



Fall 2020

INSPIRE Newsletter Fall 2020

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**TIER 1 UNIVERSITY
TRANSPORTATION CENTER (UTC)**

Sponsored by the Office of the Assistant Secretary for Research
and Technology in the U.S. Department of Transportation



INSPECTING AND PRESERVING INFRASTRUCTURE THROUGH ROBOTIC EXPLORATION

VOL. 4 | ISSUE 2 | (FALL)
INSPIRE-UTC Biannual Publication

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Awarded in December of 2016 by the U.S. Department of Transportation, the five-year **INSPIRE UTC** is a Tier 1 University Transportation Center with a research priority of preserving the existing transportation system as part of the UTC Program (<https://www.transportation.gov/utc/2016-utc-grantees>) that was authorized under the Fixing America's Surface Transportation Act.

CONSORTIUM MEMBERS



The City College
of New York



Director's Message

Greetings colleagues and friends! Since our last newsletter, the INSPIRE UTC has held a virtual annual meeting with its members and a graduate student poster competition. The center continues to host webinars on a quarterly basis, engaging attendees worldwide on infrastructure and transportation related topics.



In the largest single gift in the history of Missouri higher education, St. Louis businessman Fred Kummer and his wife June have donated \$300 million to a foundation that will support Missouri S&T. The new gift will enable the university to establish a new school of innovation and entrepreneurship, develop new areas for research, provide numerous scholarships and fellowships for students, and promote research opportunities with INSPIRE UTC and throughout the university.

The INSPIRE UTC team has also continued research and operation modifications since early March of 2020 due to the coronavirus pandemic. The team continues to try their best to minimize the COVID-19 impact on various INSPIRE research activities.

The INSPIRE UTC continues to focus on ways to engage new and existing members of interest in transportation research. In this edition, we will highlight a new Educational Module Series that serves as one lecture of each completed research topic for undergraduate students from community colleges – our minor partners. This initiative is targeted at a pipeline of workforce development in the area of transportation infrastructure inspection. We will also update the pooled-fund study for field validation of the advanced technologies developed at the INSPIRE UTC, which serves as a venue of technology transfer to practitioners through professional training.

This newsletter issue will feature three articles focusing on the forensic studies of corrosion-, scour-, and fire-induced bridge collapses reviewed by INSPIRE researchers at Missouri S&T. These forensic studies can help better understand the failure modes and mechanisms of some bridge structures under service and extreme loads so that inspection of similar bridges can be targeted at representative damage locations, levels, types, and working conditions. Other highlights will include a seminar with EuroStruct Live Talks on Future Infrastructure Management using 4.0 Industrial Revolution Technologies and outreach activities of our members to promote transportation-related research in primary and secondary education.

We hope you enjoy the featured articles and exciting news of INSPIRE UTC, and invite you to visit our website at <https://inspire-utc.mst.edu> for additional information about upcoming events and webinars.

Genda Chen, Ph.D., P.E., F. ASCE, F. SEI, F. ISHMII

Director, INSPIRE University Transportation Center
Director, Center for Intelligent Infrastructure

Missouri S&T Receives \$300 Million Gift from June and Fred Kummer for Research



Fred & June Kummer. Photo by Terry Barner/ Missouri S&T

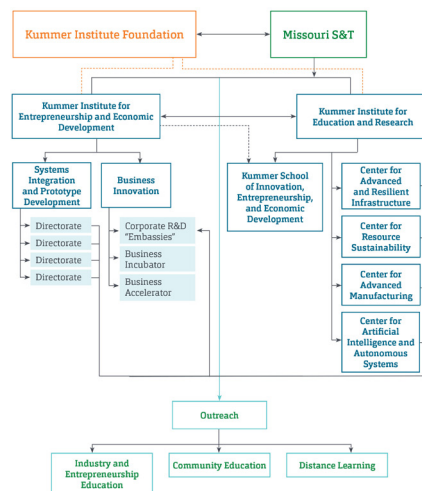
Missouri S&T is the recipient of one of the largest philanthropic gifts ever made to a public university in the United States. June and Fred Kummer (CivE '55) donated \$300M to establish the Kummer Institute (KI) for Student Success, Research and Economic Development, a gift intended to secure the relevance, excellence and future of Missouri S&T. Research is in the middle of the institute's name, and central to the KI's blueprint. Research will be the means to spur economic development, a key element of the Kummer's vision, and lead to transformational change at S&T in terms of reputation, quality of students, and overall culture, making Missouri S&T a true *Destination of Choice*.

The new gift will enable the university to establish a new school of innovation and entrepreneurship, develop new areas for research, provide numerous scholarships and fellowships for students, and bolster the Rolla region's economy.

"This gift is transformative for S&T, the Rolla region and our state," said Dr. Mo Dehghani, Missouri S&T chancellor. "For nearly 150 years, Missouri S&T has been known as the state's premier technological university. Now, thanks to June and Fred, S&T will have the opportunity to become one of the nation's leading universities for innovation. At the same time, this gift will make our school a center for entrepreneurship, thereby energizing the economy of the Rolla area and the entire state of Missouri.

"With this gift, we expect to be able to dramatically increase the size of our student body, recruit outstanding new faculty, establish powerful new centers of research, and engage with the community in new and exciting ways," Dehghani said.

"I owe much of my success to the education I received at Rolla," Fred Kummer said. "My Rolla experience taught me how to think, how to work hard and how to manage my own career. June and I believe in the mission of this great university, and that's why we have chosen to invest in S&T's future success. We believe that Missouri S&T's best days are ahead."



DEPUTY PROVOST'S MESSAGE



The big news on the Missouri S&T campus this fall has been the announcement of the transformational gift from June and Fred Kummer (CivE '55) that will create the Kummer Institute for Student Success, Research and Economic Development. The intent of the Kummer Institute is to elevate the university and to have an economic impact by creating a culture of innovation and entrepreneurship on campus. By residing at the intersections of many of the key research pillars of the Kummer Institute, including advanced and resilient infrastructure, autonomous systems, and resource sustainability, INSPIRE is uniquely positioned to help lead the transformation of Missouri S&T, and I am confident that Genda Chen and the INSPIRE team will do exactly that.

Richard Brow

Deputy Provost for Academic Excellence

Original Version Posted <https://news.mst.edu/2020/10/missouri-st-receives-300-million-gift-from-june-and-fred-kummer/>



Kummer Institute to Promote Research Centers at Missouri S&T

The current spending plan for the Kummer Institute includes an endowment that will provide annual costs for up to 100 PhD fellowships, 500 undergraduate scholars, ten endowed professorships, ten endowed chairs (including four center directors), and affiliated administrative personnel, principally to support the KI research mission. One-time costs related to the start-up packages for the endowed faculty are also included in the spending plan, along with capital investments that include equipment and instrumentation, and an expansion of research space, including the EngX building that will link the Materials Research Center to the Engineering Research Lab, and the new Systems Integration and Prototype Facility, to be located on the north side of I-44. Current faculty will have opportunities to recruit these students, use the equipment and new facilities, and compete for the endowed positions. Expenditures outside of the spending plan for the Kummer Institute, however, will not be considered.

KI research centers were selected to align with the donor’s background, experience, and interests, and to address “Grand Challenges” that will raise the reputation of our university, while still meeting the overall goal and vision to generate economic activity. The first KI research centers are:

- Advanced and Resilient Infrastructure
- Resource Sustainability
- Advanced Manufacturing
- Artificial Intelligence and Autonomous Systems

The KI Centers are intended to be cross-cutting and will significantly expand the scope and activity of a number of current research centers, while building new capabilities and research partnerships across our campus, the state, and the nation. Faculty affiliated with the centers will build and nurture multidisciplinary teams that will create innovations in different scientific and engineering fields, and the technical breakthroughs of the KI are intended to catalyze and grow the region’s and the state’s economic standing.

We anticipate that other KI research centers will be created in the future to address similar “Grand Challenges”; they will be selected by the KI Foundation Board to further raise the reputation of our university and advance economic development.

