2022 Annual REVIEW

Safety Through Science.

CSRA

CONSTRUCTION SAFETY RESEARCH ALLIANCE

Table of Contents

Letter From The Chair

Mike Court

Graham • Senior Vice President •
Health Safety Environment Quality & Sustainability

As we close out our third year as the leader in construction safety research, I remain in awe of what the CSRA has achieved. Our mission and values remain unwavering, and the focus work ethic of the CSRA staff is genuinely inspirational.

We are making strong progress toward our vision of eliminating serious incidents and fatalities year after year. With the quality of our research and the recognition from the industry, the CSRA is fast becoming the single source of scientific SIF research for the construction industry. The CSRA's theme of 2022 has been growth. The industry membership has increased by 32% to a total of 74 member companies. To support this growth and diversify the CSRA's expertise, we were fortunate to welcome a new Associate Director of Research, Dr. Fred Sherratt. Dr. Fred's research has always prioritized construction workers with a focus on their occupational safety, health, and wellbeing. The CSRA academic team also grew with the addition of a senior Administrative Assistant, Ayleen Perez, who helps support the organization of CSRA activities and creation of work products. This enormous growth is a testament to the quality of the CSRA research, our outreach, and growing reputation as a leading research institution.

Over the past year, our research teams have been hard at work. We have completed three projects, have other projects underway, and two new projects set to kick off in early 2023. In addition to our full team projects, we pursued two additional projects, one focused on the emerging opportunity to integrate better safety metrics in ESG reporting and the other focusing on mental health through the CSRA's first joint venture with the Construction Industry Institute (CII). The portfolio of research will undoubtedly yield useful and applicable results for our members and the industry.

I am grateful for the tremendous resiliency, collaboration, and commitment shown by our research team members, board of advisors, and academic colleagues. The CSRA community continues to dedicate their time and expertise to advance the CSRA vision. I would personally like to thank each of you for your contributions.

As I close, I want to extend my gratitude to each of you for your financial and in-kind support. I also want to welcome those of you who are joining the CSRA. Your presence, insights, and creative contributions will enable us to achieve our vision and continually improve. Given our current trajectory, we are well positioned to achieve our goals and truly make a difference.

Mike Court

Alternatives to TRIR

If not TRIR, than what...?

In 2020, our work on the Statistical Invalidity of TRIR was published in the *Professional Safety Journal*. The key finding was that the timing of recordable injuries is almost completely random (akin to flipping a coin), which means that in most practical circumstances differences in TRIR are statistically meaningless.

Since this work, the CSRA has been on the quest to determine how safety performance *should* be measured and compared. Using a combination of empirical evidence and expert opinion, the CSRA studied the strengths and weaknesses of existing and emerging safety metrics such as Leading Indicators, Safety Climate, Near Miss rates, and more. Each metric was evaluated against the following six criteria:

Metric Evaluation Criteria

Empirical Evidence

1. **Predictive:** Trends from the past provide information about the future
2. **Objective:** Observations may be made with minimal potential for bias
3. **Valid:** Data may be collected in sufficient volume to reveal statistically significant trends

Expert Judgement

4. **Clear:** Easy to explain to everyone on the project team
5. **Functional:** Enables cost-effective actions that improve future performance.
6. **Important:** Reflects what matters most to the team

In the past, we have extolled the benefits of popular metrics without recognizing their weaknesses. This study showed that no metric is perfect. However, combining metrics may lead to a more holistic understanding of safety performance. An example of two contrasting metrics – TRIR and leading indicators – is provided below.

	Strengths	Weaknesses
Leading Indicators	• Predict future safety performance • Data are verifiable & objective • Data may be collected frequently	• No standardized means to measure quality • Requires significant investment • Inconsistent definitions & metrics across companies
TRIR	• Consistent definitions & reporting • Data are based on empirical obversions & strict regulation • Reflects mostly highly consequential events	• Not predictive of future safety performance • Statistically unreliable because recordables are rare & random • Promote reactive behavior

Evaluation of Potential Metrics

Figure 1 shows the comparative strengths and weaknesses among potential safety performance metrics. Through this comparison, we can see that all metrics have strengths and weaknesses. Metrics related to more severe injuries (TRIR, DART, and fatality rates) tend to be clear, objective, and important but are not predictive, valid, or functional. In contrast, alternative metrics such as leading indicators, precursor, and climate tend to be predictive, valid, and important but score comparatively low in clear and objective criteria.

