2026 Annual Conference

Poster Showcase

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Poster 1

CKD Smart App Multimodal Non-Invasive Remote Monitoring for Chronic Kidney Disease

Lohith Kumar Reddy Eepuru, Yata Sri Vaishnavi, Sayed Chhattan Shah

CKD is a progressive condition that affects millions of people worldwide and requires ongoing monitoring to assess kidney function, identify complications, and guide management over time. Current CKD assessment relies primarily on clinical visits, laboratory testing, and patient-reported information. Although these approaches are essential to CKD care, they provide periodic rather than continuous information about patient status, and frequent in-person assessment can increase the burden on both patients and healthcare providers. An increasing amount of potentially useful information can be collected outside the clinic through smartphones, smartwatches, home monitoring devices, and patient self-reporting. These technologies create opportunities for more continuous monitoring and greater patient participation in CKD self-management. However, the resulting data are typically fragmented across separate tools. Wearable devices primarily capture physiological and activity measurements, food-tracking applications focus on nutrition, urine-strip tools provide individual home-test results, and blood-pressure and weight devices operate independently. These heterogeneous observations are rarely integrated into a unified longitudinal record designed for CKD monitoring and research. This fragmentation limits the ability to examine relationships among symptoms, physiological measurements, activity, nutrition, home measurements, and clinical indicators over time. It also limits the development of multimodal longitudinal datasets that could support CKD research, patient-specific modeling, and future personalized monitoring. The CKD Smart App addresses this gap by developing a multimodal, non-invasive platform that integrates CKD-relevant patient-generated data from smartphones, smartwatches, home monitoring devices, and patient-reported information into structured longitudinal records to support research, future patient self-management, and clinician-supervised monitoring.

Poster 2

Controlled Compost and Marine Systems for Measuring Bioplastic Biodegradation

Christopher Alesi, Omolola Kafi, Mahdi Vaezi

Global plastic waste reached 353 million metric tons in 2019, and approximately 22 million metric tons leaked into the environment, according to the OECD. Bioplastics may reduce impacts, but a “biodegradable” label is meaningful only when the material is tested under the environment in which it is expected to break down. Compost and marine settings differ sharply in temperature, moisture, oxygen, salinity, and microbial activity; performance in one cannot be assumed in the other. Moreover, mass loss or visible fragmentation can reflect leaching and disintegration rather than microbial conversion of polymer carbon. This project is developing controlled, instrumented systems that pair physical observations with respirometric evidence to evaluate bioplastic biodegradation in compost and seawater. For each environment, a large chamber accommodates multiple specimens for repeated measurement of mass loss, dimensional change, and visible deterioration. Smaller parallel chambers quantify carbon dioxide (CO_2) evolution associated with microbial mineralization. Sensors, microcontrollers, heating elements, aeration hardware, and pumps provide monitoring and control. The compost platform regulates temperature, moisture, and airflow; the marine platform maintains defined seawater conditions while supporting comparable CO_2 measurements. Blank and reference runs will distinguish material-derived signals from background biological activity and establish repeatability. Combining both data streams will show whether a specimen merely falls apart or is converted biologically, producing more defensible comparisons among formulations. The systems are research infrastructure rather than a one-material test, enabling studies of composition, thickness, pretreatment, and environmental conditions. Once validated, they will help researchers screen materials, refine formulations, and substantiate environment-specific end-of-life claims before external certification testing.

Poster 3

A Digital Twin Framework for Proactive Chronic Kidney Disease Management

Tahmid Mostafa Ali, Sayed Chhattan Shah

Chronic Kidney Disease (CKD) is a long-term condition characterized by a gradual decline in kidney function that affects millions of people every year and is associated with high morbidity and mortality rates. Current clinical management of CKD consists of periodic lab testing during clinical visits and delayed symptom reporting instead of continuous monitoring. Other than clinical monitoring, most existing CKD management tools tend to focus on just one of three areas: single-modality physiological data recording, isolated predictive modeling, or reactive decision support. None of them incorporate all of them into a single unified framework. To address this gap, we present a conceptual framework for a digital twin (virtual representation) of the kidney called NephroTwin, which is a patient-centric model designed to transform CKD care from reactive to proactive. The framework consists of 3 interacting layers: multimodal renal data integration, a physiological kidney digital twin model, and a personalized AI engine. The multimodal renal data integration layer is designed to collect and harmonize heterogeneous data from a variety of sources such as wearable physiological sensors, smartphone-based urine analysis, behavioral and lifestyle tracking, electronic health records, and patient-reported symptoms. All these data will be used to create a mechanistic physiological model of the kidney to represent core renal processes including glomerular filtration, renal blood flow, tubular transport, and fluid balance. A machine learning model will be used alongside the mechanistic model to capture complex relationships among the multimodal signals. The output from the digital twin can be used by a personalized AI engine to support early detection and long-term management of CKD. The implementation of the data integration layer is currently in progress and will lay the foundation for the implementation of the digital twin model and personalized AI engine.

Poster 4

The Stress-Gut Connection: Prairie Voles (Microtus ochrogaster), as a Translational Model for Intestinal Barrier Dysfunction

Adam Baldocchi, Pallavi Singh

Everyday psychological stress does more than affect our mood, it directly weakens the protective lining of our digestive system and lays the groundwork for chronic gut inflammation. While researchers understand that stress disrupts this mucosal barrier, standard laboratory mice and rats are highly inbred and isolated which fails to reflect how real-world social stress impacts human health. To bridge this gap, our research have utilized the prairie vole (Microtus ochrogaster), a socially complex rodent whose social bonds and stress responses closely mimic human dynamics.

This literature review synthesizes existing research of the microbiota-gut-brain axis (MGBA) to evaluate the prairie vole as a translational model to unravel the mechanism between stress and gut disorders. We have surveyed current findings on how stress hormones and shifts in gut bacteria compromise the key seal-forming proteins such as occludin and claudin-1 which keep the intestinal wall intact. Furthermore, we assessed published evidence on non-invasive indicators. Specific targets included stool-based markers like fecal calprotectin and bacterial imbalances which may signal early gut damage.

By mapping cross-disciplinary findings across neurobiology, gastroenterology, and behavioral ecology, this review outlines what is currently known about social stress as a driver of gut vulnerability. Connecting these fields highlights a clear “why” for regional biotechnology and healthcare innovation: understanding these stress pathways will enable the development of accessible, non-invasive screening tools and preventative therapies to improve gut health specifically under stress.

Poster 5

Predicting Visual Attention in Children with Autism Spectrum Disorder versus Typically Developing Children

Pukar Bhandari, Ying Chen, Jun Qin

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by differences in social communication and interaction, as well as restricted and repetitive behaviors. Children with ASD also exhibit distinctive visual attention patterns, creating challenges for computational models designed to predict human gaze. This study systematically evaluates whether existing visual saliency models, computational methods for predicting visual fixation, adequately characterize the viewing behavior of children with ASD. Using a publicly available eye-tracking dataset comprising children with ASD and typically developing (TD) children, we benchmark eight state-of-the-art saliency models, from classical feature-based methods to modern deep neural networks-based models. Model performance is assessed across six complementary evaluation metrics, enabling a comprehensive comparison of predicted and observed fixation patterns across the two groups. Our results show that saliency models perform substantially better on TD children fixation data but exhibit marked performance degradation when applied to fixation patterns of children with ASD. This population-dependent performance gap suggests that saliency models developed primarily around neurotypical visual behavior may not adequately represent the distinctive attention patterns observed in ASD. These results reveal a structural gap: the existing saliency models are built and tuned for neurotypical viewing behavior and fail to capture the atypical attention patterns that define ASD. By quantifying this gap, our work lays the groundwork for ASD-tailored computational tools with direct applications in life sciences and regional innovation in health and education, including earlier screening, personalized learning technologies, and data-informed neurodevelopmental care.

Poster 6

Image-based Artificial Intelligence (AI) Techniques to Improve Medical Diagnostics and Early Disease Detection

Ying Chen

Medical imaging plays an important role in modern medical diagnosis and early detection of diseases. Recent advances in artificial intelligence (AI), particularly deep learning and machine learning, have created new opportunities in enhancing image-based medical diagnostics to contribute to advancements in life sciences. This research investigates image-based AI techniques for improving medical disease classification, medical image reconstruction, and medical data processing. Complementary image-based AI approaches are presented, including deep learning techniques in computer-assisted diagnosis for two-dimensional chest image based pulmonary diseases classification, and machine learning techniques in three-dimensional limited-view digital tomographic imaging to improve image reconstruction and tomographic simulation. These approaches aim to extract meaningful diagnostic information from medical images while addressing challenges associated with automated disease classification and limited imaging data. The results demonstrate that image-based AI techniques have great potential in assisting the automated detection of imaging abnormalities in diseases classification. The image-based AI also enhances the capabilities of limited-view digital tomographic imaging to improve early detection by providing new insights into the tomographic reconstruction and data processing. Collectively, this research highlights the potential of image-based AI techniques to advance medical applications and support life science related research, contributing to improved diagnostic capabilities and early disease detection.

Poster 7

Using a Portable Fluorescent Imaging Platform for Automated Real Time Data Visualization with a Smartphone and AI Model.

Nicholas Figarelli, Vahidreza Shojaei, Mona Dehghankar, Logan Tindle, Hui Li

Fluorescent Imaging is highly regarded in the field of diagnostics for its high sensitivity, high specificity, and its multiplexing capabilities. However, current methods require specialized equipment and personnel to handle imaging. This makes the imaging process very difficult and lengthy. Because of this, we developed a fluorescent detection “box” that is compact and highly automated with data analysis. The box takes a device that has been loaded with a biological sample and fluorogenic dye, splitting into nine independent wells that can be modified for different parameters. While the device is being incubated, an LED light is used to excite the dye and cause it to emit a signal to indicate active cells. Along with the box, a smartphone app is used to take photos of the device inside it over time. The smartphone app allows the user to customize when the LED turns on to activate the dye, as well as how many photos the device takes in an imaging session. Through the box and smartphone app, a user can see the signal change in a sample in real time. Furthermore, we have produced an AI model that can detect the fluorescent signals produced in the box. The photos taken by the phone can be input into the model, which automatically detects the location of the previously mentioned wells. These locations get read for their signals and an output graph shows how each well had their signal changed over time. We hope that this device can allow users to use the benefits of fluorescent imaging while being portable, highly automated, and accessible.