Research Center Directors: National searches will be conducted to select the founding directors of the KI Centers. Internal applicants will be eligible and encouraged to apply. The search process is intended to use this incredible gift to raise national visibility and enhance our peer reputation, which of course impacts national rankings and our ability to attract high quality students and the best faculty. These positions are intended to attract National Academy level scientists and engineers who will help S&T complete the “transformational change” that was part of June and Fred Kummer’s motivation in making this gift to Fred’s alma mater. These searches are also intended to attract faculty who can help us double, or even triple, the research expenditures on campus, such that we may make significant progress toward meeting the Trustee’s mandate of S&T becoming a Carnegie R1 university. We will be seeking leaders who have experience in initiating and building national-level centers and who have transitioned discovery and innovation to practice to realize true economic impact. A critical component of choosing these leaders will be to find people that build and leverage existing resources, and this includes the ability to collaborate with and mentor our current faculty.

Chancellor Dehghani has established a faculty advisory panel to help him formulate strategies regarding the research component of the Kummer Institute. It is important to note that this is not a decision-making panel, but it is a means to collect and amplify faculty concerns and ideas related to the KI research mission. The panel represents the broad and diverse demographics of our faculty, including levels of seniority and range of interests and experiences. On that panel are:

- Denise Baker, Psych Sci.
- Laura Bartlett, MSE
- Genda Chen, CAEE
- Mahelet Fikru, Econ
- Jie Huang, ECE
- Frank Liou, MAE
- Marek Locmelis, GGPE
- Angela Lueking, CBE
- Manashi Nath, Chemistry
- Julia Medvedeva, Physics
- Sarah Stanley, BIT
- Don Wunsch, ECE
- Grace Yan, CAEE
- Hu Yang, CBE

Information about the KI can be found here— <https://kummerinstitute.mst.edu/>

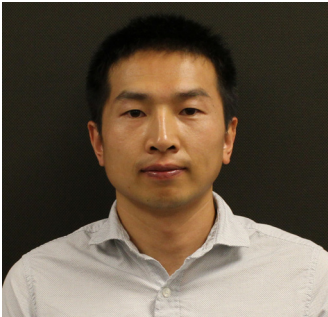
INSPIRE UTC Annual Meeting and Graduate Student Poster Session Hosted

Online

The INSPIRE UTC held its 2020 annual meeting in a teleconference on August 3-4, 2020. Activities included technical research presentations by the INSPIRE UTC faculty, an executive meeting with the INSPIRE UTC director, external advisory committee, INSPIRE UTC principal investigators, and pooled-fund study department of transportation members, a graduate student poster session, and awards ceremony.

2020 Graduate Student Poster Session Winners

On August 3-4, 2020, graduate students from all INSPIRE consortium institutions attended the INSPIRE UTC 2020 annual meeting. Participating students interacted with transportation professionals from government and industry transportation sectors. A graduate student poster session was held to offer students the opportunity to showcase their research, communicate results to other students, faculty and staff, engage with representatives from the transportation industry, and facilitate interdisciplinary work by exchanging knowledge and ideas between individuals from multiple disciplines. The INSPIRE UTC external advisory committee members attended the meeting and Dr. Lesley Sneed, professor of civil engineering, chaired the three-judge student poster evaluation committee. The other two judges on the poster evaluation committee were Dr. Sreenivas Alampalli from New York Department of Transportation, and Mr. Bill Duvall from Georgia Department of Transportation. First, second and third place awards were given to the following students:



1st Place- **Haibin Zhang**, Missouri S&T
UAV-based Smart Rock Localization for Determination of Bridge Scour Depth



2nd Place- **Muhammad Monjurul Karim**, Missouri S&T
Bridge Inspection Video Data Analysis for Data-Driven Asset Management Mobile Sensors



3rd Place- **Yu Otsuki**, Georgia Institute of Technology
Autonomous Ultrasonic Thickness Measurement of Steel Bridge Members using Mobile Sensors



For more information, visit: <https://inspire-utc.mst.edu/studentprograms/>

Chen Invited to Speak at EUROSTRUCT Talk

Dr. Genda Chen was selected to present during the EuroStruct Talk on July 9th, 2020. The EuroStruct Association aims to promote the understanding and advancement of practice on quality control of bridges and structures at the European level. Dr. Chen's presentation was selected as part of the EuroStruct mission to collaborate with organizations and institutions with similar objectives. Dr. Chen's talk on "Future Infrastructure Management using the Fourth Industry Revolution Technology" discussed recent

developments in robotics, measurement science, and the Internet of Things which can potentially revolutionize the way and process that civil infrastructures are managed. In this grand yet challenging transition era, automation and informatics are two emerging concepts that will boost a wide range of innovations in civil engineering. In this presentation, new developments and potential applications of nondestructive evaluations, sensing systems, imaging systems, data analytics, and climbing and flying robots will be introduced and reviewed in the context of bridge inspection and maintenance. Sensing and imaging systems and robots can be integrated into the current practice of visual inspection in a systematic framework to transform the current ad-hoc approach to a data-driven management of bridges. Some of the culture and policy challenges in leveraging sensing, imaging, and computer simulation tools for managing existing infrastructures was discussed.

Future Infrastructure Management using the Fourth Industry Revolution Technology



Speaker

Genda Chen

Ph.D., P.E., F. ASCE, F. SEI, F. ISHMII

Professor and Abbett Distinguished Chair in Civil Engineering (<https://care.mst.edu>)
Director, Center for Intelligent Infrastructure (<https://cii.mst.edu>)
Director, INSPIRE University Transportation Center (<https://inspire-utc.mst.edu>)
Associate Director, Mid-America Transportation Center (<https://matc.unl.edu>)
Missouri University of Science and Technology (<https://www.mst.edu>)

Moderators

Jan Bien, Wrocław University of Science and Technology, Wrocław, Poland
José Matos, University of Minho, Guimarães, Portugal

For more information, visit: <https://bit.ly/32RWTkV>

University of Missouri System names CII Faculty Member as Presidential Engagement Fellow



Three Missouri S&T faculty will serve as University of Missouri System Presidential Engagement Fellows during the 2020-21 academic year. The faculty members will serve as ambassadors in the region and speak to local organizations and communities about their areas of research and expertise. There is no cost for an organization or individual to host a speaker.

Dr. Guirong (Grace) Yan is an assistant professor of civil, architectural and environmental engineering at S&T. Dr. Yan is director of the Wind Hazards Mitigation Laboratory (WHAM) at the university, where she conducts research into wind hazard mitigation and computational fluid dynamics, structural health monitoring, damage detection and more. She has built two small-scale tornado simulators that use models to mimic the destruction phenomena of high-speed twisters. She hopes to build a larger-scale simulator at S&T. She is available to speak about structural health and damage detection, resilient infrastructural systems, smart materials, bridge engineering, and wireless sensor networks.

Original Version Posted July 7, 2020-Missouri S&T News and Events

University of Missouri System Strategic Investment Initiative

In summer 2019, Dr. Genda Chen's team received a Tier 2 University of Missouri (UM) System Strategic Investment Award for a total of \$250,000 in two years. Part of that initiative was to explore new research directions towards the development of an open-source digital infrastructure city using digital twin technologies. In summer 2020, an open competition for exploratory research ideas was solicited among the Center for Intelligent Infrastructure (CII) members. CII received eight proposals and awarded three of them as listed below:

1. Can Multi-Modal Routes Maximize Social Welfare in Futuristic Transportation Cyber-physical Systems by Drs. Venkata Sriram Siddhardh Nadendla and Sajal K. Das from Computer Science
2. Preparing Multidisciplinary Datahub for Digital and Intelligent Infrastructure System by Drs. Jenny Liu and Xianbiao (XB) Hu from Civil Engineering
3. Wireless Sensing for Structural Health Monitoring of Civil Infrastructure by Drs. Kristen M. Donnell and Mohamed ElGawady from Electrical Engineering and Civil Engineering, respectively.

