Annual Review

2023

Safety Through Science

CONSTRUCTION
SAFETY RESEARCH ALLIANCE

Contents

Letter from the Chair

As we conclude another year in the journey of the CSRA, I wanted to take a moment to reflect on our achievements, express my gratitude, and outline our vision for the future.

First and foremost, I want to extend my sincere appreciation to each and every member of the CSRA's exceptional community. Together, we have worked to propel construction safety research to new heights, working towards making a meaningful impact in the industry. The dedication and unwavering commitment to bringing workers home safe have been instrumental in this, the fifth year of the CSRA's journey.

Over the past year, we have achieved significant milestones, including the successful launch of three groundbreaking research projects; Safety Culture, Controlling High Energy, and Mental Health Crisis: An Approach Based Evidence - the last one stemming from a joint venture with CII where we produced a guidebook to help everyone in our industry have good conversations about mental health. We also made progress with the widespread dissemination of research products via national and international conferences and peer-reviewed publications. We welcomed twelve new members this year and our Communities of Practice registrants nearly doubled. These accomplishments are a testament to our collective effort and the core values that define the CSRA.

Looking ahead, our plans for next year are just as bold. We remain committed to our vision of eliminating serious injuries and fatalities in the construction industry via transformative research and defendable science. In my second term as chair of the CSRA's Board of Advisors, I am focused on keeping the CSRA as the premier source of construction safety research, the CSRA continues to foster a culture of continuous learning in the prevention of SIFs, and the CSRA adapts to the ever-evolving needs of our industry's workforce.

Each year we determine our next strategic focus based on your collective. The two new projects are: Decluttering Safety and Changing our approach to Last Minute Change.

I encourage you to take a moment to reflect on your individual contributions to our shared success. Each one of you has played a pivotal role in shaping our journey, and I am immensely proud of what we have accomplished together.

In conclusion, I extend my heartfelt thanks to all of you for your exceptional work and unwavering dedication. Let us celebrate our achievements and approach the future with renewed vigor and enthusiasm. There is much work to be done.

Mike Court

Mike Court

SVP HSEQ and Sustainability Graham

Science of SAFETY TRAINING

Safety training is the cornerstone of most, if not all, safety management systems. Significant resources are spent in delivering multitudes of training to workers that not only communicate policies and procedures but also improve their safety skills. The construction workforce is a unique group of adult learners with dramatically different educational backgrounds and a highly uneven proclivity to learn safety science. Therefore, we need to derive findings from this specific audience to effectively revise how we design and deliver safety training to workers. Instead of adding a new training to the ever-growing list of different safety training programs we already deliver, let's figure out how to do what we already do really well. To that effect, this project asked 3 questions.

Q1. What do workers and trainers say are the characteristics of the best and worst training delivered on construction sites?

To understand the positive and negative characteristics of any safety training program, we surveyed trainers and trainees across multiple organizations and sectors. A total of **140** construction workers and **193** trainers responded to the following open-ended questions:

Workers

Can you recall and describe the best safety training you have received? Please describe why.

Can you recall and describe the worst safety training you have received? Please describe why.

Trainers

Can you describe the best training experience you've delivered as a trainer?

What is your biggest challenge when training workers?

The resultant qualitative data was analyzed using content analysis to unpack the agreements, disagreements, and complexities that exist among construction workers and trainers on the quality of training programs to provide nuanced and scientifically valid results. Finally, a team of 20 industry practitioners translated the academic findings into practical guidance to equip trainers on how to engage workers better during training. The guidance will support trainers to deliver any training more effectively in future.

Q2. Which training delivery style is most effective in improving safety learning outcomes among workers?

A field experiment was launched by the team to test 5 different delivery styles that are commonly used in practice within the industry. A key objective of this experiment was to ensure high ecological validity. In other words, we sought to design the experiment to mirror real-world settings as much as possible. By having different actual trainers across different organizations and industry sectors involved in delivering the training in the field experiment, we were able to incorporate the "human factor" in the delivery of training in this experiment. Therefore, the results presented in this study can be applied to practice with a high degree of confidence.

Delivery styles tested

Hands-On Workshop	• A 120-min lecture with collaborative learning exercises and a dynamic hands-on activity.
Hybrid Seminar	• Two-part training spread over 2 weeks. First session provided information using an 18-min video. • Second session was in-person collaborative learning exercises and a dynamic hands-on activity.
Interactive Session	• A 50-min lecture with collaborative learning exercises (e.g., think-pair-share, collaborative brainstorming etc.).
Lecture Seminar	• A 30-min one-way delivery of information. • In-person delivery and trainees were encouraged to ask questions.
Video Only	• A 18-min high quality production. • An experienced safety trainer was recorded in the video delivering the training.