Poster 8

Mechanical Characterization of PLA/PBAT and PHA/PBAT Hemp-filled Biocomposites

Ian Janusz, Omlola Kafi, Mahdi Vaezi

Hemp processing generates fiber, dust, powder, and hurd streams with distinct morphologies and interfacial behavior. Converting these materials into biocomposite fillers can reduce polymer demand and create value-added uses for agricultural residues, but stiffness gains may be accompanied by losses in strength or ductility. This study examined how filler form and polymer-blend composition affect the tensile performance of poly(lactic acid)/poly(butylene adipate-co-terephthalate) (PLA/PBAT) and polyhydroxyalkanoate/PBAT (PHA/PBAT) biocomposites. PLA and PHA were blended separately with PBAT and compounded with untreated chopped hemp fiber, waste hemp dust, powdered hemp fiber, or cannabinoid hemp hurd by single-screw extrusion, followed by injection molding and tensile testing. The PHA/PBAT/hemp-fiber and PLA/PBAT/compatibilized-hemp-powder formulations remained flexible, with elastic moduli of 0.23 and 0.27 GPa, respectively. Adding 20 wt.% waste hemp powder to PLA/PBAT increased modulus from 0.57 to 0.63 GPa, but tensile strength and strain at break declined relative to the unfilled blend. Likewise, 20 wt.% cannabinoid hemp hurd increased PLA/PBAT modulus from 0.66 GPa to 0.75-0.89 GPa, while tensile strength decreased from 65.0 MPa to 51.1-56.4 MPa. These results show that hemp residues can stiffen bioplastic blends, but filler addition alone does not guarantee reinforcement. Polymer selection, filler morphology, and fiber-matrix compatibility must be tuned together to manage the tradeoff among stiffness, strength, and flexibility. The findings support matching hemp-processing residues to molded products according to measured performance rather than treating all fillers as interchangeable.

Poster 9

Quantum Sensing and Medical Practice

Andy Jeon, Jay Jeon

Quantum sensing is an application of quantum mechanical principles in order to sense any kind of physical change with extraordinary sensitivity, which offers new possibilities to measure biomedically. This paper reviews the use of two main techniques of quantum sensing – "quantum magnetometry" and "quantum interferometry" and analyzes their present and potential contribution to medicine. Quantum magnetometry, using superconducting quantum magnetometers, including superconducting quantum interference devices (SQUIDS), allows detecting extremely weak magnetic fields. Quantum magnetometry also includes various technologies based on superconductivity with possible medical applications related to the heart and others. On the other hand, quantum interferometry uses quantum effects of superposition and in some cases even entanglement in order to make precise measurements. Despite the great potential, quantum interferometry still remains mostly experimental in biomedicine. The paper reviews the existing barriers for the clinical application of quantum interferometry, including problems with cryogenic cooling, noise, complexity and costs. Finally, it discusses the way of how future progress in quantum sensing can allow making increasingly accurate measurements of biomedical processes.

Poster 10

Smaller, Faster, Just as Accurate: A Compact Deep Learning Model for Rapid Detection of E. coli and Salmonella

Bibek Koirala, Anas Alsobeh, Namariq Dhahir, Amer AbuGhazaleh, Abdur Rahman Bin Shahid

Conventional culture-based detection of foodborne pathogens requires 18–24 hours or longer, delaying intervention in the food supply chain. This study evaluates whether a carefully designed compact deep learning model can achieve early detection of Escherichia coli and Salmonella Typhimurium micro-colonies with accuracy comparable to that of large foundation models. A dataset of 2,000 phase-contrast microscopy images was acquired between 2 and 4 hours of incubation on plain agar and an onion food matrix. A ResNet-50-based segmentation model with deep supervision (28.3 M parameters) was compared with a Segment Anything Model (SAM) based model (94.5 M parameters) and two DINOv3-based models, all trained and evaluated under the same protocol. Both species were reliably detected and identified within 2 hours of incubation. The compact model achieved the highest foreground IoU (0.901), Dice score (0.944), boundary F1 (0.962), and panoptic quality (0.825), with a mean colony-count error of 0.16 per image for E. coli. It was also the fastest model at 8.1 ms per image, 22 times faster than the SAM-based model while using 10 times less computation and 14 times less GPU memory. Two-hour Salmonella remained the most challenging condition for all models (F1 0.75–0.91), indicating a limitation of the visual signal rather than of model capacity. These results show that a compact model can enable accurate, low-cost screening of foodborne pathogens within 2 hours.

Poster 11

Pan-Genome Analysis of Elizabethkingia Reveals Extensive Diversity of Carbohydrate-Active Enzymes

Chen Shicheng, Shicheng Chen

Elizabethkingia anophelis is an emerging opportunistic pathogen that occupies remarkably diverse ecological niches, including mosquito vectors, aquatic environments, and human hosts. Despite its ecological versatility, the genetic basis underlying carbohydrate utilization and adaptation to distinct nutritional environments remains poorly understood. In this study, we performed a population-scale comparative genomic analysis of E. anophelis genomes representing mosquito-associated, environmental, and human clinical isolates collected from diverse geographic regions. Carbohydrate-active enzymes (CAZymes) were identified using the dbCAN pipeline, and polysaccharide utilization loci (PULs) were predicted to characterize the carbohydrate metabolic potential of the species. Comparative analyses revealed that E. anophelis possesses a diverse repertoire of glycoside hydrolases, glycosyltransferases, carbohydrate esterases, polysaccharide lyases, carbohydrate-binding modules, and auxiliary activity enzymes, although the abundance and distribution of individual CAZyme families varied among phylogenetic lineages and ecological sources. Population-wide analysis further identified conserved carbohydrate utilization systems shared across the species, together with lineage-specific CAZyme families and predicted PULs that may contribute to metabolic diversification. Collectively, our findings provide the first comprehensive population-scale characterization of carbohydrate utilization in E. anophelis and establish a genomic framework for understanding the metabolic adaptations that may contribute to its ecological versatility and persistence in diverse environments.

Poster 12

Estimand-Aware Evaluation of Personalized Neoantigen Ranking at the Decision Unit

David Weng, Na Yang, Yanhui Guo

Personalized ranking systems are often evaluated by pooling all scored items even when the actual action selects alternatives within one patient or another local decision unit. We develop a decision-unit concordance framework that separates equal-unit operational performance, pair-weighted within-unit performance, between-unit concordance, and pooled area under the receiver operating characteristic curve. The framework identifies how informative pair counts change weighting, proves that within-unit pairs become an asymptotically vanishing fraction of the pooled metric as the number of bounded-size units grows, constructs two decision-equivalent score systems with an exactly quantified pooled-AUC separation, and provides decision-unit influence-function inference with whole-unit resampling as a robustness check. Simulations verify the structural identities and show severe undercoverage when clustered pair information is treated as independent. In a frozen personalized neoantigen-vaccine benchmark, 99.80% of 577,800 pooled positive-negative pairs across 348 patients are cross-patient; no predictor-superiority claim is supported on the estimand-aligned subset. In MovieLens 100K, removing a user-specific score offset leaves every within-user ranking and equal-user concordance unchanged while pooled AUC decreases from 0.7801 to 0.7244. These results show why the decision unit and target estimand should be stated explicitly when model outputs are used for local personalized ranking.

Poster 13

How Long Does Tissue Take to Relax? Poroelastic Time Scales of Hydrated Soft Materials from Indentation Simulations

Cayla Weygand, Md Mahmudul Hasan

In the human body, soft, hydrated tissues such as muscles, cartilage, and the cornea are often put under repeated mechanical loads from everyday activity. Commonly, the mechanical properties of these soft-water filled materials are tested by compression, tensile testing, and MR elastography which reports a single elastic modulus. However, these tests leave out poroelastic behavior, the time-dependent response caused by fluid flowing through the tissue under load. Measuring this directly takes a long time as the fluid moves from under the probe to surrounding tissues and into equilibrium, as a result, this behavior is rarely studied. We suspected that under constant-depth indentation loading, the tissue would undergo stress relaxation due to the fluid flowing through the solid, showing an exponentially decaying reaction force until reaching an equilibrium. The time scale for most cases takes is quite long, for this reason, we chose to use finite element simulations for experiment to indent materials ranging from stiff, low permeability cartilage to soft muscle tissue at several length scales. This relaxation time was defined as the time for the reaction force to reach its equilibrium value. The estimated relaxation time from each simulation reflects the tissue's permeability and stiffness. Because the fluid must travel across the contact region, the time constant is expected to scale with the square of the contact length. Comparing instantaneous and equilibrium forces further reveals how load is shared throughout the material. Because relaxation time depends on tissue permeability, which changes with disease, the results of this work support earlier detection of diseases such as osteoarthritis and gain a better understanding of drug transport within tissues.

Poster 14

Smartphone - Based Urine Strip Analysis for Chronic Kidney Disease Monitoring

Sri Vaishnavi Yata, Huang, Xiaolan, Shah Sayed Chhattan

Chronic Kidney Disease (CKD) requires continuous monitoring of urinary biomarkers to track kidney function and detect complications early. Traditional urine strip analysis depends on manual visual interpretation, which is subjective, inconsistent across readers, and unsuitable for frequent home-based monitoring. Existing approaches rely on controlled lighting, older CNN architectures, or analyze only a single parameter at a time. The most recent related work YOLOv11-SAMNet, applies a similar architecture to urine sediment under microscopy but provides no colorimetric interpretation or clinical alert output. None deliver a complete end-to-end clinical report pipeline from an uncontrolled smartphone photograph across all ten strip parameters simultaneously. This work addresses that gap by fine-tuning YOLOv11m on 2,691 labelled images to detect all ten chemical pads, then applying Meta SAM - Meta AI's Segment Anything Model (trained on 11 million images) as an automatic annotation upgrader, converting 4-point rectangle labels into precise 8-20 point polygon masks. This single intervention improved pad detection mAP50 from 0.469 to 0.915, a 95% improvement. An HSV colorimetric engine maps each pad's pixel-level color to a clinical value, generating a structured report with automatic abnormal value alerts without human interpretation. The pipeline identified a CKD-consistent pattern of elevated Protein, Blood, and acidic pH and detected bacterial UTI across 17 test images. The Roboflow dataset of 2,691 images follows a 95.4/3.9/0.6 train-validation-test split, limiting the test set to 17 images. Future directions include integrating additional urine strip datasets and advancing the pipeline through two-stage detection, learned color classification and other. This pipeline is developed as a component of a larger non-invasive multimodal wearable chronic kidney health monitoring platform for continuous longitudinal CKD monitoring outside the clinic.