Agrawal Receives ASCE Arthur M. Wellington Prize



Dr. Anil Agrawal, City College of New York, received the 2020 Arthur M. Wellington Award in October 2020 for the paper, "Heavy Truck Collision with Bridge Piers: Computational Simulation Study," which was published in the Journal of Bridge Engineering in June 2019.

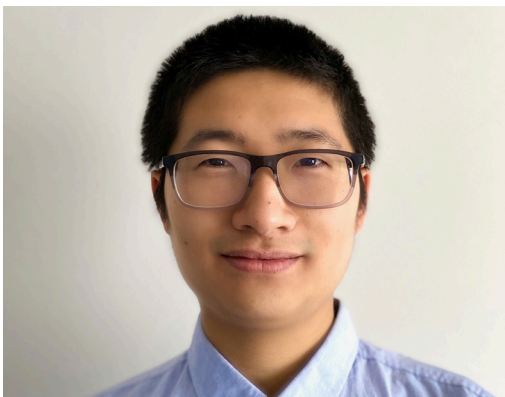
The Wellington Prize was created in 1921 by the American Society of Civil Engineers (ASCE) and is presented annually for papers on transportation on land, water, air, or on foundations and closely-related subjects.

The Wellington Prize is a milestone achievement in the ASCE. The lead author will receive a plaque commemorating this achievement.

New Researchers Join INSPIRE UTC



Mr. Rafael Cardona Huerta's primary research areas include, but are not limited to, structural health monitoring, infrastructure management, virtual and augmented reality, unmanned aerial vehicles and efficient design for construction. Prior to working as a Research Civil Engineer at the Center for Intelligent Infrastructure and the INSPIRE UTC at Missouri S&T, Huerta worked as a Civil Engineer at an international construction firm where he had the opportunity to gain experience in the field on important construction projects such as the Riyadh Metro Project. Huerta obtained his BS and MS in Civil Engineering from the School of Civil Engineering of Ciudad Real at the University of Castilla-La Mancha (Spain), during which he had the opportunity to participate in a study abroad program at the University of Technology of Gdansk and work on an internship, also as research engineer, at the University of New Mexico.



Dr. Bo Shang is currently a postdoctoral fellow in the INSPIRE UTC research group at Missouri S&T. Dr. Shang is responsible for developing a flying and climbing robot for bridge inspection, designing a climbing robot for bridge scour evaluation and developing an unmanned aerial system of visible light, infrared and hyperspectral cameras with novel signal processing and data. System integration of various parts from open sources and defect identification from images are his main duties. The outcomes of the related work are robots that can climb on a structural surface or fly and traverse along a bridge beam as demonstrated in both laboratory and field conditions. Fusion techniques from a set of heterogeneous data will be developed. Additionally, the results of Dr. Shang's work on these projects are expected to be published in peer-reviewed journals and presented in conferences in the near future.

Center for Intelligent Infrastructure Faculty Named IISE FELLOW



Dr. Suzanna Long, chair of engineering management and systems engineering (EMSE) at Missouri S&T, has been selected as a fellow by the Institute of Industrial and Systems Engineers (IISE), an honor granted to only 0.1% of the organization's members in any given year. According to IISE, the fellow award recognizes outstanding leaders of the profession who have made significant, nationally recognized contributions to industrial and systems engineering. A fellow is the highest classification of IISE membership. Dr. Long will be recognized at a ceremony in New Orleans late this fall.

"Being named a fellow of the IISE has long been a dream of mine, and I cannot find the words to express how deeply honored I feel," says Long. "I am truly thankful for the recognition that this brings to me, EMSE and Missouri S&T."

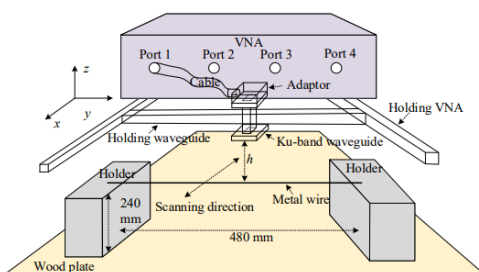
Dr. Long has been chair of EMSE for three years, managing a department budget of more than \$4 million. She has been the primary investigator or co-primary investigator in 39 externally funded research projects since 2008, with grants awarded from organizations such as the Missouri Department of Transportation and the National Science Foundation. Her research areas include critical and sustainable infrastructure, supply chain management and transportation, organizational behavior, strategic management and systems management. Dr. Long's research has resulted in approximately 150 journal articles, conference papers and book chapters, and has contributed practical applications to transportation and other industries. Her geospatial project through the U.S. Geological Survey was selected for inclusion on GEOPLATFORM, the first time that any project funded by the U.S. Department of the Interior has been selected for the honor.

"Dr. Long is very dedicated to her field and to her department," says Dr. Richard Wlezien, vice provost and dean of the College of Engineering and Computing. "It comes as no surprise that colleagues hold her in such high regard. The IISE Fellow Award is well deserved."

In addition to her membership in IISE, Dr. Long is a member of the Institute of Electrical and Electronics Engineers, the American Society of Engineering Education, and the American Society of Engineering Managers. She also holds membership in the International Council on Systems Engineering and Epsilon Mu Eta, the engineering management honor society.

Original Version Posted June 15, 2020-Missouri S&T News and Events

Former INSPIRE UTC PI'S Research to be Published in IEEE Journal



Dr. Reza Zoughi, IEEE Fellow, has recently been accepted for publication of his research on the "Influence of Antenna Pattern on Synthetic Aperture Radar (SAR) Resolution for NDE Applications" in the *IEEE Transactions on Instrumentation and Measurement*. The project research simulation results concluded the pattern shape and not only the Half Power Bandwidth (HPBW) play a significant role in the SAR spatial resolutions both in the range and cross range directions, which is particularly notable when operating in the array near-field where the depth distance is usually very small compared with the synthetic aperture length. The concept of an effective aperture was introduced and empirical calculation was presented. The effective aperture is used to calculate the SAR spatial resolutions and measurements were performed and results corroborated the simulations and empirical models. Dr. Zoughi's project ended on June 30, 2020 and he recently transferred to Iowa State University.

Scholar's Mine Joins Transportation NTDPN

In June 2020, Scholars' Mine, Missouri S&T's on-line repository of research papers, creative works and other documents, became part of the collection 'National Transportation Data Preservation Network (NTDPN)' (<https://fairsharing.org/bsg-c000076>).



For more information, visit: <https://fairsharing.org/>

THE COLLAPSE OF THE SILVER BRIDGE

The Silver Bridge carried the U.S. Route 35 over the Ohio River connecting Point Pleasant, West Virginia, and Gallipolis, Ohio [1]. The bridge represented a major east-west connection for the U.S. Route 35 and served average daily traffic of 4,000 vehicles. The bridge converted Point Pleasant to a central hub in the highway system. The bridge was built to last 100 years and therefore was painted with a coat of glimmering aluminum paint for corrosion protection. Thus, the bridge gained its name, Silver Bridge. Local people also knew the bridge upon its opening as the "Gateway to the South" [2] since it connected the capital of Ohio, Columbus, to major cities such as Charleston, West Virginia.



The Ohio River Silver Bridge After Collapse on December 15, 1967 [2]

Construction of the Silver Bridge began in 1926 [3], and it was open for traffic on Memorial Day, May 30, 1928. The two-lane 1760-foot-long bridge consisted of two 380 ft and one 700 ft span. The General Contracting Company of Pittsburgh built the piers while the American Bridge Company of Pittsburgh [4] constructed the bridge. The bridge was designed following the design guidelines developed by the American Society of Civil Engineers [3]. The bridge featured many unique qualities and, as such, attracted much attention from day one. It was also the first bridge in the U.S. that was painted using aluminum. The bridge design was the first of its kind in the U.S. and the second in the world after the Hercilio Luz Bridge in Florianopolis, Brazil, constructed in 1924 [4]. The bridge was built using an eyebar suspension system, rocker towers, and a unique anchorage system consisting of reinforced concrete troughs filled with soil and concrete [5].