We were able to measure changes in hazard recognition performance, controls identification, risk perception, risk tolerance, and interest in safety training before and after the training was delivered to them.

Q3. How well does VR work?

Virtual reality (VR) has long been talked about as an alternative platform to effectively train construction workers on craft and safety skills. Unfortunately, to date there has not been a comprehensive study that examined whether or not VR is actually effective or not. This National Science Foundation funded project is being completed with the support provided by the CSRA membership.

Data is being analyzed from this experiment that will inform us whether or not VR is an effective platform for workers to practice their knowledge and gain second-hand experiential learnings.

A total of

847

workers participated in the experiment.

Understanding the MENTAL HEALTH CRISIS within the Construction Industry

When it comes to Mental Health, the right mantra is: we need to do something, not anything. As non-medical experts, construction professionals are acting undoubtedly in good faith, but we can understandably underplay the likelihood of ill-planned interventions that can, at best, result in nothing, but, at worst, can cause further harm. This project, therefore, aimed to equip professionals in the industry with knowledge on not only what can and should be done but also how to avoid falling prey to ineffective and ill-conceived solutions.

By using validated literature from medical sciences and behavioral psychology, and survey data from

1,197

employees, the team created a guide that answers the following questions:

1. Why does the construction industry need to act to improve the mental health of its employees?
2. Why should the industry not engage in solutions that seek to diagnose and treat the mental health of individuals?
3. What is the industry doing specifically that is harming the mental health of its employees?
4. How should the industry respond?
5. How should management measure the success of interventions and solutions?
6. How can the industry avoid furthering harm?

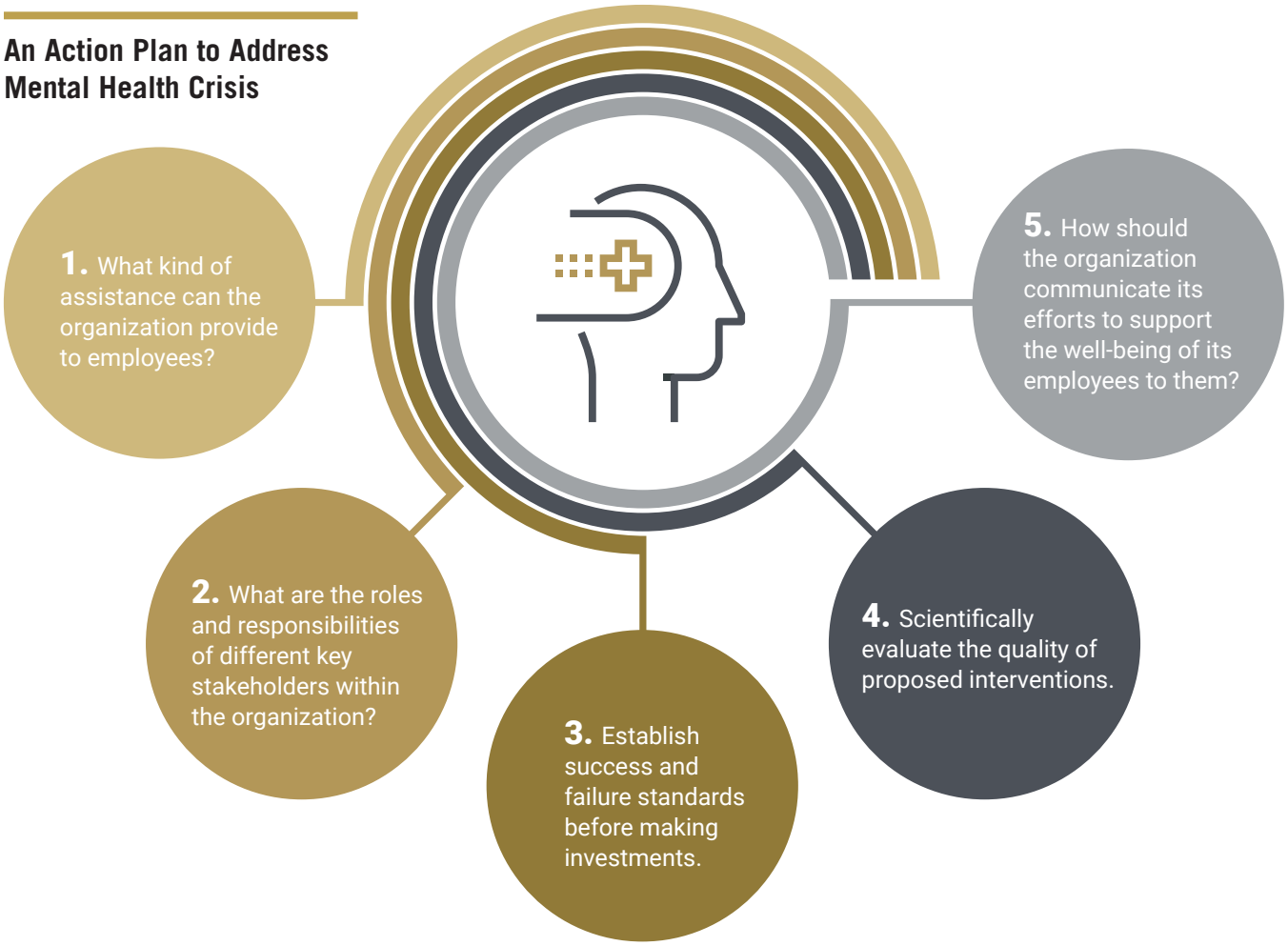
Some notable findings described in the guide are:

- In medical science literature, there are no validated non-medical interventions that organizations can apply ubiquitously across different demographical groups.
- Human beings, despite training and education, are very biased. Asking individuals within the organization to identify other individuals with mental health concerns can further exacerbate stereotypes and stigma.
- The two most important work-related stressors are: **financial uncertainty** and **job demand**.

- The three most desired work-related wellness outcomes are: **job satisfaction**, **financial security**, and **sense of belongingness**.
- Above findings were consistent for Caucasian workers, Hispanic workers, younger and more mature employees, and even for employees working primarily in the field and the office. This gives a clear mandate from employees if management is keen to address the issue of mental health.
- The data also showed mixed results for peer support (a popular intervention being peddled by many consultants). Not surprising, as the finding is consistent with evidence from medical science, which shows it to be marginally effective at best.

These findings are further edified in the guide. The guide also provides a 5-step process that would allow any construction organization to design an appropriate mental health support program by advising on:

An Action Plan to Address Mental Health Crisis



The guide is open source to promote transparency and encourage debate, and to combat consultants who aim to sell debunked self-help solutions within the industry. An issue as serious as mental health deserves scrutiny from everyone involved to ensure we do not further harm. Over the next two years, a new CSRA research project is aiming to deepen our understanding of the work-related stressors, test preventative and remedial interventions, and propose a pathway for the industry to make a few structural change that minimize the risk of our employees developing mental health issues due to work-related stressors.

On-Going RESEARCH PROJECTS

Safety ROI Update

Creating a scientifically validated method to estimate safety ROI.

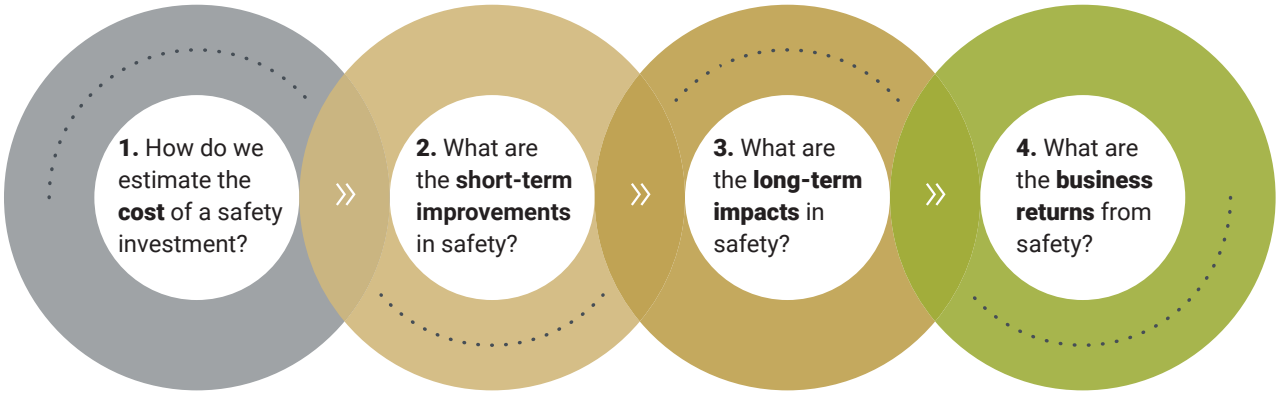
As organizations spend millions of dollars annually on safety programs, there is no up-to-date tool that can objectively measure the impact of these safety investments to know which one yields the 'biggest bang for the buck'. Consequently, organizations don't know yet if they're putting their efforts in the most useful programs. As a result, the CSRA embarked on an ambitious project to compute the realized safety return on investment (ROI) of key interventions using research methods from the fields of pharmaceuticals and finance.