Poster 15

Resistome Simplification but Not Elimination: Antibiotic Resistance Genes and Residues Across Urban and Rural Wastewater Treatment Plants

Barsha Bhattarai, Rachel Poretsky, Pallavi Singh

Antibiotic Resistance (AR) poses a grave global health threat with the potential to cause more than ten million deaths per year in the coming decades if not effectively addressed. The environmental spread of AR is increasingly recognized as a critical, yet understudied, driver of this crisis. This study employed wastewater-based epidemiology to monitor and identify AR patterns and drivers both at the population and environmental levels. We hypothesized that urban wastewater treatment plants (WWTPs) would show greater resistome complexity and antibiotic residue burden than rural plants, and that treatment would substantially reduce antibiotic resistance genes (ARG) abundance before river discharge. To test this, samples were collected bimonthly over one year from six WWTPs (three urban, three rural; n = 72) along with their corresponding upstream (n = 36) and downstream (n = 36) riverways. Metagenomic sequencing was used to characterize the resistome, liquid chromatography-mass spectrometry (LC-MS) was used to quantify antibiotic residues. Microbial community composition did not differ significantly between urban and rural WWTPs, with Pseudomonadota consistently dominant (~40%) across wastewater and river samples, followed by Bacteriodota (~15%). LC-MS detected multiple antibiotic compounds, including azithromycin, cephalexin, sulfamethoxazole, ciprofloxacin, clarithromycin, and difloxacin. These findings indicate comparable urban-rural resistome burden points to AMR dissemination as a broader, non-urban-specific phenomenon. Future work will use quantitative microbial risk assessment to estimate seasonal human exposure risk to carbapenem- and cephalosporin-resistant bacteria. Collectively, this study underscores the value of wastewater-based epidemiology for monitoring environmental AMR and its associated public health risks.

Poster 16

Pharmacy Deserts in Rural and Downstate Illinois: A GIS-Based Assessment of Access and Vulnerable Populations

Stacey Brown-Amilian, Jennifer Hookstra, Jayme Swanke,

Objectives: To evaluate spatial disparities in pharmacy accessibility in rural and downstate Illinois and examine how the distribution of pharmacy deserts intersects with sociodemographic vulnerabilities across census tracts.

Methods: This study utilizes geographic information systems (GIS) and geospatial processes to map geographic variations in retail pharmacy access. Tract-level data are integrated with sociodemographic covariates, including median age, educational attainment, and mobility indicators, to quantify disparities in proximity to these critical health points.

Results: Spatial analysis reveals that pharmacy deserts are highly concentrated in older populations, specifically those near-retirement and early-retirement populations, those with less educational attainment, and economically vulnerable and marginalized areas. In these communities, pharmacies function as vital, low-barrier hubs for preventative public health infrastructure rather than mere commercial spaces. The resulting geographic barriers disproportionately burden populations characterized by lower mobility and higher socioeconomic vulnerability.

Conclusion: The spatial mismatch in pharmacy access may create barriers to healthcare access by isolating populations with the highest clinical needs. This geographic gap is particularly concerning given the well-documented reliance on prescription medications, polypharmacy management, and face-to-face clinical counseling among older adults. Addressing these spatial inequities requires targeted policy interventions and structural support for independent retailers to ensure that geographic isolation does not dictate health resource availability for aging and vulnerable demographics.

Poster 17

LC-MS Analysis of Motorsport Contribution to 6PPD-Q Pollution in Proximal Water Systems

Nevannah Harlan, Kevin Tucker

The transformation product of a tire additive, 6PPD-Quinone (6PPD-Q), has quickly gained notoriety as a contaminant of emerging concern (CEC), largely attributed to its role in causing widespread mortality events of coho salmon and its LC50 in the parts-per-trillion (ppt) range. Understanding the transport and temporal variability is crucial to inform mitigation strategies. To this end, a year-long event-based analysis of 6PPD-Q was conducted to trace its transportation through a connected urban-industrial-riverine system influenced by motorsport activity using LC-MS/MS analysis and EPA Draft Method 1634. Field sites were located on the Mississippi River or Metro East IL that are upstream and downstream to a motorsport racetrack. To establish baseline monthly variation, surface water samples were collected monthly in triplicate from October 2025 to January 2027. Further sampling was conducted before and after two race events, IndyCar and NASCAR, to assess high intensity event contribution. Based on the sampled period from October 2025 to July 2026, as well as pre- and post- IndyCar race, the racetrack-adjacent sites consistently exhibit the highest 6PPD-Q concentration compared to other sampling sites, with the highest concentration quantitated at195 parts-per-trillion.

Poster 18

Turning Laundry Lint into Strong Injection-Molded PLA/PBAT Composites

J. C. La Barbera, Omolola Kafi, Mahdi Vaezi

An International Union for Conservation of Nature assessment identified washing synthetic textiles as a major source of primary microplastic releases to oceans. Fiber shedding also creates dryer lint, a concentrated mixture of short natural and synthetic fibers that is captured at the point of use yet commonly discarded because its variable composition and low apparent value complicate recycling. This study investigates whether lint can instead serve as a functional reinforcement in scalable, higher-value molded products. Cleaned and ground household lint was compounded at 5–15 wt% with a 95/5 wt% blend of polylactic acid (PLA) and polybutylene adipate terephthalate (PBAT). PLA supplies renewable-content stiffness, PBAT improves toughness and processability, and the mixed lint provides a recovered fibrous phase. Unlike earlier lint-composite work based mainly on compression molding and narrowly controlled processing, the blends were injection molded, a manufacturing route capable of producing complex parts rapidly and repeatably. Tensile testing showed ultimate strengths of 48–55 MPa, maximum strains of 22–26%, and elastic moduli of approximately 3 GPa across the investigated formulations. These strengths substantially exceed the 15–25 MPa range reported for prior compression-molded lint-derived materials, while the measured strain indicates that useful deformability was retained. The results demonstrate that heterogeneous laundry lint can be incorporated into PLA/PBAT without reducing the material to a low-performance filler application. By transforming an unavoidable, collected textile residue into a reinforcing feedstock, the approach can displace a portion of virgin material, retain value in the polymer system, and support circular manufacturing. Ongoing work will identify how lint composition and loading affect processing consistency, durability, and end-of-life behavior so that suitable noncritical consumer or industrial applications can be selected.

Poster 19

Surveillance of Bacteriophages Targeting Carbapenem-Resistant ESKAPEE+C Bacteria in Wastewater

Paula Luengo Carretero, Pallavi Singh

Bacterial infections are treated with antibiotics; however, the overuse and misuse of antibiotics has accelerated the emergence of antimicrobial resistance (AMR), making it a global threat. AMR in ESKAPE bacteria (Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter) is of clinical relevance, causing 2.8M infections annually. In this study, an expanded ESKAPEE+C was developed to incorporate Escherichia coli and Citrobacter bacteria for bacteriophage (phage) surveillance. Whilst AMR clinical surveillance is comprehensive, environmental surveillance has been limited. Wastewater treatment plants (WWTPs) serve as reservoirs of antibiotic-resistant genes and resistant bacteria, which can further spread into riverways and the environment. Phages are natural bacterial predators and are found where their hosts thrive; thus, they could potentially be used to identify potential AMR hotspots. We hypothesize that phage activity and distribution will differ between seasons, and the pattern will be different across all sample types. To test this, 1L samples (n=30) were collected: hospital waste (n=6), WWTP influent (n=6), WWTP effluent (n=6), upstream of WWTP (n=6), and downstream of WWTP (n=6) every 30 days for 3 months over Fall and Summer. Samples were enriched, centrifuged, filtered (0.22 µm), serially diluted, and plated for phage isolation. Predominantly, phages against Acinetobacter (18.8%) were recovered more frequently, followed by Citrobacter (17.8%). Phage recovery was highest in WWTP influent (30.7%) and hospital waste (28.7%), and higher in Fall (61.4%) than in Summer (28.7%). This work demonstrates that aquatic environments are reservoirs for phages and key to microbial dynamics. Environmental surveillance of phages may enable early detection of AMR and guide precision interventions in WWTPs.

Poster 20

Freeze-Thaw Damage In Granular Geomaterials Integrating Pore-Scale Thermodynamics with Contact Network Degradation

Bijay Nepal, Suvechha Dhakal, Nitin Tiwari

Freeze-thaw weathering is a critical deterioration mechanism in cold-region geomaterials, yet existing theoretical frameworks do not adequately capture the multiscale physics governing progressive damage. This work develops an analytical model unifying pore-scale thermodynamics with granular contact mechanics. Five mechanisms are integrated: pore-size dependent ice formation; temperature-dependent bond degradation; cryogenic suction-driven water redistribution; anisotropic freezing-front propagation; and ice-lens amplification in topologically vulnerable zones with low coordination numbers. Dual-component damage parameters separately quantify bond fracture Db and contact loss Dl, coupled with coordination-number evolution toward the isostatic threshold $Ziso = 2d$. The ice-induced radial strain emerges from multiplicative coupling of baseline thermodynamic expansion with five enhancement factors. Three principal results are established. First, a critical water-saturation threshold $Sw\ cr$ exists below which damage vanishes; for weakly cemented granular materials it ranges from 66% to 83%, providing a basis for drainage-based mitigation. Second, the temperature dependence is nonmonotonic, with maximum damage near −10 ◦C, where the product of ice content and inverse bond strength peaks. Third, contact loss of 14–25% predicts mechanical instability through coordination reduction to the isostatic limit, consistent with observed failure at total damage of 30–50%. Damage rates scale inversely with bond tensile strength and linearly with porosity and saturation. The framework predicts damage localization in bands perpendicular to thermal gradients and explains accelerated deterioration through positive feedback between ice accumulation and coordination reduction.

Poster 21

Distributionally Robust Control of Agrivoltaic Systems for Coordinated Energy and Crop Production

Md Sayed Hasan Rifat, Billy G Ram, Md Zahidul Islam

Agrivoltaic systems co-locate photovoltaic panels and crops on the same land, using dual-axis tracked panels that continuously adjust their orientation to balance electricity generation against the sunlight delivered to the crops below. System performance depends critically on the tracking controller, yet existing designs are typically formulated under idealized, fully known operating conditions. In practice, agrivoltaic operation faces substantial uncertainty, including variability in incident sunlight and imperfections in the environmental data the controller relies on, such as sensor noise, data loss, and data manipulation. This uncertainty is largely overlooked in current designs, leaving a gap between simulation and dependable field operation.

This work pursues two objectives. First, we formulate and optimize the combined objective of maximizing crop yield and electricity generation through coordinated dual-axis tracking, capturing the trade-off between shading the crop and harvesting solar energy. Second, we develop a distributionally robust dual-axis controller that sustains high crop yield and electricity generation under realistic uncertainty in sunlight and in the environmental data stream. The robust formulation explicitly accounts for the distribution of possible operating conditions, preserving performance when the true conditions deviate from nominal assumptions.