The then state-of-the-art suspension bridge was built using heat-treated high strength, 120 ksi, eyebar links instead of the original wire cable design [3]. The eyebar chain design was selected as an alternate, more economical design and construction procedure [4]. Each chain link consisted of two eyebars, and each had a 2 x 12 in. cross-section and lengths ranging from 45 ft to 55 ft. Using two eyebars in each chain was unusual as the common engineering practice was to use four to six eyebars, such as the system used in the Clifton Suspension Bridge, to ensure the redundancy of the system. Each eyebar

ended with an 11 in. diameter loop "eye," allowing it to be connected to the adjacent eyebar as a pin connection. The chains represented the suspension cable and the top chord of the steel trusses in the middle of each span [4].

Inspections of the bridge until 1941 were carried out by the private owner, where the original wooden plank roadway was widened and replaced by a steel grid filled with concrete. Beyond that, the State Road Commission inspected the bridge in 1959, 1963, 1964, and 1965 [6]. The last one recommended \$30,000 repair work, which was completed in 1965. Two more inspections were concluded on December 6, 1967. It should be noted that bridge inspections in that era were often conducted from a distance with binoculars [3].

The Silver Bridge collapse occurred on Friday, December 15, 1967, during rush-hour traffic [4]. People were back from work at about 4:58 p.m., and the bridge was packed with 37 cars; and all of a sudden, the bridge collapsed, emitting a loud sound compared to a loud gunshot or a jet plane taking off. Thirty-one vehicles plunged into the 44-degree water of the river claiming the lives of 46 people. Two of the victim bodies were never found, while 21 people survived the disaster. This incident is characterized as the deadliest bridge disaster in the U.S. [7] Once the bridge collapsed, the St. Mary's suspension bridge, 75 miles North of the Silver Bridge, which had the same design and contractor, was decommissioned and replaced.



Deadliest Bridge Disaster in US History Caused by 2.5 Millimeter Deep Crack [7]

The National Transportation Safety Board issued a report in 1971, determining the cause of the bridge collapse [8]. Experimental work was also carried out to better understand the failure mechanism [3]. Forensic investigation and analyses of the bridge revealed that failure was triggered by a small defect of 0.1 in. (2.5 mm) deep crack in the suspension chain, which was inaccessible to visual inspection. The report commented that "the crack was inaccessible to visual inspection" and could not have been detected "without disassembly of the eyebar joint." It was impossible to detect the crack. The eyebar also corroded

at the crack, and the crack had evolved around the steel's impurity in eyebar 330. The crack grew and extended due to corrosion and continuous movement along the pin joint during the bridge's service life. Once the first eyebar snapped, the other eyebar fractured in a more ductile behavior. Then, the domino effect continued, and the remaining of the eyebars failed, and the bridge collapsed. The Report found that in 1927 "stress corrosion and corrosion fatigue were not known to occur in the bridge materials used under conditions of exposure normally encountered in rural areas." [4]

Further analysis indicated that the bridge's actual loads were heavier than the original design loads as vehicles get much heavier and the mounting traffic jams on the bridge. For example, at the bridge construction time, the typical family car weighed 1,500 lbs, which went to 4,000 lbs at the time of the bridge collapse [5]. One of the main lessons learned from the Silver Bridge collapse is the combined effects of corrosion, fatigue, material deficiency, and overload. The slight flaw in the eyebar 330 subjected to corrosion and fatigue loads over forty years of service loads, led to the progressive collapse of the bridge [3-5].

The collapse of the bridge led to the creation of the National Bridge Inspection Standards (NBIS) to ensure bridges' safety and functionality. The NBIS updated and standardized bridge inspection efforts that have been developed by individual states. The NBIS requires that all 20-foot long bridges be inspected every other year. Bridges categorized as high risk of potential issues must be inspected more often as deemed necessary until they are repaired or commissioned [4].



ABOUT THIS REPORT

Led by Dr. Mohamed ElGawady, Professor and Benavides Faculty Scholar in Structural Engineering, this study was supported by INSPIRE UTC. In this forensic research study, the focus is on corrosion and scour induced bridge collapse or severe damage. While working on corrosion H-pile retrofitting Dr. ElGawady wrote this article to highlight forensic studies of corrosion induced bridge damage and collapse. For more information on this project, please contact Dr. ElGawady at elgawadym@mst.edu or (573) 341-6947.



FOR MORE INFORMATION CONTACT:

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The 1460-foot Suspended Portion Collapsed into the River [4]

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FAILURE INVESTIGATION OF BRIDGE COLLAPSE DUE TO SCOUR

This article reviews findings from two case studies of bridge failures due to scour: Schoharie Creek Bridge, U.S., and Malahide Viaduct, Ireland. The aim of this review report is to summarize the failure mechanism of the bridges and the lessons learnt from those tragedies. In general, scour-induced collapses are dominated by local scour.

Fig. 1 illustrates the process of local scour when the water flow in a river is interrupted by obstacles such as piers. During the scour process, horse-shoe and wake vortices produce both lifting and shear forces, and remove river bed deposits from around the bases. The scour hole generated reduces the stiffness of foundation systems and potentially causes a foundation failure without warning. Therefore, the maximum scour depth is a critical parameter that engineers can use in their foundation stability analysis to ensure the safety of bridges. Scour damage often exacerbates when flood occurs. High stream velocity caused by flood tends to increase the scour depth around a bridge foundation. As a result, the American Association of State Highway and Transportation Officials (AASHTO) in 2007 required that bridges be investigated for potential scour under dual flood conditions, i.e. a design for 100-year flood and a check for 500-year flood.

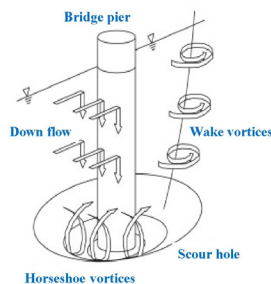


Fig. 1 Principle of local scour

Based on literature reviews, the substructure type of bridges vulnerable to scour is with little or no reinforcement. Their piers supported shallow foundations have limited ductility to resist hydrodynamic forces. The simply-supported superstructure of bridges with no redundancy leads to sudden collapsing of bridges.

The Schoharie Creek Bridge was 165 m in length with five simply-supported spans supported on two columns fixed within a lightly reinforced plinth, which was positioned on a shallow reinforced spread footing. Nearly one year after its completion, the bridge survived a 100-year flood in 1955. However, the bridge collapsed in the morning of April 5, 1987. Rainfall totaling 15 cm mixed with melting snow produced an estimated 50-year flood. This catastrophe claimed the lives of 10 people. The collapsed bridge and its schematic plan are shown in Fig. 2. The bridge collapse was initiated by the toppling of Pier 3 mainly due to the local scour, leading to a progressive collapse of spans into the flooded creek. At the time, the flow was extended to the open field passing

the sloped embankment at west channel, implying the occurrence of contraction scour.

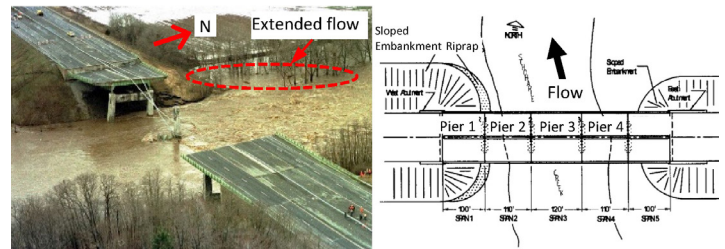


Fig. 2 Photo of failure and schematic plan of Schoharie Creek Bridge [1]

The maximum velocity of water flow during the 1987 flood was in the same order of that during the 1955 flood. Therefore, some modification factors between 1955 and 1987 likely played a role in this accident. Indeed, berms were built in 1963 on the upstream side of Pier 3, formed a curve in the river bank, and created a creek channel on the west embankment. In addition, even the 1955 flood exceeded the design flood event for the bridge, which may have already disturbed the riprap protection to potential scour. Due to this concern, sheet pilings were intended (by the designer) to leave in place to protect the piers, but removed after construction likely due to lack of clear requirements in design. In fact, shortly after the completion of the construction, the pier plinths began to form vertical cracks due to high tensile stresses. Although this crack problem was fixed by adding plinth reinforcement to each of the four piers and was difficult to extend the reinforcement into the columns. As a result, the added plinth reinforcement was not adequately anchored, contributing to the brittle and sudden nature of the subsequent collapse.