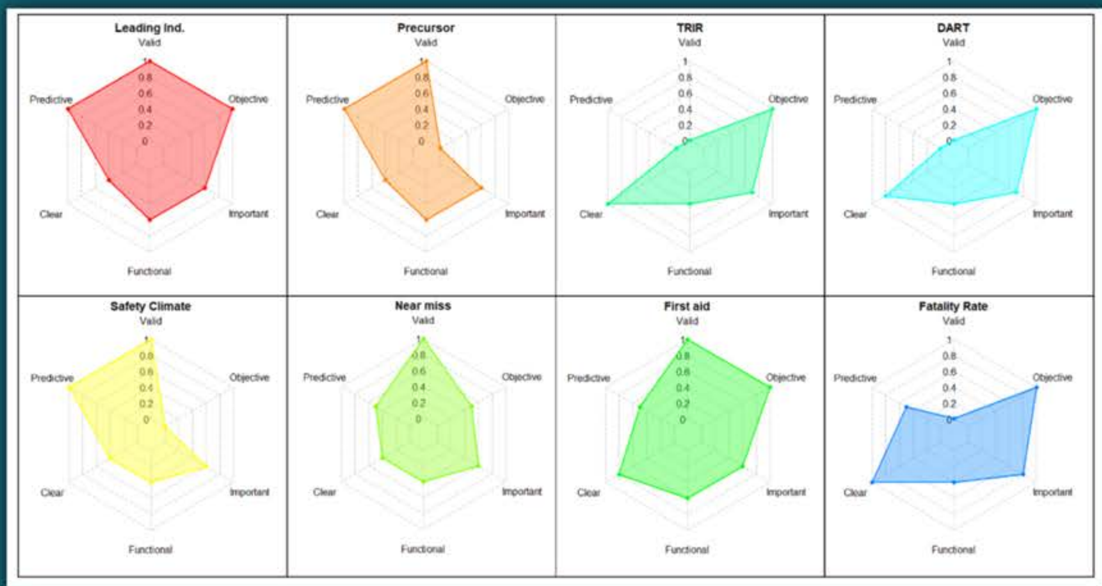
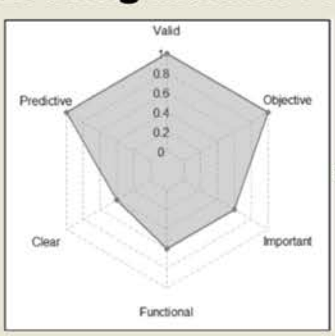


Figure 1

Envisioning these diagrams as puzzle pieces, it becomes clear that some metrics may be strategically combined to provide a more well-rounded understanding of safety performance. For example, leading indicators and TRIR may be combined to include both inputs and outputs.

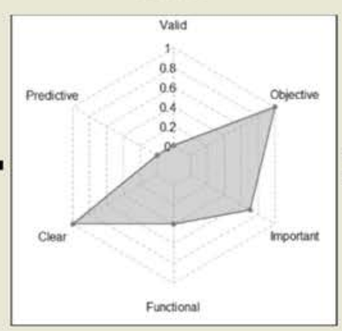
- ***Leading Indicators*** bring the advantage of continuous system monitoring to support strategic proactive decision-making.
- ***TRIR*** has the inherent strength of being a clear and objective measure of recordable incidents.

Leading Indicators



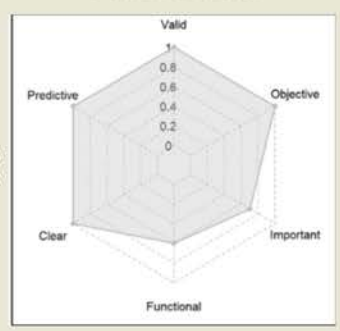
+

TRIR



=

Combined



The CSRA is currently testing some completely new metrics such as high-energy control assessments (HECA) and severity-based lagging indicators (SBLI) to better understand how multiple metrics tell one story that enables more strategic discussions and more proactive decisions.

Measuring & Monitoring Safety with High-Energy Control Assessments (HECA)

"Safety is NOT the Absence of Injuries, But the Presence of Controls"

In the last decade, safety philosophy has evolved to define "safety" to be the presence of safeguards. However, most safety metrics such as TRIR are antithetical to this view because we implicitly consider work periods without injuries to be "safe." To address this issue, the CSRA has developed and tested a new metric – High-Energy Control Assessments (HECA) – that directly measures the presence or absence of safeguards in life-threatening work scenarios.

High-Energy Control Assessment (HECA) is defined as the percentage of high-energy hazards with a corresponding Direct Control. Structurally, HECA is a binary metric because every condition observation is modeled only as ***success*** (the high-energy hazard has a corresponding Direct Control) or ***exposure*** (the high-energy hazard does not have a corresponding Direct Control).

Although the computation of HECA is simple, the challenge in applying HECA is a consistent application of definitions of a high-energy hazard and Direct Controls.

Direct Control: Aligning with the idea of safety as the presence of safeguards, HECA is built on the notion that every high-energy hazard should have a corresponding control. The term Direct Control refers to a control that meets the minimum standards offered by the Edison Electric Institute (Hallowell 2020).

High Energy Control Assessment

The proportion of high-energy hazards with a direct control

$$\text{HECA} = \frac{\text{\# Of High-Energy Hazards with A Direct Control}}{\text{Total \# of High-Energy Hazards Observed}}$$

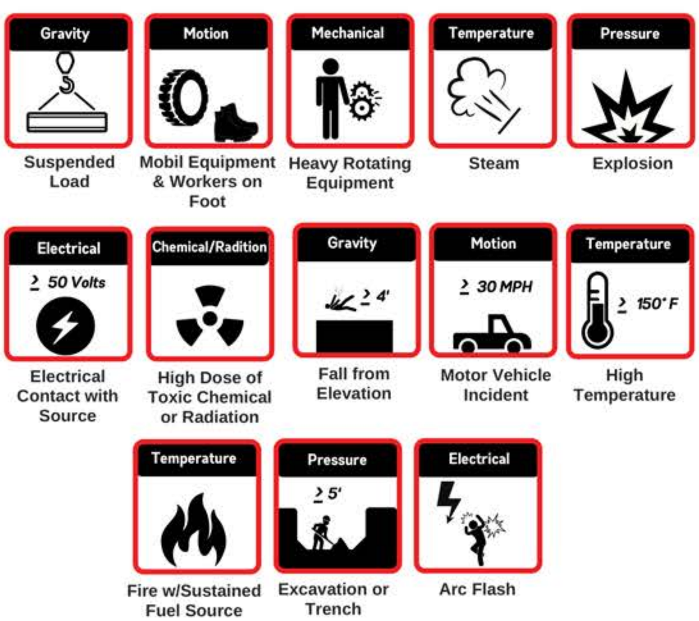


Figure 2: Example High-Energy Hazards

Direct Control Criteria

CRITERIA 01

Target to the high-energy hazard.