To develop and evaluate the controller, we build an integrated simulation of the agrivoltaic system, combining a hardware-realistic Simulink model of the photovoltaic array and its maximum-power-point-tracking power electronics, a physics-based photovoltaic power model, and an EPIC crop-growth model, all driven by real environmental data. This framework captures the complete chain from environmental sensing, through the tracking controller, to both the electricity produced and the end-of-season crop yield, providing a realistic basis for designing dependable controllers.

Poster 22

Medical Emergency Response Transport Team (MERTT)

Gavin Visser, Jake Smith, Ryan Whitener, Aiden Hanson, Hafizur Rahman MD

In emergency situations, most emergency vehicles do not have the off-course traversing capability to drive through extreme conditions. Our approach to solving this problem includes a lift-mechanism system to rescue patients. In a rough environment where the average emergency response vehicle is not able to give patients in critical condition the care they need, our smaller and more rugged vehicle is able to reach these patients with a smaller crew than the average vehicle. Our lift mechanism is able to move the patient into the bed of our vehicle and the canopy shields them from any environmental or atmospheric danger. The GPS enabled the crew to never be lost when in these remote areas, and installed lights to improve visibility.

Poster 23

The Impact of Immigration Infrastructure on Water Quality: Quantifying Microplastic Pollution in the Rio Grande at Eagle Pass, Texas

Emma Prott, Adriana E. Martinez

The U.S.–Mexico border has undergone significant changes amid intensified international relations and efforts to deter undocumented immigration. In the Rio Grande, approximately 500 interconnected plastic buoys have been deployed as an aquatic barrier, potentially introducing a source of plastic pollution into the river. Increased human activity and ongoing mechanical and chemical abrasion may accelerate the release of microplastics from the buoys into the surrounding water. In addition to the potential microplastic contamination, the barrier may alter sediment deposition patterns and river dynamics, raising concerns about ecosystem health, drinking water quality, and U.S. compliance with international waterway treaties. To evaluate the buoys as a potential source of microplastic pollution, we collected 49 one-liter water samples from two upstream reference locations and on both the U.S. and Mexican sides of the barrier. Samples were collected using the grab sampling method while facing upstream, with duplicate samples collected at each sampling location. The samples were then processed through organic digestion, plastic density separation, and heating before analyzing them with Laser Direct Infrared Spectroscopy (LD-IR). This analysis will characterize the shape, size, abundance, and polymer composition of the plastics detected in the samples, helping assess the potential contribution of the aquatic barrier to microplastic pollution in the Rio Grande. Understanding these impacts is essential for evaluating the environmental consequences of the barrier's construction, maintenance, and continued presence, as well as the potential risks to river health and the communities that depend on it.

Poster 24

Multimodal AgTech for Crop Health and Yield Forecasting in Illinois

Kiran Beerelli, Yanhui Guo

Illinois agriculture depends on timely information about crop health, expected yield, and changing environmental conditions. However, remote-sensing and agricultural analytics systems often treat crop monitoring and yield forecasting as separate tasks, limiting their ability to use shared information across related agricultural decisions. We propose a multimodal, multi-task learning framework that integrates satellite imagery, environmental measurements, crop information, and historical agricultural statistics to jointly model crop condition and yield.

The framework combines data from Sentinel-2, Landsat, MODIS, SMAP, precipitation, temperature, crop classification, and historical agricultural records using modality-specific encoders and a shared spatiotemporal representation. Task-specific prediction heads estimate crop condition and yield, allowing information learned from crop-health dynamics to inform yield forecasting. Predicted yield can subsequently be combined with acreage and market-price scenarios to estimate potential regional production and economic value.

The study will evaluate whether multimodal fusion and joint learning improve prediction compared with independently trained single-task models through systematic ablation experiments. An interactive Illinois-focused dashboard will translate model outputs into maps and scenarios for crop health, yield, production, and potential economic impact.

This work illustrates how artificial intelligence and multimodal remote sensing can support next-generation agricultural technologies by connecting field-scale crop monitoring with regional decision support for Illinois agriculture.

Poster 25

OECT-Based Smart Nitrate Monitoring System for Vertical Hydroponic Farming

Vinay Budhraja, Fahian Mahmud, Alejandro Bello, Bruno Romero, Jake Schultz, Alexander Ibarra,

Nitrate concentration is an important parameter in hydroponic farming because it directly influences plant nutrition, growth, and fertilizer management. This collaborative project with the Agriculture Department will develop a printed organic electrochemical transistor (OECT)-based nitrate sensing system for real-time monitoring of nutrient solutions in vertical hydroponic lettuce farming. The sensors will be fabricated and characterized in the engineering laboratory and then deployed in the Agriculture Department's greenhouse hydroponic vertical-farming setup for real-world evaluation. The OECT sensors will be integrated with a custom PCB, signal-conditioning electronics, microcontroller, and power-management system for continuous nitrate monitoring. Using Wi-Fi connectivity, nitrate measurements will be transmitted to a smartphone or cloud-based interface, where data will be stored and displayed as daily and weekly concentration trends. Students will gain interdisciplinary experience in sensor fabrication, PCB design, embedded systems, IoT communication, data analysis, greenhouse experimentation, and smart agriculture.

Poster 26

Upcycling Wheat Straw into Stiffer PBAT Biocomposites through Fiber and Surface Engineering

Jason Hicks, Omolola Kafi, Mahdi Vaezi

Wheat production creates a lignocellulosic residue stream that is often underused, while polymer products continue to consume virgin material. Using wheat straw (WS) as composite reinforcement could create value from agricultural biomass and replace part of the polymer matrix. The challenge is that hydrophilic plant fibers bond poorly with polymer matrices, while fiber length and loading strongly affect stress transfer and failure. This study evaluates how these factors influence poly(butylene adipate-co-terephthalate) (PBAT), a flexible biodegradable polyester with limited stiffness. PBAT composites were prepared at different WS contents and fiber lengths using untreated or chemically modified fibers, then evaluated by tensile and flexural testing. Tensile strength increased with longer fibers, higher WS loading, and chemical treatment, reaching 14.42 MPa. Higher loadings of untreated long fibers raised the elastic modulus to 0.90 GPa, compared with 0.02 GPa for neat PBAT. Chemical modification caused a modest reduction in modulus relative to untreated WS composites but improved flexural strength, which reached 20.18 MPa at 40% fiber content. These results reveal a useful design tradeoff: untreated long fibers maximize stiffness, whereas surface modification improves bending performance and fiber-matrix load transfer. Fiber morphology and interface engineering are therefore practical tools for tailoring PBAT/WS composites rather than simply increasing residue content. Incorporating up to 40% WS can reduce polymer demand and create a higher-value outlet for wheat straw without conventional synthetic reinforcement. Moisture uptake, durability, processing consistency, and end-of-life behavior must still be evaluated before application-specific or biodegradability claims are made for the finished composite. The study connects agricultural-residue utilization with measurable mechanical gains and provides a basis for molded materials with lower polymer content.

Poster 27

Deep Learning Models for Automated Soybean Foliar Disease Severity Estimation in Field Conditions

Golam Jilani, Mandeep Redhu, Ahmad Fakhoury, Md Belayat Hossain

Soybean production is severely threatened by foliar diseases that collectively cause annual yield losses of 10–40% in susceptible cultivars and amount to billions of dollars in economic damage worldwide. Illinois, the nation's top soybean-producing state, is acutely exposed to these losses. Accurate and early estimation of soybean foliar disease severity is critical for timely management decisions. However, this remains challenging due to symptom heterogeneity and illumination variability, particularly under field conditions. Certain diseases remain more challenging due to diffuse lesion boundaries, semantic ambiguity, and continuously varying texture patterns. To address these challenges, we developed a segmentation pipeline built on zero-shot and retrieval-guided few-shot foundational models (SAM3) to estimate per-leaf disease severity, requiring only a handful of reference images rather than thousands of manually annotated masks. We also developed a segmentation pipeline with three other CNN architectures: UNet, UNet++, and DeepLabV3+. To develop these, we used three soybean foliar diseases: Cercospora Leaf Blight (a highly annotation-resistant disease), Frogeye Leaf Spot, and Target Spot. Our work presents an efficient, automated method for estimating plant disease severity in field conditions, with the potential to extend to additional soybean pathogens.

Poster 28

Biodegradable PCB Substrates from Soy-Derived DMMP-M4sPLA and Hemp Fiber

Omolola Kafi, Ryan Mueller, Julia Lunsford, Mahdi Vaezi,

The Global E-waste Monitor 2024 reports that electronic waste reached 62 million metric tons in 2022, while only 22.3% was formally collected and recycled. Printed circuit boards (PCBs) are especially difficult to manage because their structural core is typically a tightly bonded fiberglass-epoxy laminate that persists after metal recovery. This project addresses that end-of-life barrier by developing a renewable, potentially biodegradable substrate from soy-derived DMMP-M4sPLA thermoset resin and alkaline-treated hemp fiber. The material concept connects Illinois agricultural feedstocks with a high-value electronics application while retaining the stiffness, heat resistance, and flame response required of a PCB support. DMMP-M4sPLA was produced through a three-stage route that builds a star-shaped polylactide backbone, introduces phosphorus functionality, and adds reactive end groups for curing. Fourier-transform infrared and proton nuclear magnetic resonance spectroscopy verified the expected chemical changes across multiple batches. Resin films and controlled-basis-weight hemp mats were then consolidated by compression molding into laminate coupons. Cured M4sPLA showed removal of the conventional PLA melting transition, supporting formation of a thermoset network. In preliminary soil burial, cured DMMP-M4sPLA resin lost 42.1% of its initial mass after four weeks; this result demonstrates rapid physical loss under the test conditions but is not presented as proof of complete mineralization. The project therefore evaluates the full substrate - not synthesis alone - through six qualification gates: mechanical performance, thermal stability, flame behavior, moisture resistance, electrical insulation, and manufacturing compatibility. The outcome is a testable pathway toward locally sourced PCB laminates that could reduce reliance on persistent fiberglass-epoxy cores and improve end-of-life options for electronics.