The 1949 AASHTO Provisions were unclear about the design requirement for piles for thruway bridges like the Schoharie Creek Bridge. Without the piles, leaving sheet pilings in place or providing enough ripraps would have helped protect the piers from scour effect. The use of continuous spans would have provided redundancy to allow for the redistribution of hydrodynamic forces between the spans, preventing brittle failure of the bridge. Similarly, adding reinforcement on the plinth and anchoring it into the columns to close the crack in the plinth of Pier 3 would also be helpful. However, as pointed out by the National Transportation Safety Board [2], the key lesson learnt from this disaster is to identify critical features leading to the bridge collapse and to ensure those features can be inspected frequently and adequately.

The Malahide Viaduct was 176 m in length simply-supported on 11 masonry piers for railway transportation between Dublin and Belfast, originally built in 1844 and renewed in 1965. After the renewal of the bridge, the pre-stressed concrete girder instead of iron lattice girder was used. On August 21, 2009, Pier 4 of the

viaduct collapsed just after a train passed over it, leading to the falling of two spans into the river, as shown in Fig. 3. Fortunately, there was no casualty due to timely discovery. Nevertheless, this disaster caused the closure of a large section of the rail line from Belfast to Dublin for three months.

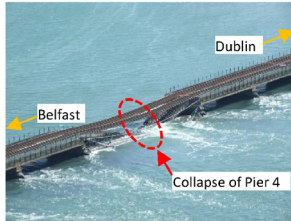


Fig. 3 Collapse figure and water flows of Malahide Viaduct

There was no flood event occurring when the bridge was collapsing. The bridge failure was due to combined effects dominated by local scour. Based on the reduced-scale prototype experimental results during the bridge failure investigation, when a water tide reached to a certain critical flowrate, a hydraulic jump formed between Pier 4 and Pier 5, leading to a significant increase of water flow velocity up to 5.5 m/s [3]. An increase of the hydraulic gradient would result in a substantial removal of grouted and non-grouted rock armor weir materials, undermining the groutapron that supports Pier 4.

The collapsing of the Malahide Viaduct was complicated by contraction scour, particularly two factors as illustrated in Fig. 4. Vertically, the bridge foundation was built on a permeable stone weir, which raises the velocity of water flow when passing over it. Horizontally, the construction of the viaduct reduced the width of the estuary exit, increasing the velocity as well.

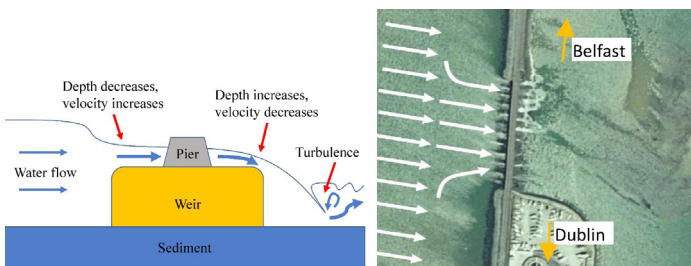


Fig. 4 Schematic of contraction scour of Malahide Viaduct [1]

ABOUT THIS PROJECT

This review was prepared by Dr. Haibin Zhang, a post doc in the INSPIRE UTC at Missouri University of Science and Technology. For more information on this report, please contact Dr. Zhang at zhanghaib@mst.edu or (573) 341-6114.



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There were some signs of the incipient bridge collapse, which did not attract enough attention. For example, four days before the bridge collapse, the stones around the base of Pier 4 were reported to be washed away, indicating the dismantling of the riprap protection strategy and the acceleration of erosion process. Three days before the collapse, a viaduct inspector observed that the ebb flow hydraulic control point had moved further towards the upstream between Pier 4 and Pier 5, as indicated in Fig. 5. This implies the acceleration of water flow in the upstream of the west foundations of Pier 4, and the occurrence of serious erosion, leading to the collapse of the viaduct.

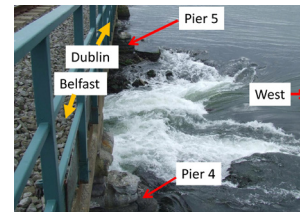


Fig. 5 Ebb flow through Pier 4 and 5 of Malahide Viaduct (RAIU, 2010) [3]

In closure, this report demonstrated two examples of sudden bridge failures due to scour without warning. The lessons learned from these include: (1) not only superstructure and substructure, but also foundation and underwater feature of bridges/viaducts should be inspected on a regular basis, (2) in-situ monitoring of scour risk in real time (e.g., through scour depth estimation) may help the owner of bridges/viaducts to learn the condition and stability of foundations in time for emergency responses, and (3) continuous spans provide redundancy that allows for a ductile failure of the bridge.

References:

- [1] C. Storey, and N. Delatte. Lessons from the collapse of the Schoharie Creek Bridge, Forensic Engineering (2003) 158-167.
- [2] NTSB. Collapse of New York Thruway (1-90) Bridge over the Schoharie Creek near Amsterdam, New York, April 5, 1987, Highway Accident Report: NTSB/HAR-88/02, 1988, Washington, D.C.
- [3] RAIU. Malahide viaduct collapse on the Dublin to Belfast Line on the 21st August 2009, Railway Accident Investigation Unit, Investigation Report No. 2010 – R004. Blackrock, Ireland.

AN OVERVIEW OF FIRE-INDUCED BRIDGE DAMAGE

The aim of this report is to give an overview on fire-induced bridge damage and contrast it with that of buildings under fire. Three bridges under fire conditions were reviewed for comparison.



Fig.1 Oakland highway bridge collapse in California, 2007 [1]

In April of 2007, the MacArthur Maze (known as a multi-level freeway Interchange Bridge) collapsed in Oakland, CA, as shown in Fig. 1. A tanker carrying 32.6 m³ gasoline ran at a speed of 80 km/h on the I-80/880 interchange and suddenly overturned under I-580 and caused a fire in Oakland, CA. Firefighters rushed to the scene within 14 minutes from the start of accident and witnessed the collapsing of two I-580 spans at approximately 22 minutes after the fire. Each span consisted of six un-protected welded plate girders with a span length of 25.6 m and their supported reinforced concrete deck. During the fire, the temperature reached 1100°C and induced large deflections of the girders, resulting in high stresses at connections due to deformation constraints. According to California DOT, more than \$9 million is needed to repair the bridge, out of which approximately \$4.3 and \$2 million is spent on removal of the damaged section of I-580 and traffic control, respectively. The time spent to complete the construction and reopen the Maze freeway to traffic was 26 days. Since the freeway connected several major cities in California, the economic impact to San Francisco Bay Area was estimated around \$6 million a day during the closure of the Maze [1][2].

In July of 2009, a fire occurred at the I-75 overpass in Hazel Park, MI. As in the previous study, a tanker with 50,000 liter fuel collided with a truck and burst into flames. During the fire, the maximum temperature was estimated in the range of 850-1000°C. This high temperature caused significant degradation of the unprotected steel girders. The load-carrying capacity of the steel girders was reduced significantly, leading to the collapse of the overpass within 20 minutes from the start of the fire, as indicated in Fig. 2. Firefighters spent 105 minutes in extinguishing the fire. This accident caused an economic loss of about \$2 million due to traffic disruptions and detours caused by the collapse of the bridge.