Measuring the impact of key safety interventions: How do we know it wasn't something else?

When organizations have simultaneous safety programs in place, it is hard to know if an improvement in safety was caused by a specific intervention and not something else. Attributing cause-effect relationships is extra challenging in construction settings where there could be numerous alternate plausible explanations. The researchers will use a Multiple Baseline Testing (MBT) field experimental protocol to measure and isolate the true effects of an intervention from any of these possible confounders. The experiments will measure the short-term safety improvements gained by the case study interventions.

The Safety ROI Research Team selected three interventions as potential case studies for the MBT experiments: (1) training on 'what good looks like' for pre-job safety briefs, (2) implementing speed bumps in work zones, and (3) the use of in-vehicle monitoring systems (IVMS).

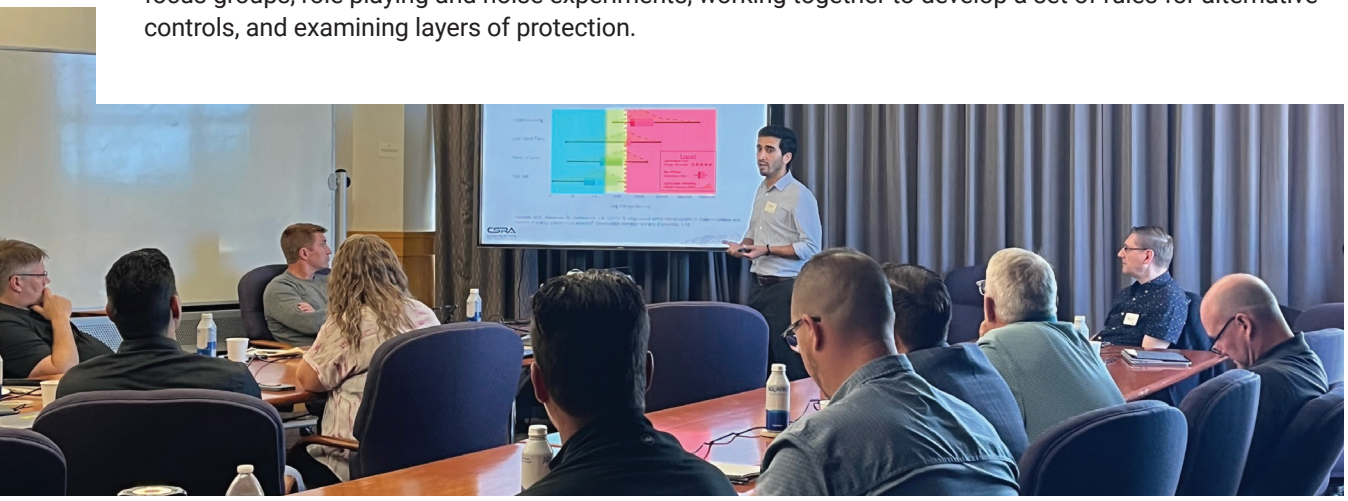
Return on Investment Research Process



High Energy

Controlling the Uncontrollable

SIF-focused safety systems require strict attention to the control of high-energy hazards (i.e., the stuff that kills you or STKY). Grounded in the principles of energy-based safety and human performance, Direct Controls are adequate to protect against high-energy hazards because they (1) effectively mitigate a high-energy hazard; (2) are installed, verified, and used properly; and (2) are immune to unintentional human error. However, for a large proportion of high-energy hazards – around 33% – there are simply no direct controls available. We have been calling these "STKY situations." In this project, we have been unpacking STKY situations to determine what is an acceptable alternative level of control and examining the potential to develop direct controls or alternative work practices. Since February, the team have been involved in focus groups, role playing and noise experiments, working together to develop a set of rules for alternative controls, and examining layers of protection.



Safety Culture

Measuring the Unmeasurable

The Safety Culture team has been unpacking the very messy concept that is safety culture. The team has affectionately labeled itself 'Team Spaghetti and Meatballs' because some aspects of culture are immediately observable (meatballs), some may be untangled through strategic analysis (spaghetti), and others are nebulous yet essential to the recipe (the sauce). Whilst safety meatballs are easy to see and count – such as PPE, compliance, and risk assessments – other things such as commitment, values and accountability are much more like the safety 'sauce', which is much harder to define and measure. Using Q Methodology, the team revealed that most important safety activities for a positive safety culture are also the most difficult to identify and measure. The team have also been grappling with a useful definition of safety culture, and thinking about what is measurable and what is not. Empirical data collection will begin later this year to confirm what we should be measuring to give a valid and reliable recipe for safety culture, with tools to help organizations readily and easily implement positive change in practice.