The control must be specifically designed and intentionally used to address the high-energy of concern.

CRITERIA 02

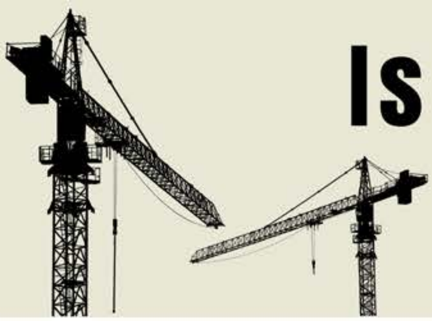
Effectively mitigates the high-energy hazard when installed, verified, and used properly.

A Direct Control must either eliminate the energy or mitigate the energy exposure to below the 1500 Joule threshold. Additionally, a control is only considered present when it is installed, verified, and used properly.

CRITERIA 03

Effective even if there is unintentional human error during the work (unrelated to the installation of the control).

Controls are not considered adequate to protect against life-threatening hazards if they require workers to be perfect when using them.



Is HECA leading or lagging?

Neither! It's a monitoring variable.

Safety metrics are often categorized as lagging or leading with no metrics in between. HECA is different. It is neither leading nor lagging because it is not an injury rate, and it is not a measure of a safety activity. Thus, instead of attempting to characterize HECA as one or the other, we position it as a variable that may moderate and explain the relationship between leading and lagging variables.

A safety metric is only as useful as the intelligence that it provides. Since HECA is based on the actual conditions around a work environment, it supports both tactical response and long-term strategic planning. By monitoring actual current conditions, we can support learning, real-time trending, strategic discussions, and the mobilization of resources before serious incidents occur. A monitoring variable such as HECA enables the organization to control safety rather than measuring and reacting to random and potentially aberrant historical trends.

HECA data may help to answer questions such as:

1. **Which high-energy hazards are relatively well controlled, and which are not?**
2. **Which controls are typically present, and which are most commonly missing?**
3. **How do my projects or business units compare with respect to controlling specific high-energy hazards?**
4. **To what extent have targeted interventions correlated with improvement in the control of high energy hazards?**
5. **To what extent do HECA trends predict future performance?**

High Energy Observations

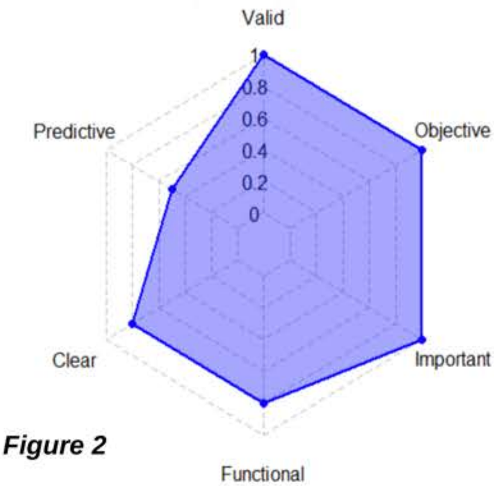


Figure 2

*HECA received a 0.5 for predictive because it has yet to be tested.

As shown in Figure 2, HECA is:

Clear: HECA is formula-based and an indicator of actual conditions on jobsite making it relatively easy to explain.

Important: HECA is focused on high energy hazards and the presence and absence of corresponding direct controls, it is one of the first SIF-oriented metrics.

Valid: HECA data can be collected in high volume since observations can be generated to desired frequency.

Objective: Based on standardized and measurable reporting of existing conditions on jobsite.

Functional: Finally, it is functional as well because the copious amount data is fairly easy to collect albeit expensive compared to some prevailing metrics.

Predictive: HECA received a 0.5 for predictive because it has yet to be tested.

The CSRA is currently conducting further research to determine the associative relationship between HECA scores and SIF rates (i.e. predictive capacity).

DEFINING SERIOUS INJURIES

In pursuit of a common definition of a "serious" injury

Every advanced scientific domain has clearly defined terminology that grounds theories and enables clear communication. For example, the organization responsible for naming planetary bodies created and curates a strict scientific definition of the word planet to, "help our understanding of astronomical objects and processes." Without such a definition, astronomers and physicists would not be able to communicate even the most fundamental aspects of their field or understand each other scientist's work. Other fields have similar definitions that are fundamental to their field (e.g., the definition of a glacier, cell, or atom).

As safety evolves into a scientific field, definition has become urgently important because we still lack basic definitions for near misses, safety culture, and other commonly used terms. Unfortunately, we often use the same words with very different meanings, which has hampered scientific progress. Given that the CSRA's vision is to eliminate serious injuries and fatalities through defendable science, we conducted a study to create a scientific definition of a serious injury.

After a year of literature review, the academic team found variety of definitions on serious injuries used across different industry sectors. These scales are not perfect but within the context of the industry, they are useful in generating standardized thresholds. The academic team extensively reviewed different scales to build a template of how the construction industry could define serious injuries.