In 2004, the Wiertalbrücke Bridge in Germany was under fire as shown in Fig. 3. A fuel tanker carrying 33,000 liters of gasoline was hit by a skidded car, ran through guardrails, fell 10 m, and exploded on impact. The fire caused by the collision induced a maximum temperature of 1200 °C. But the steel deck was believed to be heated to about 500 °C and thus deformed notably over a length of 60 m. Following the fire, a 20 m x 31 m segment out of the 30.25 m x 705 m bridge deck was removed and reconstructed due to significant fire-induced permanent deformation. The economic losses from this fire event were estimated at \$38 million.



Fig.2 Fire-induced girder collapse Hazel Park overpass in Michigan [3]



Fig.3 Tanker truck accident on the Wiertal Bridge [4]

The common features of the above three bridges in response to fire can be summarized as follows. The bridge fires are caused by the collision of a gasoline tanker with either bridges or vehicles on roads such as cars and trucks. These fire events induced temperature in the order of 1,000 °C and caused bridge collapses within approximately half an hour from the start of fire. The short duration limited the ability of firefighters' response to extinguish fire, particularly to those bridges far away from fire engines. As such, fire-induced bridge collapses will continue as more fuel tankers run on highways and will thus be a threat to the safety of travelers.

Fire-induced bridge collapses caused significant economy losses since travellers are forced to detour when the damaged bridges are being repaired or replaced. Therefore, the closure time to traffic is critical in the aftermath of fire. A rapid yet effective evaluation method for the post-fire condition of bridges would help engineers to make informed decision on the post-fire construction: repair versus replacement. The lack of understanding on the performance of damaged bridges results in uncertainty in whether the bridges must be replaced or strengthened and how the repairing strategy is optimized to reduce costs and downtime.

In comparison with buildings, bridges have a much less likelihood to be burnt due to their limited interaction with flammable fuels. On the technical side, bridges also respond to fire differently from buildings as discussed below.

1. Fire source: as mentioned earlier, the gasoline tanker collides with other vehicles and burning of gasoline causes main source of ignition in bridges. However, fire in buildings are usually caused by the burning of wood and plastic-based products in a sealed environment with windows. As a result, the likelihood of a fire in buildings is higher than that of bridges while the severity of a fire in bridges is greater than that of buildings.
2. Fire ventilation: bridge fire usually has an open-oxygen conditions, while building fire is limited by the amount of ventilation.
3. Fire severity: more intense fire gasoline (hydrocarbon fire) can be produced locally in bridges.
4. Fire protection: bridges are not well protected with fire-resistance materials and are lacking of provisions, while buildings have.
5. Uncertainties: fire in buildings has lower uncertainties related to characterize the fire action in a compartment than bridges heated locally. In buildings, fire flashover can be assumed and the temperature of the fire and gases can be calculated and simulated in a compartment.

6. Failure mode: generally, bridges have a deeper girder than buildings. Shear-induced buckling in the web probably dominates the failure mechanism while flexural failure in buildings is preferred.
7. Structural connections: bridge girders are usually supported on the bottom flange. In contrast, buildings have connection on the web or top flange. These support conditions might result in different structural response under fire.

Finally, to study bridge or member responses under fire condition, typical analysis methods include experimental tests and finite element modeling. For experimental tests, fire energy (i.e., heat release rate) needs to be designed first. Structural responses (i.e., temperature, deformation and strain) need to be carefully monitored during tests. However, measurement technologies for each of these parameters needs to be further studied due to the effect of high temperatures. For finite element modeling, models of structural components in commercial software need to be validated through comparison with experimental test results (such as failure time and deformation shape). Material properties under high temperatures from experimental test are input for finite element models. The validated models can be used in parametric studies to save cost and time.

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[2] V.K.R. Kodur, M.Z. Naser, Designing steel bridges for fire safety, *J. Constr. Steel Res.* 156 (2019) 46–53. doi:10.1016/j.jcsr.2019.01.020.

[3] V. Kodur, E. Aziz, M. Dwaikat, Evaluating Fire Resistance of Steel Girders in Bridges, *J. Bridg. Eng.* 18 (2013) 633–643. doi:10.1061/(asce)be.1943-5592.0000412.

[4] https://en.wikipedia.org/wiki/Wiehlta_bridge

ABOUT THIS PROJECT

This review report was prepared by Yanping Zhu, PhD candidate in Civil Engineering at Missouri University of Science and Technology, which will serve as part of the study supported by Mid-America Transportation Center (MATC). For his Ph.D. study, Zhu aims to understand the failure mechanism (or full failure process) of composite floor systems with aid of distributed fiber optic sensing under combined fire and mechanical loads. For more information, please contact Yanping Zhu at yz6d7@mst.edu or 573-341-6114.



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EDUCATIONAL MODULE SERIES

LONG PERIOD FIBER GRATING BASED FIBER OPTIC SENSOR FOR DETERIORATION DETECTION IN REINFORCED CONCRETE STRUCTURES

BY DR. GENDA CHEN, MISSOURI S&T

In this 50-minute lecture, the fundamental concepts of optic fiber, fiber Bragg grating (FBG) and long period fiber grating (LPFG) are discussed. A Fe-C coated LPFG sensor is introduced for corrosion induced mass loss measurement. The sensing system operates based on the principle that LPFG is responsive to both thermal and mechanical deformation, and the change in refractive index of any medium surrounding the optical fiber. Fabrication process of the LPFG is demonstrated through the CO₂ laser aided fiber grating system. To enable mass loss measurement, a low pressure chemical vapor deposition (LPCVD) system is introduced to synthesize a graphene/silver nanowire composite film as flexible transparent electrode for the electroplating of a thin Fe-C layer on the curve surface of a LPFG sensor. An integrated sensing package is illustrated for corrosion monitoring and simultaneous strain and temperature measurement. Two bare LPFGs, three Fe-C coated LPFG sensors are multiplexed and deployed inside three miniature, coaxial steel tubes to measure critical mass losses through the penetration of tube walls and their corresponding corrosion rates in the life cycle of an instrumented steel component. The integrated package can be utilized for in-situ deterioration detection in reinforced concrete structures in future application.

MICROWAVE MATERIALS CHARACTERIZATION AND IMAGING FOR STRUCTURAL HEALTH MONITORING

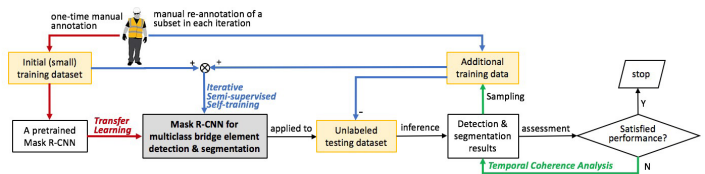
BY DR. REZA ZOUGHI, IOWA STATE UNIVERSITY

Microwave signals span the frequency range of ~300 MHz to 30 GHz. Signals at these frequencies can easily penetrate inside dielectric materials and composites and interact with their inner structures. The relatively small wavelengths and wide bandwidths associated with these signals enable the production of high spatial-resolution images of materials and structures. These methods are also very useful for materials characterization of cementitious materials. In this presentation the basics of the methods for materials characterization and a comprehensive set of results including alkali silica reaction (ASR) detection and evaluation are provided. In addition, results related to using high-resolution synthetic aperture radar (SAR) imaging for detecting rebars in concrete (corroded and uncorroded) are also presented.

BRIDGE INSPECTION VIDEO DATA ANALYSIS FOR ACHIEVING DATA-DRIVEN ASSET MANAGEMENT

BY DR. RUWEN QIN, MISSOURI S&T

This 50-minute lecture briefly discusses the role of bridge inspection video data analysis in data-driven asset management, introduces the fundamental concept of deep learning, and illustrates the development and implementation of a Mask Region-based Convolutional Neural Network (Mask R-CNN) model for analyzing inspection video data. Mobile robotic platforms are developed by the INSPIRE UTC so that big video data of bridge inspection are collected in a rapid, safe, and less expensive way. Assisting bridge inspectors to efficiently detect and retrieve bridge structural elements from the big, complex video data is the first step of inspection video data analysis. Deep learning models such as CNN have significantly improved the capability of image data analysis. Yet, no existing deep learning models are directly applicable to the task of detecting and segmenting multiclass bridge elements. This lecture explains the process for efficiently transferring and adapting a pre-trained Mask R-CNN model to this task using transfer learning and an iterative semi-supervised self-training (IS3T) algorithm. Bridge inspectors are engaged in this process to annotate a small amount of training data. The domain expertise of bridge inspectors helps the model quickly reach a satisfied performance. The lecture further shows results from testing the developed model to demonstrate the helpfulness of the model in the inspection video data analysis.