Poster 29

Sprayable Soy Protein–Cellulose Nanofiber Coatings for Postharvest Strawberry Protection

Manila Kunwar, Omolola Kafi, Mahdi Vaezi

Food loss is a food-security and resource-efficiency problem: the Food and Agriculture Organization estimates that 13.2% of food is lost between harvest and retail, with fruits and vegetables experiencing the highest loss rate at 25.4%. Strawberries are a demanding model because moisture loss, respiration, softening, and microbial spoilage limit marketable life. Edible biopolymer coatings can slow mass and gas transfer, but a formulation that works as a cast film may fail as a spray because viscosity, flow behavior, surface tension, settling, and storage stability govern atomization and coverage. This study develops a sprayable coating from soy protein isolate (SPI) and cellulose nanofibers (CNF) for postharvest strawberry protection. SPI supplies the film-forming matrix; CNF, plasticizers, and stabilizing additives are investigated to improve network integrity, flexibility, and moisture resistance. A fractional factorial screening design will identify the ingredients and interactions that most strongly influence clarity, barrier potential, sprayability, and stability. Candidate dispersions will be stored for 14 days at 4 °C and monitored for viscosity, pH, and sedimentation. Rheological behavior and surface tension will define a practical spray window, after which lead formulations will be applied to strawberries to evaluate coating formation and coverage. The project addresses a translation gap by treating delivery performance and shelf stability as design requirements rather than testing only the dried coating. Its immediate outcome will be a formulation window and candidates for subsequent trials of fruit mass loss, appearance, firmness, decay, and shelf life. A successful spray process could add value to soy-based ingredients, reduce reliance on petroleum-derived packaging, and offer growers and packers a scalable tool for protecting perishable produce without the handling burden and cross-contamination risk associated with dip coating.

Poster 30

Industrial Biochar–Biopolymer Composites: Processing Feasibility and Tensile Performance

Mark Martinez, Mark Martinez, Omolola Kafi, Mahdi Vaezi, Mahdi Vaezi

Demand for lower-carbon materials is expanding biochar beyond soil amendment. Made by thermochemical conversion of biomass, biochar can valorize agricultural and forestry residues, partially replace polymer and conventional fossil-derived fillers, retain biogenic carbon in products, and add stiffness or functionality. Benefits depend on feedstock, surface chemistry, dispersion, matrix compatibility, and loading; poor interfaces can instead reduce strength and ductility. This study compared three industry-supplied biochar systems in polylactic acid (PLA)-based matrices. Two biochars were added at 5 and 10 wt.% to 90/10 PLA/poly(butylene adipate-co-terephthalate) (PBAT); SBR-modified eucalyptus, PEG-containing, and untreated mixed-wood biochars were tested in PLA at 10 wt.% effective biochar. Blends were single-screw extruded, pelletized, injection molded, and tensile tested. PLA/PBAT blends processed without abnormal torque; as-received PLA powders formed continuous strands despite intermittent bridging, but molded voids showed that drying and feeding need optimization. At 10 wt.%, the PLA/PBAT biochars increased modulus by 25.4% and 18.9% while retaining 88.8% and 78.8% of control ultimate tensile strength. In PLA, all three variants increased modulus by 10.3–17.9%; untreated mixed-wood biochar performed best, retaining 92.8% of neat-PLA strength with a 10.3% modulus increase. Ductility decreased in every filled series. Different test speeds in some series limit conclusions to trends rather than design values. Biochar was a manufacturable stiffening filler, but composition and processing governed the strength–ductility tradeoff. Particle-size control, moisture management, feeding, dispersion, and compatibilization remain scale-up priorities.

Poster 31

Transparent Soy Protein–Cellulose Nanofiber Films for Sustainable Food Packaging

Alborz Mike Nasseri, Sarahjean Brown, Manila Kunwar, Omolola Kafi, Mahdi Vaezi

Flexible food packaging must combine strength, transparency, and moisture protection, yet these functions are commonly supplied by persistent petroleum-based films. Illinois soybean processing offers renewable feedstocks for an alternative: soy protein isolate (SPI) forms continuous transparent films, while cellulose recovered from soy hulls can provide nanoscale reinforcement. The challenge is that unmodified SPI films are often brittle and moisture-sensitive, and gains in strength can reduce flexibility or optical clarity. This study develops a balanced SPI–cellulose nanofiber (CNF) composite film for sustainable food packaging. A 50:50 sorbitol/glycerol plasticizer system tunes flexibility, CNF strengthens the protein network, and citric-acid crosslinking with sodium hypophosphite is evaluated to improve cohesion and water resistance. Solution-cast formulations are assessed for tensile strength and elongation, optical transparency, water resistance, and moisture-barrier performance. Initial films remained transparent while reaching tensile strengths of at least 25 MPa—above the project's 15 MPa target, above the less-than-10 MPa strength typical of many unmodified SPI films, and within the approximately 15–30 MPa range associated with low-density polyethylene. These results show that an agricultural protein and a soy-hull-derived reinforcement can be combined without sacrificing the appearance expected of a packaging film. The research now focuses on the tradeoffs among crosslinking, plasticization, CNF loading, moisture sensitivity, and extensibility rather than optimizing strength alone. A successful formulation would create value from two soy-processing streams, reduce dependence on fossil-derived flexible packaging, and provide a platform for applications requiring transparency, handling strength, and controlled end-of-life behavior. Food-contact safety and biodegradation will require separate validation before use claims are made.

Poster 32

Adapting Water and Sediment Control Basin (WASCoB) to enhance Nitrogen and Phosphorus attenuation during runoff

Kehinde Ojeniyi, Karl Williard, Eric Brevik, Samuel Indorante, Amanda Weidhuner, Jon Schoonover

Water and Sediment Control Basins (WASCoBs) are widely implemented conservation practices designed to slow surface runoff and retain sediment from agricultural fields; however, their potential to attenuate nitrogen (N) and phosphorus (P) losses remains underexplored. This study evaluates whether modifying WASCoBs through targeted soil amendments and adjusting retention time (RT) can enhance nutrient attenuation beyond sediment retention alone. The research was conducted on 70-ha corn–soybean rotation field in southern Illinois characterized by Hosmer soils (2–5% slope) and a history of gully erosion. Six WASCoBs were evaluated, including three RT (slow, normal, and fast drain) and three amendment-treated basins (gypsum, biochar, and woodchips). Water samples were collected at basin inlets and outlets across depths of 4 to 18 inches. A total of (16) significant rainfall events have been sampled from March 2024 - May 2026 to quantify nutrient loads, attenuation and trapping efficiency. Nitrate attenuation ranged from 18–29% for RT and 17–20% for amendment, with the slow-drain treatment achieving the highest reduction over fast and normal drain and woodchip having the highest within the amendments. NH_4^+-N averaged approximately 39% across treatments within RT and increased to 46% following amendment application with. DRP reductions ranged from 14–18%, while TP attenuation varied between 18–27% for RT. Biochar achieved the highest DRP reduction (28%) and was significantly more effective than gypsum (19%) and sawdust (7%) ($p=0.0413$). TP reduction ranged from 17–36%, with sawdust exhibiting the lowest retention efficiency at ($p=0.1137$). TSS across both treatment group varied between 32–48% with no statistically significant differences. Reductions in NH_4^+-N, DRP, and TP were significantly greater during soybean and cover-crop periods than during corn production. These findings highlight the importance of RT and amendment in optimizing WASCoB performance.

Poster 33

Improving Municipal Special Event Coordination Through Lean Six Sigma

Liz Awuor, Monalisa Lamptey, Jaby Mohammed

Special events support community engagement, downtown activity, and economic vitality in Bloomington, Illinois. The City coordinates special event permitting across six departments and managed an average of 126 special events annually between 2022 and 2024. During that period, event activity showed continued growth, including an 86.9% increase in downtown visits, a 55.9% increase in City in-kind support, and a 23.5% increase in vendor fees collected from the Farmers' Market.

As event activity continues to expand, the permitting process presents opportunities to further strengthen cross-departmental coordination, communication, and workflow visibility. Analysis of 2025 process data found that 39% of applications were submitted fewer than 30 days before the scheduled event, while the average permit-processing time was approximately 41 days. Applications submitted with shorter lead times were processed more quickly, reflecting the need for departments to coordinate within compressed timelines to support scheduled events.

This study applies Lean Six Sigma process-improvement principles to examine how digital redesign can further enhance the City's special event permitting process. The proposed framework includes a centralized digital permitting platform with real-time application status visibility, standardized and required application fields, parallel departmental review, consistent service-level expectations, and automated reminders and escalation notifications.

These recommendations can foster process consistency, reduce manual follow-up, improve interdepartmental communication, and provide applicants with clearer visibility throughout the permitting process. The project demonstrates how data-driven process improvement and digital workflow design can help municipalities efficiently support growing community events while strengthening public service delivery, collaboration, and local economic activity.

Poster 34

A Bilevel Optimization Framework for Flood Resilient Electric Vehicle Infrastructure on Urban Transport Networks

Wencheng Bao, Eleftheria Kontou

Rapid growth in electric vehicle (EV) travel combined with more frequent pluvial and river flooding events is challenging the resilience of urban electric transport networks. We develop a bilevel optimization framework to jointly select roads and charging stations for flood protection under a limited budget. The upper level maximizes feasible origin-destination demand and minimizes total system time. The lower level models route and charging choices using a static multi-class stochastic user equilibrium with flood-adjusted travel times, M/G/K charging queues, and battery-feasible paths. We use a Benders-inspired hyper-matheuristic to solve the upper-level problem and an adjusted method of successive averages to solve the lower-level problem. We apply the framework to Chicago's regional network, using a rainfall-based flood-depth for the July 2, 2023 event in a fixed three-hour peak-impact window. In the modeled flood scenario, 86.26% of charging ports become unavailable, and average in-vehicle time rises from 22.89 to 33.89 minutes. All remaining charging stations have unstable queues because arrival rates exceed service capacity, so the network cannot support all charging-dependent trips in steady state. Among the tested budget levels, queues at all operating charging stations become stable only when the budget reaches $5 million. Investments of $15 million, $25 million, and $45 million then reduce average in-vehicle time to 31.18, 29.86, and 28.15 minutes, recovering 24.6%, 36.64%, and 52.18% of the flood-induced increase. Under the $25 million plan, mean total link flows on I-90 and I-94 more than double from the flood-only case, and stationary mean charging waits at all operating stations fall below 4.8 minutes. The framework equips planners with a prescriptive tool for allocating limited resilience funds across road and charging infrastructure fortification as EV adoption accelerates and hazard exposure intensifies.

Poster 35

Satellite-Based Agricultural Water Stress Monitoring for Climate-Smart Irrigation Planning

Nishan Bhattarai, Dewasish Dahal, Roshan Sewa, Bikash Subedi, Bibas Pokharel, Ajay Kalra

Increasing climatic variability and pressure on freshwater resources are creating significant challenges for sustainable agricultural water management. Conventional field-based monitoring of crop water stress is often limited by the cost, spatial coverage, and frequency of observations, particularly in regions where irrigation and agricultural monitoring infrastructure are limited. This study explores the application of satellite remote sensing and geospatial analysis for identifying agricultural areas experiencing water stress and supporting climate-smart irrigation planning.