INDUSTRIES AND AGENCIES	BASIS FOR CLASSIFICATION	SEVERITY ASSESSMENT STRATEGY
Healthcare, automotive medicine	Nature of the injury	Triage systems and severity scales
Sports medicine, military, insurance law	Functional limitations	Time away from duty
Transportation sector	Type of medical treatment and nature of the injury	Need for in-patient hospitalization; lists of injuries

A focus group of safety practitioners from different sectors was put together to find a shared perspective around serious injuries that the entire industry could coalesce around. The focus group iteratively modified the model based on literature to develop the LIFE Model to distinguish serious injuries and fatalities (SIFs) from low severity injuries (LSIs) with practical sensibilities. The aim was to develop a definition for serious injuries that is applicable across different sectors and easy to use (i.e., does not require medical background or intrusive information). The LIFE Model defines a serious injury as one that involves any of the following three outcomes:

Life-ending: incident resulted in a fatality.

Life-threatening: incident required immediate life-saving medical attention to prevent fatality.

Life-altering: incident resulted in the injured person permanently losing the use of any major organ, body function, or body part.

Importantly, the LIFE model focuses only on actual outcomes since other tools are available to assess potential injury severity.

The LIFE model sets a very high bar for an event to be considered serious.

The LIFE Model

CAUTION: *Only make a final determination once all relevant information has been received. Cases should be reclassified when new information becomes available.*

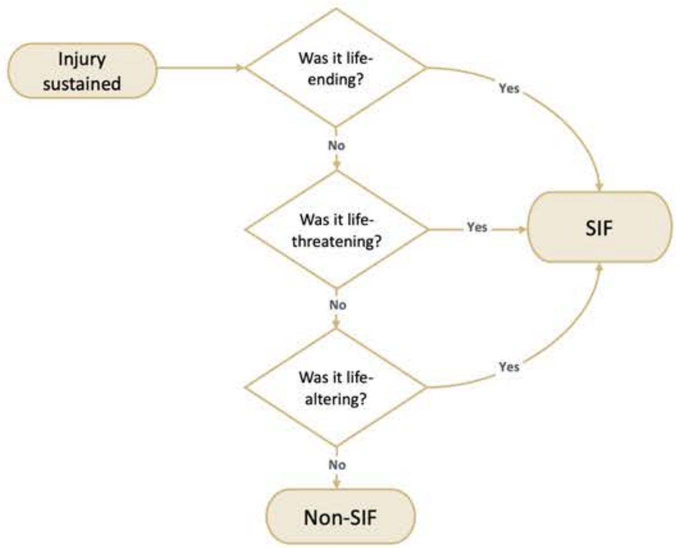


Figure 3

Injury: *Sudden physical damage to the body caused by an external force.*

Life-Ending: *Injury that results in the death of the injured person (IP).*

Life-Threatening: *Qualified person confirms that IP would not have survived without immediate medical intervention or lifesaving support (e.g., CPR, defibrillation).*

Qualified Person: *Individual with reasonable knowledge to make a determination about the IP's condition (e.g., a medical professional).*

Life-Altering: *Qualified person confirms that IP will not fully recover and will most likely suffer permanent impairment from the loss of the use of the use of a major internal organ (i.e., brain, heart, lungs, liver, and kidneys) body function, or body part.**

Body Functions: *Physiological and psychological functions of body systems. Examples include vision, range of motion, or spatial orientation.*

Body Parts**:** *Anatomical parts of the body, such as organs, limbs, and their components, that support body functions. Examples include eyes or hands.*

Note: Use the LIFE Model for determining if an ACTUAL injury is serious or not. You may use other models available for assessing the POTENTIAL severity of an incident (e.g., EEI SCL Model).

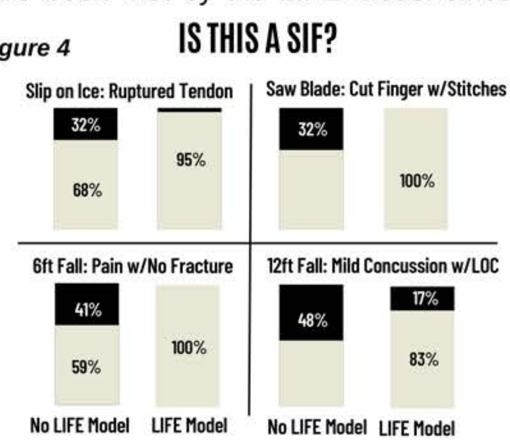
*Cases should be reclassified if new information becomes available.

Reducing Noise and Improving

A common definition of serious injuries is essential to reducing noise (i.e., variation in the classification of the same incident). To show the level of noise in classifications, we conducted a randomized experiment with case studies. Over 40 EHS professionals were provided detailed information about the severity of an injury. In the first step, each professional received a randomly selected incident and was asked to choose one of two options using their experience: serious or less than serious. Then, in the second step, each professional was provided with an overview of the LIFE model and was asked to use the LIFE model to classify a new set of randomly selected cases. The result enabled the research team to assess the ability of the LIFE model to reduce noise and increase confidence in injury classification.

As one can see from Figure 4, the model increased consistency in classification (decreased noise) among the EHS professionals. Since we ran a randomized experiment, we can be confident that the improvements were caused by the LIFE model. Although definitions are never inherently correct or incorrect, they can be accepted by a scientific and professional community if they are logical and useful. These criteria have been met by the LIFE model since it was based on adjacent literature, adapted by a group of experts, and demonstrated to reduce noise through an experiment.

Figure 4



The Next Step of This Research...