Engaging Inspectors to Develop an Interactive Video Data Analysis AI Tool as schematically shown in the above figure:

- Transfer learning for initial adaption
- Iterative semi-supervised self-training to boost the performance of the tool
- Temporal coherence analysis for correcting false negative detections and selecting additional training data



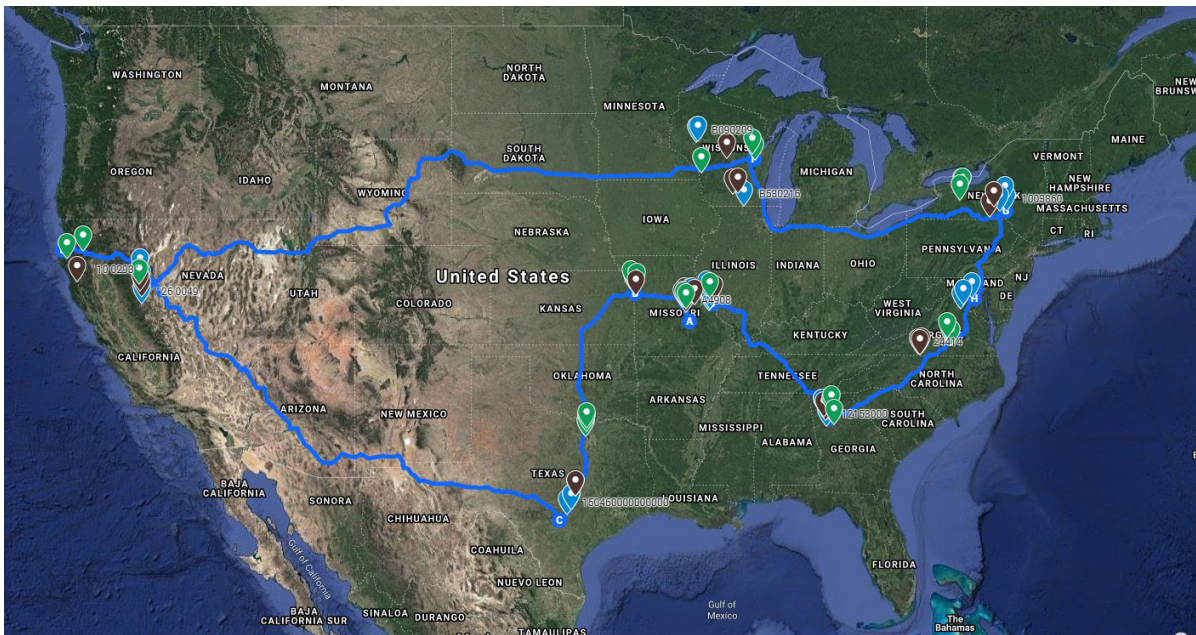
RECENT DEVELOPMENT OF THE SEVEN-STATE POOLED-FUND STUDY NO. TPF-5(395):

The Missouri S&T team continues to make progress on the pooled-fund study. The selection of the bridges that will be inspected on each of the seven participating states are being finalized. A total of nine bridges in each participating state will be inspected with the exception of Missouri in which 18 bridges will be inspected.

The bridges selected are highway bridges with more than one span in three age groups; 15-20, 25-30, 35-40 years. The selected bridges can be categorized in to two types: steel girder bridges in New York, Virginia, Wisconsin, and Missouri; and prestressed concrete-girder bridges in California, Georgia, Texas, and Missouri. The variety of the selected bridges in terms of location, type and age will give researchers a representative set of samples to extract well-informed conclusions and establish new guidelines on technology-assisted inspection procedures. These guidelines will lead to more efficient inspections that will ultimately result in an overall improvement of the Department of Transportation (DOT) resources distribution in bridge maintenance and asset management.

The field inspection works will be performed using INSPIRE University Transportation Center’s cutting-edge sensing and imaging technologies that will be deployed through the INSPIRE Bridge Inspection Robot Deployment Systems (BIRDS). The tests will be carried out with little or no traffic disruption in coordination with the corresponding DOT. The inspection team will be responsible for maintaining a close collaboration with the DOT to achieve optimal results.

The inspection team is further solidifying the details of on-site field deployment capabilities by developing a mobile testing facility that will equip the team with autonomy to travel to each of the states and collect and analyze inspection data as well as transmit the data to the base center at Missouri S&T. Currently, the team plans to travel to different states each year optimizing its routing such as the one shown below.



Selected Bridges on the 7 Participant States



INSPIRE WEBINARS

UPCOMING WEBINARS

Navier – Stokes Equations

$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla) \mathbf{u} = -\nabla p + \frac{1}{\text{Re}} \nabla^2 \mathbf{u}$$

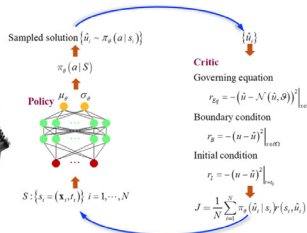
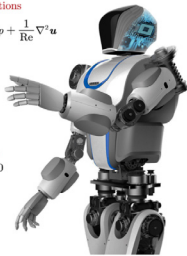
$$\nabla \cdot \mathbf{u} = 0$$

Schrödinger Equation

$$i\hbar \frac{\partial}{\partial t} \Psi = \hat{H} \Psi$$

Van der Pol Equation

$$\ddot{x} - \alpha(1-x^2)\dot{x} + x = 0$$



ARTIFICIAL INTELLIGENCE-EMPOWERED CIVIL ENGINEER

Presented: December 8, 2020, 9:00AM-10:00 AM (CST)
Speaker: **Dr. Hui Li**
 Changjiang Scholar and Professor in Civil Engineering and Mechanics
 Harbin Institute of Technology; Harbin, China
Register: inspire-utc.mst.edu/webinars

Artificial intelligence (AI) is an emerging cutting-edge technology, which have generated great impact to social science, business, medicine, natural science and engineering. The applications of AI will bring revolution to civil engineering in all sides. Most attractive concerns in natural science and engineering are that if we can create “AI-empowered SCIENTIST” and “AI-empowered CIVIL ENGINEER”. This seminar will focus on the “AI-empowered CIVIL ENGINEER” who can do design, fabrication, analysis, maintenance and disaster risk management by machine learning (ML) and deep learning. Specifically, the design of materials and the prediction of properties of materials by ML is first presented. The ML-based architecture design and topological design of structures are then introduced. Finally, a systematic approach for the ML-assisted health monitoring of structures is proposed to cover the topics such as abnormal data diagnosis, loss data recovery, modal identification, damage detection and condition assessment, load identification, and 3D model reconstruction. The applications of ML in wind engineering is also introduced.

RECENT WEBINARS



A MOBILE MANIPULATING DRONES

Presented: June 17, 2020
Speaker: **Dr. Paul Oh**
 Lincy Professor of Unmanned Aerial Systems in Mechanical Engineering
 University of Nevada, Las Vegas



UAV-ENABLED MEASUREMENT FOR SPATIAL MAGNETIC FIELD OF SMART ROCKS IN BRIDGE SCOUR MONITORING

Presented: September 14, 2020
Speaker: **Dr. Genda Chen**
 Professor and Robert W. Abnett Distinguished Chair in Civil Engineering
 Missouri University of Science and Technology

RECENT KEYNOTE/INVITED PRESENTATIONS

- Jinglun Feng, Liang Yang, Haiyan Wang, Yifeng Song, Jizhong Xiao, **"GPR-based Subsurface Object Detection and Reconstruction Using Random Motion and DepthNet"**, presented at 2020 IEEE Int. Conf. on Robotics and Automation (ICRA2020), June 1, 2020.
- Dr. Genda Chen, **"Future Infrastructure Management Using 4.0 Industrial Revolution Technologies,"** presented at EuroStruct Talks (EuroStruct Association), July 9, 2020 (virtual).