Multi-temporal satellite observations are integrated with precipitation, land surface temperature, vegetation condition, land use, and terrain information to characterize the spatial variability of agricultural water stress. Vegetation and temperature-based indicators are used to detect areas showing reduced crop condition and elevated thermal stress, while precipitation patterns provide information on meteorological water availability. The resulting indicators are standardized and integrated within a geographic information system to develop a spatial agricultural water-stress index. Agricultural areas are subsequently classified into low, moderate, and high-priority zones for irrigation intervention.

The proposed approach provides a spatially explicit and comparatively low-cost method for identifying areas where irrigation resources may be most urgently required. Rather than uniformly increasing irrigation supply, the framework supports targeted water management by prioritizing locations experiencing greater agricultural water stress. The study demonstrates the potential of satellite-based monitoring as a next-generation agricultural technology for improving irrigation decision-making, reducing inefficient water use, and enhancing agricultural resilience under increasing climate variability.

Poster 36

Girls Leadership Development as Social Innovation: The Girls Leadership Academy and the Development of Resilient Communities

Carla Childs

Building resilient communities requires investment not only in economic resources but also in the development of young people who will contribute to the social, civic, and economic life of their communities. The Girls Leadership Academy (GLA) is a community-based youth leadership program developed in partnership with a local elementary school in Southern Illinois. Designed for fourth-grade girls, GLA provides intentional opportunities to develop confidence, self-efficacy, communication, self-awareness, leadership skills, and a sense of community through mentoring and experiential learning.

GLA is grounded in Bandura's Self-Efficacy Theory. GLA activities provide opportunities for girls to practice leadership, observe peers and mentors, receive encouragement and feedback, build positive relationships, and develop skills within a supportive environment. Through weekly sessions, participants engage in leadership activities, reflection, collaborative experiences, and rotating opportunities to lead.

This poster presents GLA as a theory-informed model of social innovation and proposes a conceptual pathway connecting early leadership development to community resilience. By creating opportunities for girls to develop individual capacity, supportive relationships, and leadership identities, community-based programs such as GLA may contribute to the human and social capital that strengthens communities. The GLA model demonstrates how locally developed school-community partnerships can invest in young people today while creating possibilities for stronger, more resilient communities in the future.

Poster 37

From Overlooked Spaces to Resilient Futures: Participatory Design and Visual Communication for Community-Led Placemaking

Ainaz Fazlfarhadi, Aaron Scott

Vacant and underused urban spaces are often viewed primarily through their physical, environmental, or economic conditions. However, their potential as community assets also depends on how residents perceive, recognize, and assign meaning to these places. Spaces that are physically present within a community may remain socially and perceptually overlooked, limiting opportunities for engagement, collective imagination, and stewardship.

This research investigates how spatial analysis, participatory design, and visual communication can work together to reimagine overlooked urban spaces and contribute to more resilient communities. It asks: How can spatial systems and communication design make neglected urban spaces more visible, meaningful, and responsive to community-defined needs? How might place-based visual communication and participatory design influence community recognition, attachment, participation, and intentions toward stewardship?

The proposed methodology combines spatial and site analysis with community-generated knowledge, including residents' perceptions, needs, memories, and aspirations. These findings are then translated into visual and spatial representations that communicate community-defined possibilities rather than prescribe a predetermined redevelopment solution. The research explores communication design not simply as a means of presenting a final proposal, but as a participatory tool for making local knowledge, shared values, and possible futures visible.

By connecting spatial thinking, community participation, and visual communication, the study aims to develop a replicable interdisciplinary framework for supporting inclusive placemaking, local stewardship, and socially and environmentally resilient communities.

Poster 38

Dark Fleets: Shadow Shipping, the Limits on International Law, and Why Illinois Pays

Jarrick Honn, Cindy Buys

The growth of “dark” or “shadow” fleets presents an emerging challenge to international trade, maritime security, environmental protection, and sanctions enforcement. These networks use practices such as manipulated vessel tracking, ship-to-ship transfers, opaque ownership structures, questionable insurance, and false or frequently changed vessel registrations to obscure crude oil movements. Although dark-fleet activity primarily occurs on international waters and near major maritime trade routes, its economic consequences extend to inland states such as Illinois. Illinois producers and businesses depend on global oil markets and transportation networks that connect the state’s energy, agricultural, and industrial economy to international markets.

This research examines how existing international maritime law responds to dark-fleet operations and whether stronger coordination among maritime, economic, and environmental enforcement mechanisms can reduce the costs these networks impose on legitimate commerce. It analyzes the United Nations Convention on the Law of the Sea framework, International Maritime Organization conventions and standards, port-state control, vessel registration and insurance requirements, environmental regulation, and national and regional sanctions regimes.

The project connects these international developments to Illinois by examining how disruptions in maritime commodity markets, transportation costs, sanctions compliance, insurance, and environmental risk can affect an export-oriented state economy. It argues that dark fleets are not operating outside international law but instead exploit gaps in jurisdiction, transparency, information sharing, and enforcement. Improving maritime transparency offers a potential means of protecting both the integrity of international trade and the resilience of Illinois communities that depend upon access to global markets.

Poster 39

Strengthening Municipal Fiscal Resilience Through Data-Driven Process Improvement

Monalisa Lamptey, Liz Awuor, Mohammed Jaby

Local governments across Illinois rely on consistent utility and other municipal revenues to support essential public services and long-term community priorities. The City of Bloomington, Illinois, manages receivables across several categories, including utility billing, vehicle use tax, and business licensing, through multiple functional areas such as Finance, Collections, Legal and Licensing. As part of the City's efforts to strengthen financial processes and customer service, this project examined opportunities to improve coordination, increase payment accessibility, and better respond to predictable variations in accounts receivable.

Working collaboratively with the City of Bloomington's Utility Billing and Finance Division during the Spring semester, our team applied the DMAIC (Define, Measure, Analyze, Improve, Control) Six Sigma framework to analyze ten months of FY2026 accounts receivable data and develop an evidence-based improvement plan. The analysis identified recurring patterns in delinquent receivables, including seasonal fluctuations tied to student mobility in May and June, as well as ways to improve billing processes.

Using Pareto, I-MR control charts, and Fishbone analysis, the team identified several opportunities for process improvement. Drawing on practices in other cities such as Lexington and Syracuse, the team recommended owner-based billing, expanded digital payment options such as QR codes, a unified collection platform, and a self-service online payment-plan option.

Based on the project's analytical assumptions, implementing the proposed improvements could reduce average monthly delinquent receivables by about 20% while improving process consistency and customers' accessibility. More broadly, this project demonstrates how collaborative, data-driven process improvement can help mid-sized Illinois municipalities strengthen fiscal resilience and enhance service delivery.

Poster 40

Willingness to Pay and Local Business Spillovers of Public Fast Charging Infrastructure in Illinois

Sijia Li, Sijia Li, Eleftheria Kontou, Eleftheria Kontou

Public investment in U.S. electric vehicle (EV) charging infrastructure is expanding, but its value to EV drivers and its local economic impacts on nearby businesses and communities are rarely evaluated together. This study quantifies the benefits of public direct current fast charging (DCFC) infrastructure in Illinois for both EV drivers and nearby businesses. We estimate interregional EV miles traveled (VMT) enabled by the expanded Illinois DCFC network and EV drivers' willingness to pay (WTP). We also apply the Callaway–Sant'Anna staggered difference-in-differences estimator to foot traffic and spending data to estimate local business economic responses to nearby DCFC deployment.

The Illinois DCFC network enables approximately 7.93 billion all-vehicle-equivalent annual VMT, increasing feasible travel by 4.62% relative to a no-public-charging baseline, and generates an estimated WTP of $6,510 per battery EV driver over a 15-year vehicle lifetime. DCFC station openings are associated with an approximately 4% increase in monthly restaurant visitation, although evidence of systematic heterogeneity across distance and business categories is limited. Transaction spending estimates do not show a statistically significant response.

Together, these findings show that public DCFC infrastructure can generate benefits at multiple scales by improving statewide EV mobility while also being associated with increased activity at nearby businesses. The results provide evidence for understanding how transportation infrastructure investment can support mobility and local economic development in Illinois communities.

Poster 41

Advancing Community Flood Resilience through Green Infrastructure: Case Studies from East St. Louis and Carbondale, Illinois

Bibas Pokhrel, Bibas Pokhrel, Amisha Dutta, Krish Sharma, Bikash Subedi, Asadollahi Amin, Roshan Sewa, Nishan Bhattrai, Amardeep Kaur, Ajay Kalra, Ajay Kalra

Urban flooding, stormwater runoff, and aging infrastructure challenge communities across Illinois. This poster presents two complementary case studies connecting community engagement and PCSWMM modeling to inform green infrastructure planning in East St. Louis and Carbondale.

In East St. Louis, an interdisciplinary team from SIU Carbondale and SIU Edwardsville partnered with the city, with support from the SIU System Office of Community Engagement and Institute for Rural Health, to address environmental and health concerns in a historically underserved, flood-prone community. Community meetings and a Citizens' Advisory Board provided opportunities for residents to guide revitalization efforts. Native-species community gardens were established at City Hall, the public library, and private residences, encouraging resident stewardship and inspiring additional plantings. Alongside these activities, PCSWMM modeling is being used to evaluate the potential for rain gardens at selected sites to reduce peak runoff discharge and total runoff volume under simulated rainfall events.

In Carbondale, a planning-level PCSWMM study evaluates distributed green infrastructure practices, including bioretention cells and rain gardens. The modeling framework compares baseline conditions with scenarios representing different implementation extents and levels of impervious-area treatment under selected design storms. Peak runoff discharge and total runoff volume serve as common performance measures for comparing practices and identifying promising strategies for further site-specific investigation.

Together, the case studies illustrate how community participation and hydrologic modeling can support stormwater management at site and city scales. By linking resident stewardship with evaluation of potential runoff benefits, this work offers an approach for informing green infrastructure investment and strengthening flood resilience in Illinois communities.