Test the hypothesis that serious injuries happen for different reasons than less serious injuries. Without a definition of serious injury, ***this next phase would never be possible***. This definition and the implementation of the LIFE model will help the CSRA to grow as a scientific community and advance its mission of preventing SIFs.

FROM INVESTIGATION TO LEARNING

Investigations following accidents and incidents aim to determine what happened to prevent reoccurrence. The information generated from such investigations supports organizational learning, which in turn helps in the strive towards a reduction in SIFs. Although there are many tools available to help support organizations through the investigation process, nearly all focus on the analytical stage and tend to ignore the very first step – when information is collected from the field. Current investigation processes and tools are largely based on the assumption that the information collected is *good* information — but that is not always the case.

Some information is objective, such as training records and pre-job briefing forms, and so can't be influenced by the collection process. However, subjective information is also collected, often through interviews with the people involved or those that witnessed the event. It is this subjective information that is vulnerable and often of poor quality. As its generation is human-led it is inevitable that cognitive biases, alongside the influence of contemporary safety management thinking and theories, can affect the process — as humans, we are all inevitably biased!

Early project scoping revealed that the biggest challenge in incident investigations is asking the right questions the right way. Our research therefore focused on this neglected stage, remaining independent of the analytical method and able to align with any established organizational learning procedures. This project brought together over **300+** years of collective experience to support the collection of good information from subjective sources. Through interviews, focus groups and experiments, the team has undertaken research to co-create a number of tools for industry, able to support incident learning through the collection of high-quality information right from the very start.

Findings From The Experiments

Two real-life incidents formed the basis of the experiments, with full details known from actual court depositions. Two academic team members played the roles of the injured person and the key witness and all 34 industry team members undertook mock interviews to investigate one of the incidents using their usual approach and lines of questioning. The interview transcripts were then analyzed using a discursive psychological methodology that focused on how the questions were asked. This enabled the academic team to reveal the inevitable human biases within the process, as the different lines of questioning were unpacked.

Although the CSRA team was composed of some of the most experienced investigators, a number of different biases were evident demonstrating that even the best of us are susceptible to biases.

Anchoring bias caused interviewers to fixate on one aspect of the incident, and struggle to seek information beyond that scope.

Confirmation bias was demonstrated when interviewers asked (often leading) questions to back up their preconceptions, rather than to seek new information.

Conservatism in belief revision hinders interviewers, who can struggle to change their minds when faced with new information.

The presence of these biases was of course inevitable, so our research specifically focused on how and when they emerged, how they influenced the information collection process, and how we could look to support investigators in mitigating the effects of bias in practice.

IMPROVING INCIDENT INVESTIGATION & LEARNING

Incident investigation data is influenced by the way we collect it

No Blame or New Blame?

An interesting finding from the experiments was that taking a dogmatic 'No Blame' approach in investigative interviews can itself create a bias. This bias directs the interviewer to take lines of questioning that avoid human blame, but still seek blame in other places – for example in the tools or materials used, in supervision, in organizational processes, or even simply in 'production pressures.' This means interviewers can neglect vital information, be misdirected in their lines of questioning, and ultimately be led to the wrong conclusions too easily. Unintentionally, a no blame approach can actually hinder organizational learning. Detailed, peer-reviewed findings of this phenomenon will be published soon.

The Tools

The tools developed through the project help identify, understand, and mitigate against the different biases that can occur during interviews. They support the generation of high-quality information that is needed for analysis, learning, and prevention of future incidents. Without high-quality information, the analytical processes are valueless, and the corrective actions are potentially counterproductive.

- A short ***guide*** to support the collection of good information from incident investigation interviews, including guidance for before, during and post interview.
- An in-depth and detailed ***book*** which expands on the guide. It will cover best practices for information collection in detail, and include the findings of the experimental work in full.
- A deck of presentation slides that translate the key content of the guide and book into readily implementable ***training*** sessions for investigative teams.
- A ***web-based resource***, including the ***Check Yourself*** question tool, to support investigators in self-reflection of their own biases. This is supplemented by easily accessible information to help investigators better understand biases overall, and how to mitigate them, delivered through both text and video formats to reach the widest possible audience.

INTERVIEWS

- Scoping work
- Highlighting Key Areas of Concern

FOCUS GROUPS

- Organizational Setup
- Investigation Planning
- Investigation Execution

THE EXPERIMENT

- Controlled Mock Investigations
- Discourse and Thematic Analysis

WORKSHOPS

- Finalize Best Practices
- Operationalize The Research Findings

PREDICTIVE ANALYTICS

Predicting the Likelihood of SIF Exposures

SIF rates have plateaued for the past 10 years. To instigate the next step change in SIF reduction, we have begun to explore safety prediction with the general premise that we can prediction helps us to be proactive. Most safety prediction methods involve analyzing databases of incidents (failures) that are devoid of information about success. Unfortunately, models based only on failure data are incapable of distinguishing success from failure or estimating the likelihood that an injury will occur at all. This study aims to address this limitation by exploring the prediction of success and failure conditions rather than incidents.

Another limitation of current methods of safety prediction is that factors at different levels of the organization are typically considered independently. For example, leading indicator research focuses on the quality and quantity of injury prevention activities; safety climate research focuses on perceptions of safety and employee satisfaction with the safety system; and precursor analysis focuses on assessment of human factors. This study was the first to create a unified predictive model that includes predictors at the business, project, and crew levels.