WEBINAR ARCHIVES

- | | |
|------|--|
| 2020 | UAV-Enabled Measurement for Spatial Magnetic Field of Smart Rocks in Bridge Scour Monitoring
By Dr. Genda Chen, Missouri S&T, September 14, 2020
Mobile Manipulating Drones
By Dr. Paul Oh, University of Nevada, Las Vegas, June 17, 2020
Non-Contact Air-Coupled Sensing for Rapid Evaluation of Bridge Decks
By Dr. Jinying Zhu, University of Nebraska, Lincoln, March 12, 2020 |
| 2019 | Simulation Training and Route Optimization for Bridge Inspection
By Dr. Sushil Louis, University of Nevada, Reno
Data to Risk-Informed Decisions Through Bridge Model Updating
By Dr. Iris Tien, Georgia Institute of Technology, September 25, 2019
A Performance-Based Approach for Loading Definition of Heavy Vehicle Impact Events
By Dr. Anil Agrawal, The City College of New York, June 5, 2019
Battery-Free Wireless Strain Measurement Using an Antenna Sensor
By Dr. Yang Wang, Georgia Institute of Technology, March 6, 2019
Assistive Intelligence (AI): Intelligent Data Analytics Algorithms to Assist Human Experts
By Dr. Zhaozheng Yin, Missouri S&T, January 30, 2019 |
| 2018 | Toward Autonomous Wall-Climbing Robots for Inspection of Concrete Bridges and Tunnels
By Dr. Jizhong Xiao, The City College of New York, September 19, 2018
Climbing Robots for Steel Bridge Inspection and Evaluation
By Dr. Hung La, University of Nevada, Reno, June 21, 2018
Microwave Materials Characterization and Imaging for Structural Health Monitoring
By Dr. Reza Zoughi, Missouri S&T, March 15, 2018 |

VIEW COMPLETE LIST OF WEBINARS
scholarsmine.mst.edu/inspire_webinars

Kaleidoscope Discovery Center Provides STEAM/Robotics Programs

With the April Covid-19 lockdown, the delivery mode of activities at the Kaleidoscope Discovery Center has changed considerably. With additional grants from the Community Foundation of the Ozarks and the Missouri CARES Act, the Kaleidoscope has been able to successfully continue its work on the UTC grant by providing STEAM/Robotics opportunities in the region.

As of October 27, the Kaleidoscope is now actively supporting robotics and engineering education at four area sites reaching approximately 50 students per week! As area schools navigate their next round of flexible normal, Natalie Kost has been on site to provide valuable support to teachers, coaches, and students with robotics and coding education.

Each location where programs are supported has a slightly different Covid protocol. Given the opportunity to spread the virus among these four populations, the Kaleidoscope ardently supports the use of masks, frequent handwashing, and social distancing.

Currently, the Kaleidoscope supports the Dent R3 robotics team, the Newburg robotics program, and leads the Rolla program at the Kaleidoscope Discovery Center weekly. In addition, the Richland 4-H Afterschool program is up and running again with Natalie's support, plus an outdoor program on engineering city design was held at the Newburg Children's Museum Afterschool program was also supported! Teams have filled for the targeted FLL Explore and FLL Challenge as per the grant. The FLL Discover group still has some availability.

The FIRST Robotics program made a change this year and split the youngest robot builders and coders into a new group. Thanks to the generous funding of the INSPIRE University Transportation Center (UTC) grant, equipment for this younger group was secured and it is currently in use in Rachel Young's Vienna Kindergarten class!

On the horizon? Virtual robotic build and coding classes resume the first two weeks of December and will run for the foreseeable future. Although initially scheduled for a later fall start, a virtual teaching plan has been put into place during this time after a new curriculum was written, consistent internet secured, and an enthusiastic virtual teacher became available. In addition, through the MO CARES Act, the Kaleidoscope was able to secure proper UV light disinfecting equipment that allows the robotics kits to transfer from home to home. For a younger group of learners, hands-on opportunities are especially important during a time when much of their learning is online. It is expected that with the use of the WeDo robots secured from the INSPIRE UTC, virtual instruction will reach over 100 students by May 2021.



For more information, visit: thekaleidoscope.org/first-robotics

UNLV Robotics Laboratory Show - Saturday K-12 Programs

The UNLV team continues to work with the neighboring Clark County Las Vegas Public Library in the Saturday K-12 programs. Lesson plans include computer-aid-design (CAD), 3D printing, and embedded controllers (Arduino). Additionally, the team serves institutional outreach programs, namely Upward Bound. This program is UNLV's outreach to middle school students each Saturday led by hands-on STEM labs including drone (programming), augmented reality (projection mapping) and embedded control (Arduino).

Future City Competition 2020-2021:

The Future City Competition engages more than 45,000 middle school students each year throughout the United States and abroad. Students repeatedly report that the program increases their motivation and excitement about STEM (Science, Technology, Engineering, and Math). In addition, students and teachers report a marked improvement in students' 21st Century skills. Future City challenges students to tackle authentic, real-world problems and is accessible to every student, from the exceptional child to the gifted and talented. Female students, minority students, and low-income students from Title I schools all participate at record levels.

This year Future City has made several adaptations due to the COVID-19 pandemic and uncertainty surrounding the school year and extracurricular activities. The Future City competition will be going virtual for the 2020-2021 Competition year. Teams have the option to complete deliverables for their projects in person or remotely. The program and its deliverables have also been adjusted so success can be achieved no matter the method of learning. This year's theme is "Living on the Moon." The objective is to design a lunar city and to provide examples of how your city uses two Moon resources to keep your citizens safe and healthy. The competition's regionals and finals will take place online this year rather than in person.



🔗 **For more information, visit: <https://futurecity.org>**

NSBE Pre-College Initiative to be held virtually at Missouri S&T

This year Missouri S&T will be hosting the National Society of Black Engineers Pre-College Initiative (NSBE PCI). It will be held on February 19-20, 2021 on the Missouri S&T campus. This year due to the COVID-19 pandemic, the event will be held virtually. The PCI program supports high school students that may be considering a future career in science, technology, engineering, or math. Through information sessions and hands-on workshops students have a chance to explore career options and gain a better understanding of what college life is all about.

NSBE Jr. Aims:

- Help pre-college students develop a positive attitude towards academic excellence
- Encourage and support parental commitment to their children's education
- Stimulate enthusiasm about engineering and science among pre-college students
- Raise cultural awareness among Black and African-American youth
- Provide support to students throughout the college application process
- Increase college graduation rates of Black and African-American students
- Prepare pre-college students to be positive, contributing future NSBE members



🔗 **For more information, visit: sdi.mst.edu**



INSPIRE University Transportation Center

Missouri University of Science and Technology
112 Engineering Research Laboratory, 500 W. 16th St.
Rolla, MO 65409

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Newsletter Editors

Derek Edwards, Head Student Ambassador

Matthew Weiss, Head Student Ambassador

Lisa Winstead, Program/Project Support Coordinator

UPCOMING EVENTS

December 8, 2020

INSPIRE UTC Webinar: "ARTIFICIAL INTELLIGENCE-EMPOWERED CIVIL ENGINEER", Presented by Dr. Hui Li, Harbin Institute of Technology

<https://inspire-utc.mst.edu/webinars/>

December 8, 2020

MATC Webinar: "Reducing Flammability for Bakken Crude Oil for Train Support" Presented by Dr. Albert Ratner and Sazzad Parveg, University of Iowa

matc.unl.edu

February 19-20, 2021

NSBE Pre-College Initiative

<https://sdi.mst.edu/pci/index.html>

February 27, 2021

Missouri Future City Competition presented by Kaleidoscope Discovery Center

<https://thekaleidoscope.org/future-city/>

inspire-utc.mst.edu/events