RESEARCH
on the Horizon

Mental Health Research Project Phase 2

Are your mental health initiatives effective? Understanding the why and why not.

The alarming and sobering trends around the mental health of its employees have galvanized the construction industry to tackle this issue head-on. Unfortunately, there is very little science surrounding the actions being taken to improve the mental health of employees. With seemingly endless proprietary mental health interventions available on the market, the field of mental health has become confusing, complex, and even potentially dangerous. In response, this project aims to not only deepen our understanding of the work-related stressors causing significant harm to employees but also complete a field experiment that validates assessment tools that measure indicators of poor mental health. We will then seek to test empirically if popular strategies being deployed by organizations to improve employees' mental health are effective or not. By underpinning the process by which we would judge the efficacy of our actions, we will better know their consequences in practice, and how to rationalize our actions in the future.

Decluttering Safety

Safety professionals and front-line workers often bemoan safety paperwork; arduous, redundant, or unrealistic policies and procedures; and unnecessary activities done in the name of safety. This "safety clutter" is often introduced and institutionalized through corrective actions following incidents or because of inefficiencies related to the organization and governance of projects. This project will explore safety clutter and deploy a structured method to identify, analyze, and remove low-value safety activities. In phase 1, we will deploy learning teams with senior leaders, safety professionals, field leaders, and front-line workers, to explore the following questions: What is "safety clutter"? What are some common examples of clutter that apply broadly in construction? What was the genesis of this clutter? What is likely to happen if this clutter is removed? In phase 2, we will run field experiments to measure the consequence of removing safety clutter. The product of this research would be examples of safety clutter that can be systematically removed in favor of higher value activities. This knowledge may serve as research-backed "permission" to remove inefficient or ineffective safety practices.

Changing our Approach to Addressing Last-Minute Change

Recent research has shown that over half of all serious injuries and fatalities (SIFs) involve a last-minute change in the work process or environment. To address last-minute change, employees are often directed to plan for change, be aware of change, and stop work when something changes. However, change can range from minor, low-consequence changes to major, high-consequence changes. This project will seek to improve our ability to anticipate, recognize, and address changes that relate directly to SIFs by answering the following questions:

- **How good are we at anticipating change?**
- **What changes do we recognize, which do we miss, and why?**
- **What tools might help us improve our ability to anticipate and identify change?**
- **How do we respond to different types of change and ensure that we target and address changes that relate directly to SIFs?**

CSRA
Alumni

DR. ELIF ERKAL

is a Senior Associate with Exponent and started working as a technical consultant to help with the implementation of her research industry-wide while continuing to build her skillset in sustainability, data analytics and project management. She remembers her years in CSRA with fondness and gratitude. In her words, “I got to ask hard questions that matter with mentors who gave me support, inspiration to explore, room to succeed and courage to fail.”

HAYLEY HANSEN

worked with the CSRA for 2.5 years as an undergraduate research assistant and graduated in May 2023. She was a member of the Incident Investigation and Learning Team as well as the Safety Culture Team during her time with the CSRA. After graduation, Hayley accepted a position with Kiewit Building Group and has been working as a Field/Office Engineer. She has brought her knowledge from the CSRA to her professional career and is looking forward to continuing to work and support the CSRA.

MICHAEL COLPACK

is a master’s student at the University of California, Berkeley. While working with the CSRA, his experience gave him a great insight into the research process as well as providing him with avenues to learn from the incredible minds within the organization. It has also helped him to keep the safety of people at the forefront of his mind when thinking about different avenues of construction. He hopes to work in the design sector of the heavy civil industry after he graduates.

CSRA
Peer-Reviewed Publications

These publications form the **defendable science** from our CSRA Vision and underpin all our work. The abstracts are summarized here, with full papers available through our Knowledge Center for you to read at your leisure.

Moving beyond TRIR: Measuring & monitoring safety performance with high-energy control assessments

Professional Safety

Elif Deniz Oguz Erkal; Matthew Hallowell

Total Recordable Injury Rate - the common measure of safety performance - is flawed both statistically and philosophically. A novel approach, the High-Energy Control Assessment (HECA), was proposed to assess safeguards against critical hazards, based on the principle that all life-threatening high-energy hazards should have sufficient controls. This method quantified energy magnitude and the presence of direct controls objectively. HECA serves as a performance monitoring tool for ongoing safety management, offering ample data for informed decision-making. The study presented HECA's methodology, emphasizing its potential for reliable, data-driven strategic decision-making in safety management.