Creating & testing this new method of safety prediction involved four main tasks:

- DESIGNING A NEW OUTCOME VARIABLE BASED ON OBSERVABLE CONDITIONS.
- IDENTIFYING PROMISING POTENTIAL PREDICTORS AT THE BUSINESS, PROJECT, & CREW LEVELS.
- Collecting a sufficient volume of empirical data to make predictions.
- Testing the predictive capacity of different factors using machine learning.

1 Defining the outcome variable
What are we predicting?

All predictive techniques aim to predict an event, condition, or action. This project aimed to predict safety conditions because they are observable on an ongoing basis, which helps with data collection and model validation. Additionally, we aimed to focus on high-priority conditions, so we considered only those that had likely SIF potential. This was an opportunity to leverage the newly defined high-energy control assessments (HECA) for condition assessment. By doing so, this was the first project to measure safety as the presence of safeguards at a large scale.

2 Identifying potential predictors
What might be predictive?

Through a series of brainstorming sessions, the research team identified over 400 potential predictors. To arrive at a reasonable number of factors to study, the team used the Delphi process to rate each potential predictor based on the extent which it is actionable, measurable, simple, and predictive. This helped the team to identify the 40 most promising factors to study with empirical data collection.

3 Collecting a high volume of empirical data
What is empirically predictive?

The research team developed a strict data collection protocol to ensure consistent and reliability across the many participating organizations. Data were collected from discussions with business executives, surveys of project characteristics, and discussions and observations on site. In total, over 30 CSRA companies participated by providing data from 80 projects and 700 crews.

4 Predictive modeling with machine learning
Which factors are the best at predicting future conditions?

In collaboration with the Department of Computer Science, the academic team created a machine learning pipeline to identify the most accurate and stable predictive models. These modeling techniques included linear regressions (LR), decision trees (DT), gradient boosted decision trees (GBDT), random forests (RT), and multi-layer perceptron (MLP) algorithms. The most influential factors in the models included the crew experience working together, supervisor experience with the crew, total number of workers under the supervisor's purview, and the maturity of leadership development programs for frontline supervisors.

Predictive Analytics Project Findings

KEY FINDINGS FROM THE DATA ANALYSIS WERE:

1. While crew attributes are critical to make predictions, business and project level attributes complete the picture for higher prediction accuracy.
2. Crew member experience working together and the supervisor experience supervising the crew is crucial.
3. As a business-related attribute, having a mature leadership training program for frontline supervisors appears to be highly important in predicting SIF exposure.
4. Some high-importance features were project scope and size, crew size, the existence of drug tests as a monitored leading indicator, and the maturity of orientation procedures.

36 North America Industry Partners

41 Promising Predictors Selected Using Delphi Method

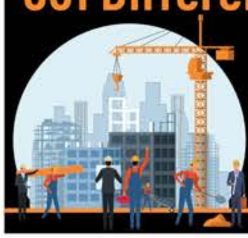
Unique Predictors Considered

Neural networks were used to support deep learning

Collected from more than 80 projects

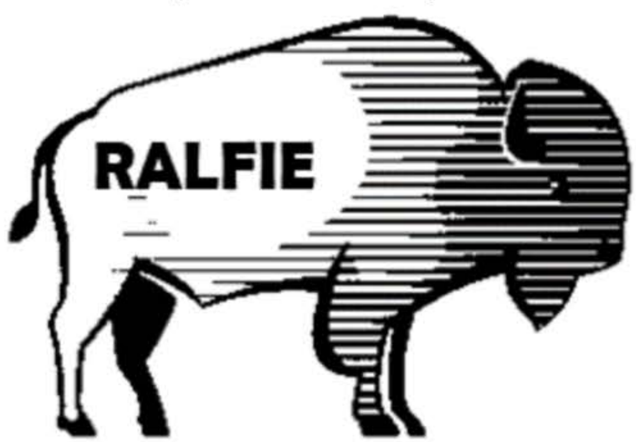
THE MODEL WAS ABLE TO DETERMINE SIF EXPOSURE FROM SUCCESS CONDITIONS AT AN 80% RATE

661 Different Crews



820 Workers Were Observed & Surveyed

The dashboard, RALFIE (Real-time Analytics and Learning Framework for Incident Exposure), was created to make the predictive models useful for the CSRA community. RALFIE offers predictions of SIF exposure probability given crew demographics, project characteristics and business factors. Information related to the key predictor variables serve as the input data, the machine learning algorithms are the engine, and the model provides key information about the likelihood of observing SIF conditions and what actions may be taken to reduce risk. RALFIE is a dynamic tool that allows a partner to see how the forecasts change with changing conditions so that the most cost-effective decisions may be identified.



ON-GOING RESEARCH PROJECTS

In 2022, the CSRA Board of Advisors voted to add two new projects to the portfolio. These projects complement the CSRA-funded projects and the two National Science Foundation projects that test emerging safety technology.

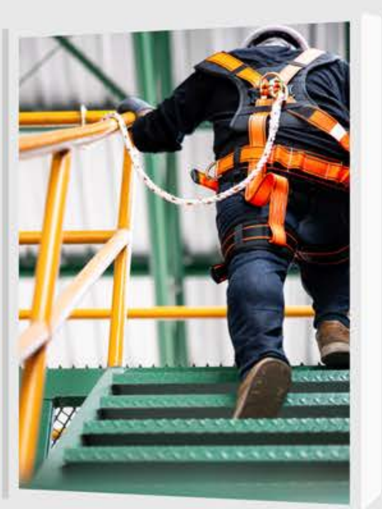
Safety Return on Investment

How do we measure the return on investment (ROI) of safety investments?