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From Visual Attention to Business Resilience: Saliency Modeling for Fashion Advertising

Jun Qin, Seung-Hee Lee, Ying Chen,

Visual attention plays an important role in how consumers perceive, remember, and respond to advertising, yet relatively little research has examined computational saliency modeling in fashion. This study investigates whether visual saliency models can predict consumers' visual attention to fashion advertisements and explores their potential to support more effective and efficient visual communication. Eight state-of-the-art saliency models were applied to predict salient regions in the advertisements and evaluated using five metrics: Area Under the Curve (AUC), Correlation Coefficient (CC), Kullback–Leibler Divergence (KL), Normalized Scanpath Saliency (NSS), and Similarity (SIM). Across the evaluation metrics, all eight models demonstrated consistent performance in predicting human visual attention, indicating that computational saliency modeling can be effectively applied to fashion advertising. The findings also have potential implications for social and economic innovation. Saliency modeling can provide businesses with a data-driven approach to understanding visual attention and improving advertising design, potentially reducing costly trial-and-error processes. This may be particularly valuable for small and resource-constrained businesses that have limited access to marketing and design expertise. More efficient visual communication can support consumer engagement, enhance the competitiveness of emerging and local businesses, and enable organizations to allocate resources more effectively. By connecting computational vision with practical marketing applications, this study demonstrates the potential of saliency-based tools to support adaptive, resource-efficient businesses and contribute to more resilient communities.

Poster 43

CogniSense: An Adaptive Learning Platform for Neurodivergent K-12 Students Combining Artificial Intelligence, Biosensing, and Facial Recognition

Akash Ravi, Elahe Javadi, Elham Buxton, Abdelmounaam Rezgui

Research has shown that when neurodivergent students experience stress, their learning ability drops substantially. We present CogniSense, a learning/testing platform based on a novel, transformative, AI-based approach to the education of neurodivergent students. CogniSense provides a learning environment that is more conducive to knowledge acquisition and retention. It uses wearable biosensors to monitor the vital signs of students with disabilities while they learn. This physiological monitoring is then used to detect changes in vital signs that can be precursors of cognitive stress which may inhibit learning. These vital signs include: brainwaves (EEG signals), heart rate (HR), respiratory rate, and brain blood oxygenation (fNIRS). CogniSense also uses facial recognition to improve the accuracy of stress detection. When high stress is predicted, AI (Claude Haiku 4.5) is used to generate learning/testing content that is suitable to the student's current cognitive state and learning ability. CogniSense is funded through an IIN Social Innovation and Impact Seed Grant.

Poster 44

Defining the Scope of Trust: Why Automation and AI Systems Need an Operational Design Domain for Trust Evidence

Ali Shahidy, Usha Lakshmanan

Assurance frameworks increasingly treat user trust as a form of evidence. The instruments that produce it are multidimensional in why a system is trusted - performance, process, purpose - but not in what it is trusted for: nearly every item asks about the system as a whole. We report two measurements from a corpus study of naturalistic AI discourse spaning 17 online communities and 38 months that make this referent difficult to defend. Among items expressing a trust or distrust evaluation, 96.97% contain no trust vocabulary at all, and 84% attach the evaluation to a specific object as measured — approximately 92% once corrected for a one-

directional coding error (Section 4) — rather than to AI as a category. A word-list detector built directly from the definition of explicit trust vocabulary reaches only $\kappa = 0.464$ against hand codes, with about two-thirds of its positive calls false. Our position is that an unscoped trust measurement is not merely imprecise: it aggregates over distinctions its respondents are actively making, producing a quantity without a clear referent. We propose that trust evidence used in assurance should carry a scope specification, the way a safety claim carries an operational design domain. This paper reports Phase 1 of a two-phase project and is exploratory throughout.

Poster 45

Consulting for the Metropolitan Mayor's Caucus: Evaluating the Greenest Region Compact to Improve Regional Sustainability

Sarah Sheridan, Brynn Pazanin, Melissa Burlingame-Greenhagen

This project explores updates to the Metropolitan Mayors Caucus's (MMC) Greenest Region Compact (GRC), which is a regional sustainability framework utilized by municipalities in the broader Chicago area. Our goal with the framework is to improve clarity, feasibility, and alignment of its strategies with current, regional climate priorities. Using a combination of strategy review methods, drawing comparisons with the 2024 Priority Climate Action Plan, and applying the MMC's Lead/Enact/Encourage framework, we evaluated GRC implementation stages and the resources provided to the municipalities. Key findings show municipalities prioritize strategies that are practical to implement, but often face funding, staffing, and capacity barriers that skew practicality depending on municipal capabilities. Our analysis also found that some strategies would benefit from clearer language and stronger implementation guidance. Based on our findings, this project recommends the Metropolitan Mayors Caucus to better clarify certain GRC language and terms, incorporate more implementation support, and apply the Lead/Encourage/Enact enhancement to the framework to better define municipal roles. Our recommendations aim to create a more actionable and accessible sustainability framework for the region and invoke further action from additional municipalities.

Poster 46

Suffering Doesn't Get You Extra Points: Mitigating Secondary Trauma in Law School Curriculum

Audrey Stallings, Carly Toepke

Strong communities require strong systems of governance. This is a problem in down-state Illinois as many law students leave for jobs in St. Louis and Chicago, leading to a legal desert in our communities. These legal deserts prevent our communities from being able to access vital legal resources in criminal and civil law. It is important to reform the way that law schools are operating to ensure that the students being trained in our communities have the resources they need to succeed.

Law students are impacted by mental health challenges at rates higher than the general US adult and these concerns do not stop when they take the bar. In learning and practicing law, students are exposed to traumatic content on a frequent basis, placing them at risk of developing burnout and secondary trauma. In 2025, the American Bar Association (ABA) passed Resolution 503 which encourages law schools to implement trauma-informed pedagogy into their classrooms. The three years students spend in law schools presents the perfect opportunity to prepare students to mitigate these health risks by integrating psychologically-backed methods into current ABA curriculum standards.

This paper examines the current state of law school mental health, using collected survey data to determine where law school administrations are potentially falling short in their goals of providing students with effective mental health support systems. 10% of US law schools responded to an anonymous, programmatic survey discussing administrative efforts and perceptions of mental health programming at their respective schools. These results were then compared to existing data on student mental health and suggest areas of improvement. By integrating psychologically-backed information into existing ABA curriculum guidelines, law schools can work towards not only compliance with Resolution 503, but a brighter, healthier future for the next generation of law students and our communities.

Poster 47

Plastic in Erosion Control Materials: A Case Study of Illinois Tollway Stakeholders

Abigail Tetteh, Robert Durbin, Colin Kuehl

Erosion control materials are widely used in transportation infrastructure to prevent soil loss, provide stability for disturbed areas, and support the establishment of vegetation. However, the use of plastic-netted erosion control blankets has increasingly raised concerns about potential microplastic pollution, wildlife entanglement, and the long-term environmental impacts of plastic materials remaining in the environment. These concerns have become particularly relevant in Illinois following the Illinois Department of Transportation's (IDOT) transition to plastic-free erosion control blankets in August 2025. This policy change raises an important question for the Illinois Tollway: should the Illinois Tollway adopt such a restriction for its projects?

The study uses a mixed-methods approach combining semi-structured interviews and a Qualtrics survey of stakeholders involved in erosion control, transportation infrastructure, environmental management, engineering, construction, manufacturing, and material supply. The study assesses stakeholder perceptions of material performance, environmental impacts, cost, availability, installation and maintenance, and the feasibility of transitioning to biodegradable alternatives. The findings of the research will inform the Illinois Tollway's consideration of environmentally responsible and operationally feasible approaches to erosion control in their projects.

Poster 48

From Classroom to Career: Better Curricula for Graduating Faster, Getting Job-Ready, and Reskilling

Bonan Yang, Gunes Ercal

AI is reshaping many jobs, skills are evolving faster, and demand for STEM talent keeps growing. Education must train talent more efficiently and help working adults retrain, but three problems remain. Many students graduate late, and each extra semester adds tuition and delays entering the workforce. What graduates learn does not always match what employers need. Transfer students and adults retraining for new careers often retake courses or take detours because requirements differ across institutions. All three relate to curriculum design: which courses form a degree, how they connect, and whether they meet workforce needs are decided largely by each institution and rarely examined together.

We offer a data-driven curriculum optimization service that maps course connections and course-skill links as networks, helping institutions in three ways. To shorten time to degree, it finds the foundational courses most later courses depend on, such as College Algebra, and models student progress to show where teaching support matters most. To meet workforce needs, it links courses to job-posting skills in a knowledge graph to reveal skill gaps, an analysis now expanding from SIUE to nearby universities. To ease transfer and career change, it separates essential prerequisites from adjustable ones. Across over 40 U.S. public universities, about three quarters of prerequisites occur at only one institution; the shared core is small, and its cross-disciplinary links run almost entirely from mathematics and basic science to engineering. This core can guide credit transfer and shorter retraining paths.

Our long-term goal is to take this service nationwide with a map of courses and skills, where every learner can find the shortest path to a target career, institutions can update curricula as skill demands change, and credit transfer has a common basis. Education can then keep pace with evolving skills and prepare the talent society needs faster and at lower cost.

Poster 49

Integrating Geothermal Energy, Carbon Storage, and Critical-Mineral Recovery: A Multi-Benefit Subsurface Platform

Nur Sazzad Hossain Chy, Bijay Nepal, Nitin Tiwari

Meeting future energy and climate goals requires technologies that can provide reliable renewable power while reducing atmospheric carbon dioxide and strengthening critical-mineral supply chains. This study reviews the potential integration of enhanced geothermal systems (EGS), geological CO_2 sequestration, and critical-mineral recovery as a multi-benefit subsurface resource platform. A systematic synthesis of 1,008 peer-reviewed publications from 1968–2026 found that only 1.0% explicitly examined all three components together, revealing a substantial research and implementation gap. The review evaluated EGS development, CO_2 storage mechanisms, mineral recovery from geothermal fluids, and the use of supercritical CO_2 ($scCO_2$) as a heat-extraction fluid. Under tight-reservoir conditions, $scCO_2$-based EGS can produce 25–40% more thermal power than water-based systems while also supporting permanent carbon storage and enhancing mineral dissolution. Basalt formations appear particularly promising because they can mineralize more than 95% of injected CO_2 within two years and may support critical-mineral recovery. For representative 25-MWe facilities, integrated systems could improve net present value by 122–288% through combined revenues from electricity, carbon credits, and recovered minerals. However, commercial deployment requires coupled thermal-hydraulic-mechanical-chemical modeling, field-scale demonstrations, CO_2-resistant materials, integrated monitoring, and coordinated permitting. These findings demonstrate how subsurface engineering can connect clean energy generation, climate mitigation, and resource security within a unified framework for sustainable economic development.