Exploring bias in incident investigations: An empirical examination using construction case studies

Journal of Safety Research

Sreeja Thallapureddy; Fred Sherratt; Siddharth Bhandari; Matthew Hallowell; Hayley Hansen

Incident investigations are vital for safety management and organizational learning. While prior research has focused on collecting and analyzing information, the process of gathering subjective data through interviews has been overlooked. Through simulated interviews with experienced investigators, biases such as confirmation bias, anchoring bias, and fundamental attribution error were identified within the process – no surprise as we are all biased! The study explored when and how these biases most frequently manifest, impacting organizational learning. It concluded that mitigating biases in investigations is crucial. Heightened awareness and education can improve incident investigation, enhance learning, and thus prevent future occurrences.

The unintended consequences of no blame ideology for incident investigation in the US construction industry

Safety Science

Fred Sherratt; Sreeja Thallapureddy; Siddharth Bhandari; Hayley Hansen; Dylan Harch; Matthew R Hallowell

A No Blame approach is widely used in incident investigations to encourage worker engagement and enhance organizational learning from incidents. However this study revealed that a blanket approach to No Blame actually brings unintended consequences to the investigative process. Analysis of simulated interview transcripts involving construction safety experts exposed a shift of focus towards blaming inanimate objects, procedures, and paperwork, whilst sidelining workers in the process. This form of No Blame ignores the workers' interaction with their work, but this is often vital for learning. Recognizing and addressing these unintended consequences becomes vital for effective incident learning and improved occupational safety.

What is a "serious" injury? Introducing and testing the LIFE model to empirically define SIF

Professional Safety

Arnaldo Bayona; Siddharth Bhandari; Matthew Hallowell; Fred Sherratt; Jennifer Bailey; James Upton.

Serious injury and fatality (SIF) prevention is a priority for safety. Because SIF incidents are relatively rare, collaboration is required across organizational boundaries to enable shared learning and improvements in practice. However, collaboration requires a common vocabulary for incident classification, and currently there is no consistent understanding of the word "serious". An expert panel used literature from medicine, military, engineering, and other disciplines to create the empirical criteria that define a serious injury (the LIFE model). A controlled experiment revealed that the LIFE model is reliable, significantly decreases noise and can serve as the foundation for professional collaboration and scientific advancement.

Formal evaluation of construction safety performance metrics and a case for a balanced approach

Journal of Safety Research

Elif Deniz Oguz Erkal; Matthew R Hallowell; Siddharth Bhandari

Safety leading indicators and climate assessments have been used as a metric of safety performance, however their weaknesses are often overlooked. This study addressed this gap by evaluating existing safety metrics against predefined criteria, exploring how combining multiple metrics can optimize strengths and offset weaknesses. The study employs evidence-based (predictive, objective, valid) and subjective (clear, functional, important) criteria, using literature review and expert opinions via the Delphi method. Findings indicated no single metric excels in all criteria, but combining diverse metrics can enhance safety evaluation. The study offers insights for safety professionals' metric selection and aids researchers in identifying reliable variables for evaluating safety performance.

Practical assessment of potential predictors of serious injuries and fatalities in construction

Journal of Construction Engineering and Management

Elif Deniz Oguz Erkal; Matthew R. Hallowell; Siddharth Bhandari

Serious injuries and fatalities (SIFs) pose a complex challenge in construction, prompting researchers to explore innovative preventive methods. These include leading indicators, precursor analysis, and data analytics-supported risk assessment, signaling a shift in safety prediction. This study identified a comprehensive range of potential SIF predictors in construction; prioritized these predictors quantitatively; and developed a ranked list for on-site testing and deployment. Industry experts proposed 254 predictors through brainstorming, subsequently rating measurability, predictiveness, simplicity, and actionability. This study identified the most practically promising predictors for predicting SIF events.

COMMUNITIES
of Practice

Communities of Practice (CoP) calls continue to go from strength to strength for the fourth year running. The CoP calls are attended by both CSRA members and non-members. They are the town-square where safety professionals and academics gather to support each other. Each month, the CSRA invites leading safety professionals and academics to share their ideas, processes, and solutions. Having an open forum that is truly by the industry, for the industry allows us all to take the 'proprietary' out of safety and make the elimination of SIFs a shared objective.