The CSRA's most ambitious project to date seeks to create an analytical framework to estimate ROI that incorporates tangible and intangible costs and impacts to observable outcomes. This project has representation from 24 different companies from construction, technology, and specialized engineering, and is supported by five academics with expertise ranging from construction safety to finance. The academic team has completed interviews with the team's industry practitioners to canvas how safety-related investment decisions are currently made. The team has also scoped out tangible and intangible costs and benefits of different safety investments. This information is being used to develop a proof-of-concept framework that will be used to calculate ROI using case studies from past investments. Through an experimental protocol under development, we plan to collect data to demonstrate how ROI from past investments can be computed.

Science of Safety Training

Which learning agents best enhance safety knowledge and skills among front-line workers?



The CSRA has begun conducting research how to improve the acquisition and retention of key safety knowledge. Specifically, the team aims to test and compare different learning environments, delivery strategies, platforms designs, and psychological cues for any safety-related content. We hope to determine which, if any, learning agents can be used across different demographic groups and industry sectors to improve learning outcomes. To undertake this ambitious experiment, we have 31 companies representing all key industry sectors, and six academics to support data collection and experimental design respectively. The academic team includes expertise in safety, learning, experimentation, and statistics.

Mental Health

What do construction professionals need to know about their role in supporting mental health?

In this joint venture with the Construction Industry Institute (CII), we are seeking to respond to the emerging challenge of poor mental health trends within the construction industry. This project seeks to scientifically ask the question: what is the role of construction companies in managing the mental health of their workforce, and how best should they do it? This project is aimed towards building a framework to assist in development of Employee Assistance Program (EAP) services that promotes wellness, but also restricts overreach from management and workers on "managing" mental health issues they are not qualified to identify, measure, and mitigate.

Thus far, the project has scoped its vision to focus on wellness (i.e., before an employee is diagnosed/suffering from any mental health illness/disorder). The vision is being used by the industry partners on this research team to determine the parameters of the reasonable strategic interventions to support workers. We hope that these parameters would allow management to determine responsible and irresponsible actions in managing employees' mental health. The academic team is also compiling a comprehensive list of industry-specific stressors that lead to poor worker mental health from controlled experiments published in reputable outlets. The focus group approach will be undertaken to brainstorm possible solutions to eliminate or mitigate the identified validated stressors that are rooted in empirical evidence, experiential learnings, and implementable by industry practitioners without medical background.

Testing Efficacy of VR and AR

Does VR improve hazard recognition skills? Does AR reduce situational awareness?

Dr. Matt Hallowell has received National Science Foundation (NSF) awards in collaboration with academics from Arizona State University, Colorado State University, and Virginia Tech to study (1) the effectiveness of Virtual Reality (VR) in improving hazard recognition performance and (2) the impact of augmented reality (AR) on situational awareness during active work. This experiment does not seek to promote either technology; rather, the goal is to attempt to determine to what degree, if at all, are VR and AR deliver on their promises.

Currently, both projects are beginning experimentation. The VR and AR systems have been created and the physical testbeds are ready. Opportunities currently exist to get involved in these projects. Professional participants are vital to the success of the work and relevance to the community.

RESEARCH ON THE HORIZON

Teams kicking off in February 2023

Safety Culture

Safety culture is one of the most provocative topics in the profession. But what is safety culture exactly? And, maybe even more importantly, what isn't safety culture?

With seemingly endless definitions, proprietary assessment tools, and maturity models, the field of safety culture has become confusing and controversial. At the same time, regulators have recently begun to require organizations to describe, measure, and report safety culture. In this study we will attempt to create a useful scientific definition by exploring which dimensions of safety culture may be empirically observed, and which cannot. We will then seek to measure the empirical dimensions using validated scientific criteria, ensuring that we at least measure what we think we are measuring. By underpinning safety culture with logic and evidence, we may begin to understand where we stand and how we can measurably improve.

Science of Controls

Controls save lives. But what makes a control adequate?

Leveraging principles of energy-based safety and human performance, a control is now considered adequate if it: **(1) effectively mitigates a high-energy hazard**; **(2) is installed, verified, and used properly**; **and** (**3) is immune to unintentional human error.** When these criteria are met, a control is labeled a Direct Control. Although a clear definition now exists, initial site testing revealed that Direct Controls are often infeasible, even in common work scenarios. This project will explore why Direct Controls are sometimes challenging; how to determine if an alternative work plan is sufficient; and how to continuously monitor the state of high-energy when workers are exposed. In pursuit of a future where all high-energy hazards have Direct Controls, this project will also create a long-term roadmap that includes a technological, engineering, psychological, and managerial solutions.

COMMUNITIES OF PRACTICE

3 YEARS

For the third year running, the CSRA has continued to grow the Communities of Practice calls to create a collaborative and engaging sharing of best practices for the construction safety community. These calls are consistently attended by over 100 individuals representing at least 75 different companies in many construction sectors.

Over the course of the year, the community tackled topics from safety leading indicators, energy-based hazard recognition, the paradox of zero, high energy and controls assessment, and alternatives to TRIR. With guest speakers from the CSRA member community to leading academic researchers, we have continued to cover topics that are relevant to our safety community. Each month, we have the opportunity to hear from leading experts and to collaborate, discuss and ask questions so that we may grow together to achieve our mission to eliminate serious injuries and fatalities. As Dr. Sherratt said after speaking on the Paradox of Zero, “It’s a delight to be part of the vibrant and engaged CSRA COP community, as a speaker you get challenging questions, interesting thoughts and great discussion making them really worthwhile - they are not to be missed!” The communities are open to both members and non-members of the CSRA. We encourage all who are interested to attend. For more information, contact Dr. Katie Welfare at dewlanek@colorado.edu.

