensing and machine learning-enabled early warning of lithium-ion battery anomalies. Columbia University, PhD dissertation, Academic Commons 2026.

Nieduzak TB, Haller HK, Narayanan D, Feng MQ. Transformer-based autoencoder for robust detection of battery thermal runaway using temperature sensors. SPIE, Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation XX 2026; 13950.

Nieduzak TB, Demo LB, Feng MQ, Aitharaju V, Wu HF. Machine learning approaches in multifunctional composites for EV health monitoring. SPIE, Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation XX 2026; 13950.

Nieduzak TB, Haller HK, Narayanan D, Feng MQ. Transformer-based autoencoder for robust detection of battery anomalies using temperature sensors. Journal of Power Sources 2026; 688(240632).

Nieduzak TB, Zhou T, Tronci EM, Demo LB, Feng MQ. Machine learning predictive algorithm for temperature-sensing electric vehicle battery enclosure. Journal of Nondestructive Evaluation, Diagnostics and Prognostics of Engineering Systems 2026; 9(1):011001.

Nieduzak TB, Demo LB, Feng MQ, Aitharaju V. Multifunctional composites - self-health monitoring technology. Society of Plastics Engineers Automotive Composites Conference & Exhibition 2025.

Demo LB, Nieduzak TB, Feng MQ, Aitharaju V. Fatigue life prediction of self-sensing hybrid FRP composites via electrical resistance monitoring and LSTM neural network. Composite Structures 2025; 119238.

Nieduzak TB, Kadner AC, Bowland CC, Gupta S, Feng MQ. Tensile and fatigue characterization of multifunctional composites. SPIE, Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation XIX 2025; 13436.

Nieduzak TB, Tronci EM, Zhou T, Demo LB, Feng MQ, Aitharaju V. Heat transfer model for temperature-sensing polymer composite EV battery enclosure. Composites Part B: Engineering 2025; (296)112258.

Nieduzak TB, Zhou T, Tronci EM, Demo LB, Feng MQ. Machine learning predictive algorithm for self-sensing electric vehicle battery enclosure. ASME Smart Materials, Adaptive Structures and Intelligent Systems 2024.

Demo LB, Tronci EM, Nieduzak TB, Feng MQ, Aitharaju V. Low-cost sensor-based damage localization for large-area monitoring of FRP composites. Smart Materials and Structures 2024; 33(6):065042.

Nieduzak TB, Tronci EM, Zhou T, Demo LB, Feng MQ. Heat transfer analysis through hybrid FRP composite for self-sensing lithium-ion battery enclosure. SPIE 2024.

Demo LB, Tronci EM, Nieduzak TB, Feng MQ. Damage localization in large-area FRP composites using a parallel array of self-sensing carbon fiber tows. SPIE 2024.

Nieduzak TB. Wind turbine foundation monitoring using optical motion magnification. M.S. thesis, University of Massachusetts Lowell 2023.

Nieduzak TB, Kulkarni N, Niezrecki C, Sabato A. Wind turbine monitoring using optical motion magnification: challenges and opportunities. Structural Health Monitoring 2023.

Nieduzak T, Valente NA, Niezrecki C, Sabato A. Optical motion magnification: a comparative study and application for vibration analysis. Society for Experimental Mechanics Annual Conference and Exposition, Springer Nature Switzerland 2023.

Sabato A, Niezrecki C, Dabetwar S, Kulkarni N, Bottalico F, Nieduzak TB. Advancements in structural health monitoring using combined computer-vision and unmanned aerial vehicles approaches. European Workshop on Structural Health Monitoring 2022.

Nieduzak TB, Veng V, Prees CN, Boutrouche V, Trelles JP. Digitally manufactured air plasma-on-water reactor for nitrate production. Plasma Sources Science and Technology 2022; 31(3):035016.

Boutrouche V, Nieduzak T, Trelles JP. Machine learning approach for plasma image processing: application to plasma-on-water characterization. APS Annual Gaseous Electronics Meeting Abstracts 2021.

Project Experience

Battery Safety & Intelligent Monitoring

- Developed deployable, real-time, transformer-based anomaly-detection machine learning methods using multimodal gas and temperature measurements to identify abnormal lithium-ion battery behavior and precursors of thermal runaway.
- Designed and fabricated multifunctional composites with embedded temperature, strain, and gas sensing capabilities, using finite element heat-transfer modeling and experimental measurements to evaluate battery-cell and composite-enclosure performance.

Structural Integrity & Composite Systems

- Characterized tensile, impact, fatigue, and self-sensing behavior of multifunctional composites using piezoresistive and piezoelectric measurements.
- Developed damage detection, localization, and fatigue-life-prediction methods using low-cost self-sensing carbon-fiber tows and time-series machine learning for automotive composite applications.

Experimental Mechanics & Optical Diagnostics

- Planned and executed static and dynamic testing using accelerometers, strain gages, LVDTs, temperature sensors, oscilloscopes, and microcontroller-based data-acquisition systems, complemented by computer vision techniques like 3D digital image correlation, optical motion magnification, and 3D point tracking to measure full-field deformation, vibration response, and natural frequencies.
- Evaluated wind-turbine foundations, wind-turbine blades, and airship structural members through field monitoring, modal analysis, flexural testing, and comparison of optical and conventional measurements.

Engineering Modeling, Analytics & Product Development

- Built Python and MATLAB workflows for signal processing, sensor fusion, computer vision, and machine-learning evaluation, and integrated results with ANSYS, Abaqus, Altair HyperWorks, and ParaView models.
- Engineered composite specimens, experimental fixtures, prototype components, and a digitally manufactured plasma-on-water reactor using VARTM, CAD, additive manufacturing, laser cutting, and waterjet cutting.

Peer Reviews

Reviewer for Journal of Energy Storage

Reviewer for Scientific Reports

Reviewer for Computers & Graphics

Reviewer for Journal of Engineering and Applied Science