Poster 50

Cultivation of the Extremophilic Alga Galdieria Sulphuraria in Real Acid Mine Drainage for Simultaneous Bioremediation and Critical Mineral Recovery

Eimtiaz Ibne Easin, T.D.B. Nawarathna, R. R. Karki, Himali Delanka-Pedige

Abandoned coal mine lands across Southern Illinois generate acid mine drainage (AMD), water with extremely low pH, high dissolved metal concentrations that cause severe environmental contamination. AMD has historically been treated as a waste, requiring energy- and chemical-intensive remediation, overlooking its valuable mineral content. In fact, AMD contains a suite of critical energy minerals with growing applications in renewable energy technologies. Our previous work demonstrated that the extremophilic alga Galdieria sulphuraria can cultivate in synthetic AMD representative of Southern Illinois conditions and remove major metals, given its inherent ability to thrive in low pH and metal- and sulfate-rich conditions. Building on these findings, this study plans to evaluate G. sulphuraria for remediating real AMD from the Tab-Simco site in Southern Illinois and recovering critical energy minerals.

We cultivated G. sulphuraria in real AMD diluted with Cyanidium (CN) medium at 10%, 25%, 50%, and 75% (v/v), as well as in undiluted 100% AMD. Experiments were conducted in triplicate for five days at 37°C, at the native pH of 2.5, under continuous illumination with 3% CO_2 in an incubating shaker, alongside control cultures grown in AMD-free CN media. Biomass growth was monitored daily via optical density at 750 nm (OD_{750}). By day 5, OD_{750} increased 10.74-fold in 10% AMD, 6.75-fold in 25% AMD, 3.73-fold in 50% AMD, and 3.54-fold in 75% AMD media, without nutrient addition. In undiluted AMD (100% AMD), OD_{750} decreased 0.40-fold by day 5, suggesting nutrient limitation rather than AMD toxicity. When nitrogen and phosphorus were added to the undiluted AMD, biomass increased 1.80-fold by day 4, warranting further studies to optimize nutrient addition for improved growth performance. Future work will quantify the extent and selectivity of critical mineral uptake by G. sulphuraria from real AMD, supporting critical energy mineral resource development for the state of Illinois.

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Physics-Informed Neural Network (PINN) for Solar Photovoltaic Power Prediction Under Limited and Out-of-Range Data

Manik Ibrahim, Bishal Roy Chowdhury, Md Amzad Hossain

The precise forecasting of photovoltaic (PV) energy generation represents a critical requirement for effective grid integration and operational plant management. Conventional machine learning approaches, however, demonstrate significant limitations when confronted with insufficient training datasets or when actual operating circumstances deviate substantially from those encountered during the training phase. This investigation presents a physics-informed neural network (PINN) architecture that incorporates the fundamental PV power equation, $P = \eta \cdot A \cdot G \cdot [1 - \beta(T_{cell} - T_{ref})]$, as an integral component of the neural network framework. A learnable correction mechanism captures irradiance-dependent phenomena that the underlying physics model does not account for. Physical plausibility is maintained through supplementary loss functions: power output must exhibit positive correlation with irradiance, negative correlation with module temperature, and approach zero when irradiance is absent. The methodology was validated using 34 days of 15-minute interval generation and meteorological measurements obtained from two utility-scale PV installations, each equipped with 22 inverters. Analysis revealed substantial correlation between irradiance and module temperature ($r = 0.91$), which impedes accurate data-driven determination of the temperature coefficient. This study demonstrate that the integration of physical principles enhances the robustness of PV power forecasting under data-constrained and extrapolative scenarios, facilitating its application to newly commissioned installations and continuous performance assessment.

Poster 52

From Healthcare Plastic Waste to Value: Thermochemical Conversion of Non-Hazardous Polymer Streams

Isaiah Kerr, Terrion Bailey Sanders, Umar Iqbal, Craig C. McLauchlan, Ryan S. Wolf, Md Hafizur Rahman

Healthcare systems rely heavily on single-use plastics to maintain safety, sterility, and operational efficiency, yet the resulting accumulation of non-hazardous plastic waste presents a growing challenge for waste management and sustainability. Although many healthcare plastics contain substantial hydrocarbon content, much of this material is still landfilled or incinerated because of feedstock heterogeneity, contamination concerns, regulatory requirements, and limited infrastructure for advanced resource recovery. This study investigates the potential of non-hazardous healthcare plastic waste as a feedstock for thermochemical valorization. Representative plastic samples were characterized using Fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA) to determine polymer composition and thermal decomposition behavior. Preliminary FTIR results indicate that the sampled waste stream consists predominantly of polyethylene (PE) and polypropylene (PP), with possible contributions from polystyrene (PS), polyamide (PA), polyvinyl chloride (PVC), and elastomeric materials. PE-, PP-, and PS-rich fractions are promising candidates for pyrolysis, whereas PVC-, PA-, and elastomer-containing fractions require selective segregation or alternative treatment. Ongoing work evaluates the catalytic pyrolysis of suitable healthcare plastic fractions to produce value-added hydrocarbon products and support circular resource recovery toward zero-waste-to-landfill goals.

Poster 53

Exploring the Potential of an Extremophilic Alga for Microplastic Remediation and Biofuel Production

Tharindu Nawarathna, R. R. Karki, E. I. Easin, Himali Delanka Pedige

Microplastics (MPs) in aquatic systems pose ecological and human health concerns. Beyond acting as contaminants, MPs may alter microbial and algal physiology, but their effects on extremophilic algae remain poorly understood. This study investigated growth and physiological responses of the thermoacidophilic red alga Galdieria sulphuraria to MP exposure, focusing on biomass and lipid accumulation.

This study was conducted in three phases to evaluate the influence of MP type, particle size, and concentration. In phase 1, G. sulphuraria was exposed to four MP types: polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), and polyethylene terephthalate (PET), under controlled culture conditions. Among the tested MPs, PET produced the strongest growth response, increasing optical density (OD750) 23.92-fold by Day 8, surpassing the MP-free controls. Therefore, PET was selected for further investigation of MP size- and concentration-dependent effects in phases 2 and 3. In phase 2, six PET particle-size ranges spanning 38 to175 µm were evaluated. The 125–150 µm size range produced the highest growth response, resulting in a 15.07-fold increase in OD750 by Day 8, compared with 9.28-fold in the control. In phase 3, PET concentrations ranging from 50 to 200 mg/L were evaluated. Growth was highest at 100 mg/L, reaching a 25.92-fold increase by Day 8, compared with 8.48-fold in the control. Microplastic exposure also influenced lipid accumulation in G. sulphuraria. Lipid content increased from 6.75% in the control to 13.5% at 100 mg/L PET concentration.

Overall, these results demonstrate that the response of G. sulphuraria to MPs is influenced by plastic characteristics. The enhanced growth and lipid accumulation observed under optimal PET exposure conditions highlight the potential of this extremophilic alga for concurrent biofuel production and PET MP remediation.

Poster 54

Sustainable Heat Transfer Analysis of The Geodesic Fuller Dome At SIUE

Dimpal Padia, , Serdar Celik

The Geodesic Fuller Dome at Southern Illinois University Edwardsville (SIUE), designed by R. Buckminster Fuller and Shoji Sadao, represents an innovative approach to sustainable architectural design through its lightweight structure, efficient material use, and geodesic geometry. However, its curved geometry and transparent triangular envelope create complex thermal interactions that differ from those of conventional buildings. Understanding these interactions is important for evaluating the dome's thermal performance and sustainability.

This study evaluates the heat-transfer characteristics of the Geodesic Fuller Dome by examining conduction, convection, and radiation across its building envelope and indoor environment. The analysis considers solar radiation incident on the curved exterior surface, conductive heat transfer through the envelope and structural components, and convective heat transfer resulting from indoor and outdoor airflow. Environmental conditions on both sides of the envelope are considered to investigate temperature distribution, natural and forced convection, thermal stratification, and airflow circulation within the dome.

The analysis provides a thermal perspective on how the dome's geometry, envelope properties, and surrounding environmental conditions influence its overall performance. The results help identify the primary mechanisms governing heat transfer and provide direction for improving thermal performance through envelope design, radiation control, insulation, and ventilation strategies.

Overall, this research applies fundamental heat-transfer principles to a geodesic structure and establishes a foundation for evaluating energy-efficient and sustainable design strategies for similar architectural systems.

Poster 55

Institutional Quality as a Catalyst for Renewable Energy in the RCEP Trade Bloc

Sayed Arafat Zubayer, Md. Tuhin Ahmed, Lubana Akter, Kevin Sylwester

This study examines the role of institutional quality in renewable energy consumption across the Regional Comprehensive Economic Partnership (RCEP) countries. The analysis uses panel data spanning 2002–2022 and applies a comprehensive econometric framework, including panel unit root and cointegration tests, multiple long-run estimators (Pooled OLS, Fully Modified OLS, Dynamic OLS, and Canonical Cointegrating Regression), and a two-step system GMM approach to address endogeneity. The results confirm a stable long-run relationship among the variables and show that institutional quality is a key determinant of renewable energy consumption in RCEP countries. Voice and accountability (VAE) exhibits an accelerating positive impact, while control of corruption (CCE), government effectiveness (GEE), rule of law (RLE), and regulatory quality (RQE) follow a U-shaped pattern. This suggests that while some democratic foundations yield immediate benefits, improvement of other institutional quality indicators may initially have limited effects, potentially due to the high transition costs and structural rigidities inherent in early-stage reforms, but beyond a certain threshold, stronger institutions provide the regulatory certainty and administrative efficiency required to catalyse renewable energy adoption. Among the control variables, CO_2 emissions, trade openness, and technological innovation have negative effects on renewable energy consumption, whereas financial development and foreign direct investment have supportive effects, particularly in the long run. The results also highlight notable heterogeneity between developed and developing RCEP economies, with stronger and more consistent non-linear institutional effects observed in developed countries. These insights highlight the need to strengthen institutional frameworks and ensure policy consistency to accelerate the sustainable energy transition across the RCEP region.

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Synthetic Capacitor for Canceling Ripple in Power Converters

Palem Poojitha, Lozowski Andrzej

Modern power converters, such as EV battery chargers, utilize switching electronics for its ability to operate at high efficiency. Switch-mode electronics, while accurate and efficient, produces undesirable high-frequency ripple that needs filtration. Typical passive filters are composed of numerous inductors and capacitors. The filter capacitors need to have very large capacitance to be effective. However, there is a practical limit to capacitance of available components. In this presentation, a synthetic capacitor concept is introduced. With the help of electronic feedback, one of the filter capacitors is grown in its capacitance value by a large factor at the high frequency of the ripple. This helps eliminating the undesirable ripple. This same capacitor exhibits no change to its value at lower frequencies allowing the standard system to operate normally without the need of re-tuning its controller parameters.