CSRA Board of Advisors

Mike Court

Chair of The Board

VP Health Safety Environment Quality & Sustainability

GRAHAM

Jenny Bailey

Vice Chair of The Board

Director of Enterprise Safety

CenterPoint. Energy

Paul Levin

Vice President, Corporate Director of HS&Ed

SUNDT
Skill. Grit. Purpose.

Matt Compher

Vice President, Safety Health Environmental Quality

QUANTA SERVICES, INC.

Nick DiMartino

Vice President of Corporate Safety

MasTec

Alicia Edsen

Vice President, Corporate Safety Director

Kiewit

Clint Harris

Director of Compliance and Assessment

CALIFORNIA RESOURCES CORPORATION

Jayme Hobson

Manager of Safety Engagements and Operations

TVA

Greg Kelly

Manager Canadian Projects Safety

ENBRIDGE

Paul Leonard

Vice President Enterprise Safety

Entergy

Brad MacLean

Chair Emeritus • Senior Vice President

WOLFCREEK SAFETY SOLUTIONS

Mike Quashne

Manager, Performance Assessment and Business Transformation

BGE
An Exelon Company

Bob Rodriguez

Associate Director, Global EHS

OTIS

Letter From The Vice Chair

Jenny Bailey
Director of Enterprise Safety
CenterPoint Energy

As the outgoing Vice Chair of the Board of Advisors for the Construction Safety Research Alliance (CSRA), now is a good time to look in the rear-view mirror to reflect on the accomplishments we've made over the last few years. Even though the CSRA is still a relatively young organization, the impact we've had on our collective understanding of traditional safety "truths" cannot be underestimated. When we challenge our long-held beliefs through the lens of academic rigor, we can only get better. The unique perspective we gain by leveraging industry members, particularly their data, brings real power to what we can (and have) accomplished.

The course of the last 2 years has brought a multitude of new safety ideas and innovations that were proposed and tested. Most notably, we challenged the idea that safer companies have lower incident rates and will forever change the discussion about how to measure success in terms of safety in the workplace. We continue to test the concept, so often adopted in traditional safety programs, that quantity of actions is more important than quality of those actions by researching safety-focused leadership engagements. Testing this idea led to the development of practical field guides designed to support both safety professionals and company leaders as they engage with employees through observations, engagements and pre-job briefs.

Looking to the future, we are wrapping up projects designed to grow our knowledge of the unique precursors to serious and fatal incidents, the financial return on investment for safety, and the science of safety training. Each of these projects challenge the conventional wisdom and our understanding of how we provide a safe workplace. With no other goal, than helping us prevent serious injuries and fatalities. And in 2023 and beyond, we'll continue to identify the most important questions so we can know more in terms of actions that will save lives.

I've really enjoyed my time as the Vice Chair of the Board of Advisors, and I look forward to supporting Paul Levin as he takes on the role. I'm excited to continue being an active part of the organization moving forward. I'll close by saying that the efforts led by the CSRA are groundbreaking and come with a higher purpose – to eliminate serious incidents and fatalities in the construction industry. The great Maya Angelou once said "I did then what I knew how to do. Now that I know better, I do better." The work the CSRA is leading allows the safety profession to know better and helps us translate that knowledge in doing better.

Jenny Bailey

Member Companies

LIMBACH

POWER ENGINEERS

TechnipFMC

ComEd

SUNDT
Skill. Grit. Purpose.

CenterPoint Energy

QUANTA SERVICES, INC.

COMFORT SYSTEMS USA

Kiewit

sabic

EVERSOURCE

MINNESOTA LIMITED
AN ARTERA COMPANY

GME Supply Co CLIMB HIGHER

WOLFCREEK GROUP

Entergy

ERGON

JE DUNN CONSTRUCTION

TELLURIAN

PGE

Exelon

ConocoPhillips

CHENIERE

ENBRIDGE

Q&D CONSTRUCTION
est. 1964

PLH GROUP

MasTec

PRICE·GREGORY

CENTURI

Honeywell

conEdison

OTIS

Xcel Energy

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

FLYNN

CAT

PEMBINA

TVA

CALIFORNIA RESOURCES CORPORATION

MYR GROUP

DPR CONSTRUCTION

GRAHAM

74+ Members & Growing...

- PCI Performance Contracting Inc
- HP
- Hensel Phelps — Plan. Build. Manage.
- NiSource
- Holder
- Orion
- Skanska
- TC Energy
- Monroe Energy — Fueling the Climb
- bird
- Allan Myers
- Ontario Power Generation
- Lockton
- FirstEnergy
- GAF Energy
- ACIG — American Contractors Insurance Group
- Weeks
- Williams
- ONE Gas
- Barnard — Changing Law for a Changing World
- Brasfield & Gorrie
- Tri-State
- Adolfson & Peterson Construction
- Artera
- Energy Safety Canada
- Hallen
- wcb — Saskatchewan Workers' Compensation Board
- American Electric Power
- Great Lakes Dredge & Dock Corporation
- Google
- Terracon — Explore with us
- BGE — An Exelon Company

Production of this publication was supported by APlus Design, LLC, 13470 SW Beach Plum Ter, Sherwood, OR, 97140