250+
Organizations are part of the community

125
attendees on average access CoP calls each month

11
Speakers from different sectors of the industry.

Next year, we are aiming to have academic and professional leaders from across different sectors share their efforts towards elimination of SIFs on the following topics:

1. Measuring Safety Performance
2. Application of Energy-based Safety
3. Science of Safety
4. Technology in Safety
5. Improving the Quality of Incident Investigations
6. Precursor-based Engagements
7. Classify Incidents and Observations using SCL Model
8. Evidence-based Actions to Improve Mental Health

To sign up for these calls, please visit our website and subscribe the receive the invites: https://www.csra.colorado.edu/csracop

2023 Speakers

HECA Assessments and Safety Observations

Paul Levin
Vice President-Corporate Director of HS&E

SUNDT
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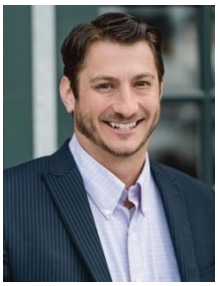
Omar Percy
Group HS&E Manager, Transportation

SUNDT
Skill. Grit. Purpose.



Brian Polis
Senior Director – Health, Safety, and Environment

GRAHAM

Precursor-based Engagements

Bob Rodriquez
Associate Director, Global EH&S

OTIS

Matt Summers
Safety Consultant

ACIG
AMERICAN CONTRACTORS INSURANCE GROUP

Mike Dickerson
Safety Consultant

ACIG
AMERICAN CONTRACTORS INSURANCE GROUP

Kevin Mooney
Vice President of Prevention and Employer Services

wcb Saskatchewan Workers' Compensation Board

How to Use Learning Teams?

Shawn Connick
Senior Human and Organizational Performance Specialist

QUANTA SERVICES, INC.

Mental Health Initiatives

William Southerland
Manager of Construction

Williams

Kim Solylo
Occupational Health Advisor

GRAHAM

Learning Through Demonstrations & Managing Risk-Taking Behaviors

Sid Bhandari
Associate Director of Research at CSRA

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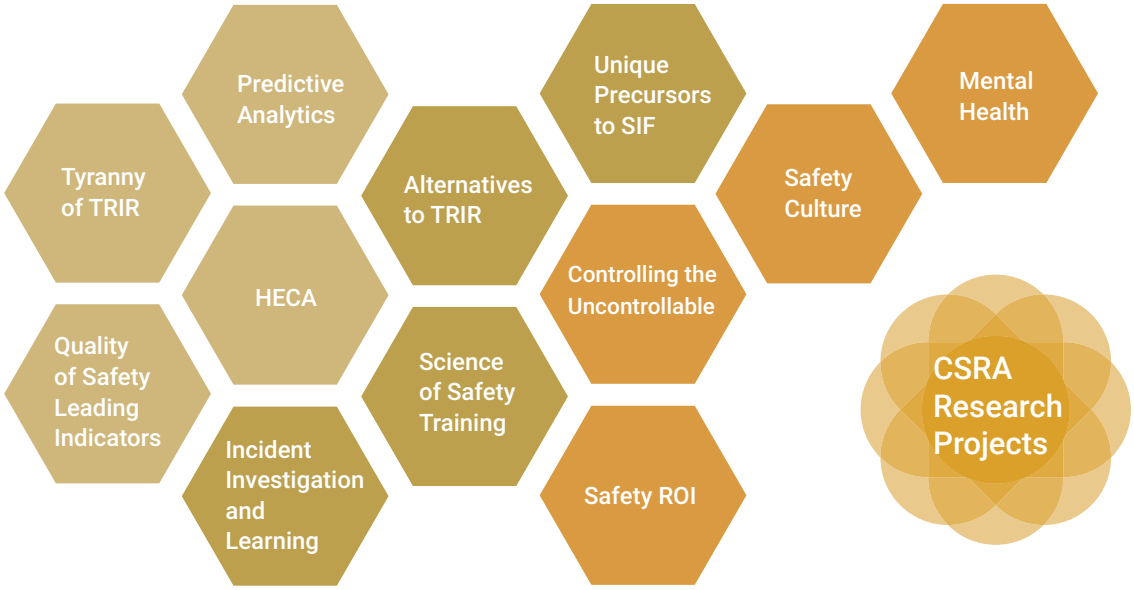
Mike Quashne
Manager, Business Transformation and Performance Assessment
exelon

LETTER FROM THE VICE CHAIR

Modern Day Safety

Paul Levin
Vice President-Corporate Director of HS&E
Sundt

Greetings CSRA members and supporters! Ideas spur ideas. And your ideas continue to inspire the CSRA in ushering in our new era of Modern Day Safety. As part of CSRA we are constructing balance, both in the research and groundwork for building Modern Day Safety, and additionally in the sharing and collaboration with industry, and our own organizations, of how to bring this research alive.



With the responsibility of Vice Chair, I strive to bring radical candor, best practices, and a 'can do' attitude to support our vision. This responsibility is imperative to grow our involvement in industry; both in recruiting industry partners and in benchmarking with owners and peers, demonstrating just how our transformative research and defendable science can help their organizations as well.

Never before has optimism been so high knowing we continue to improve the construction industry, and specifically the cause of construction safety, one which we have dedicated our careers to. On behalf of the CSRA Board of Advisors, we thank you for your continued dedication to these fun, exciting and ground breaking efforts.

We look forward to another momentous year of eliminating serious injuries and fatalities in the construction industry through transformative research and defendable science.

Thanks,

Paul

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Enbridge Life Takes Energy
Energy Safety Canada
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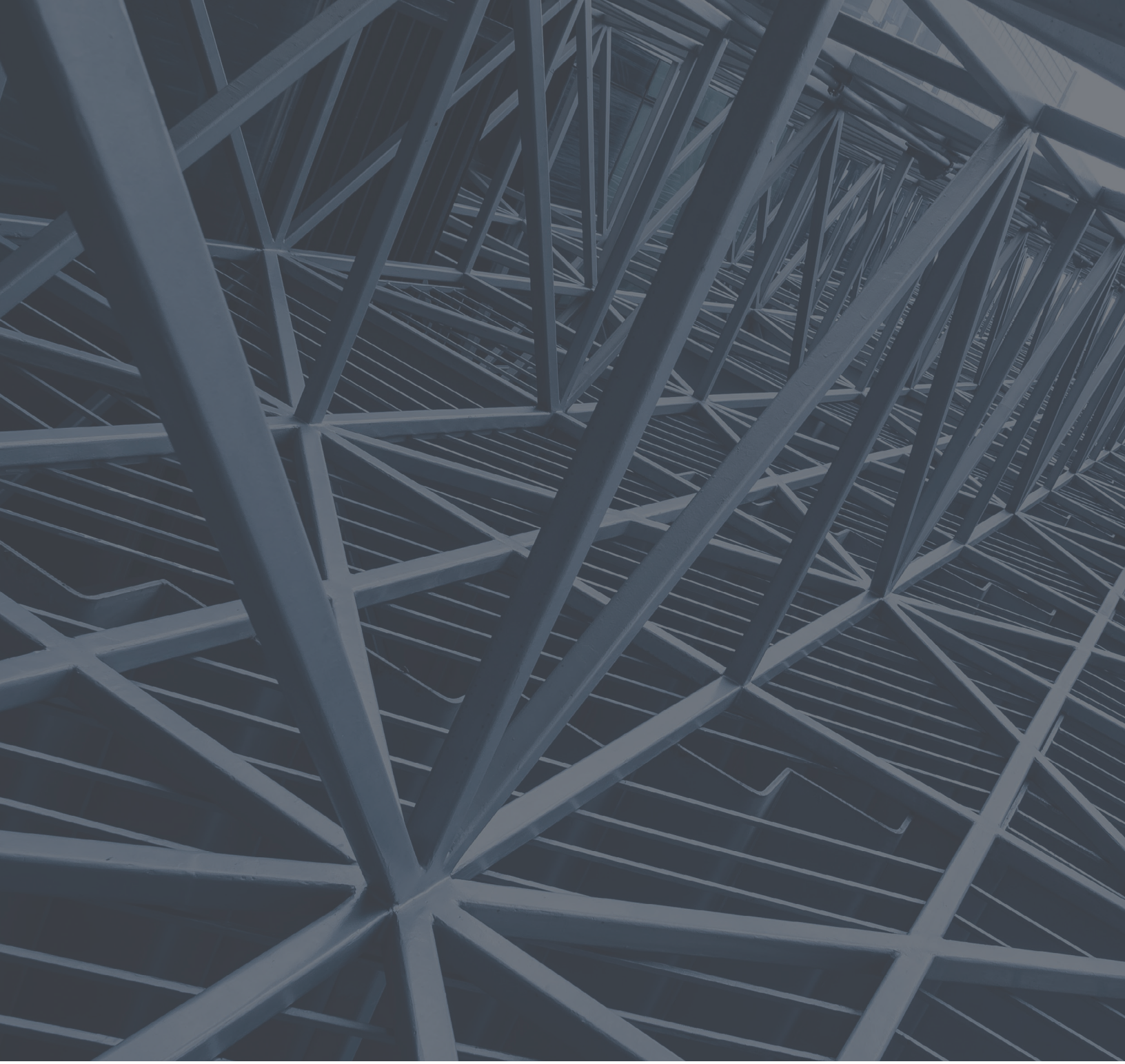

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The Construction Safety Research Alliance
UCB 428
1111 Engineering Drive
Boulder, CO 80309
www.csra.colorado.edu