WHAT MUST GO RIGHT

Integrating Critical Controls, Energy Based Safety and Critical Steps to prevent the events that kill

- Energy Based Safety
- Critical Controls
- Critical Steps

Christian Young | Founder & Director, Impress Solutions | saving lives at work

BEFORE WE START

Tell us about you

Where are you watching from today?

Drop your location in the chat. And rename your profile to your first and last name.

Rate yourself: 1 to 10

How confident are you integrating Critical Controls, Energy Based Safety and Critical Steps?

We will ask again at the end.

LET'S GET SET UP

The 3 Gets

1

Get your tools

Notepad and pen. You will want to write.

2

Get rid of distractions

Close the email. Phone face down.

3

Get in state

Sit up. This is about keeping people alive.

WHAT THIS IS ABOUT

Four lenses on the same fatality. Usually run apart.

Energy Based Safety	Critical Control Management	Critical Steps	Major Hazard Facility rigour
Finds what can kill	Manages the controls	Protects the human moment	Proves it is adequate

One outcome: prevent fatalities

Which of these do you use today – answer in the chat?

MEET THE FRAMEWORKS · 1 OF 4

Critical Control Management (CCM)

Origin: the ICMM Health and Safety Critical Control Management Good Practice Guide — the mining and resources standard.

THE CORE IDEA

A management system that identifies the fatal hazards, selects the few controls that genuinely prevent or mitigate them (critical controls), defines what good looks like (performance standards), assigns owners, and verifies they are working.

THE BLIND SPOT — why it needs the others

Can become a documentation exercise: strong on the system, quiet on the physics of what can kill and on the human at the point of work.

Energy Based Safety (EBS)

Origin: the Construction Safety Research Alliance and Dr Matthew Hallowell, built on Gibson and Haddon's energy theory of injury.

THE CORE IDEA

The hazard science. Serious injuries and fatalities come from high-energy hazards. Find and quantify the lethal energy (the energy wheel, the ~1,500 J high-energy line) and demand controls that hold even when a worker errs (direct controls).

THE BLIND SPOT — why it needs the others

A measurement and recognition lens. It finds the energy and tests the control, but is not a full management system and says little about real-time human performance.

MEET THE FRAMEWORKS · 3 OF 4

Critical Steps

Origin: Muschara, Farris and Marinus (2022), from the United States nuclear human-performance tradition.

THE CORE IDEA

The human-performance lens. It locates the single human action that triggers immediate, irreversible, intolerable harm (the Critical Step) and gives the worker positive control at that instant, plus the means to fail safely.

THE BLIND SPOT — why it needs the others

On its own it does not quantify which energies are lethal and does not provide the assurance architecture that proves to a board the controls are holding.

MEET THE FRAMEWORKS · 4 OF 4

Major Hazard Facility (MHF) / process safety

Origin: the Safety Case regime (WHS MHF, Seveso and COMAH, offshore post-Piper Alpha) and process safety (OSHA PSM, CCPS).

THE CORE IDEA

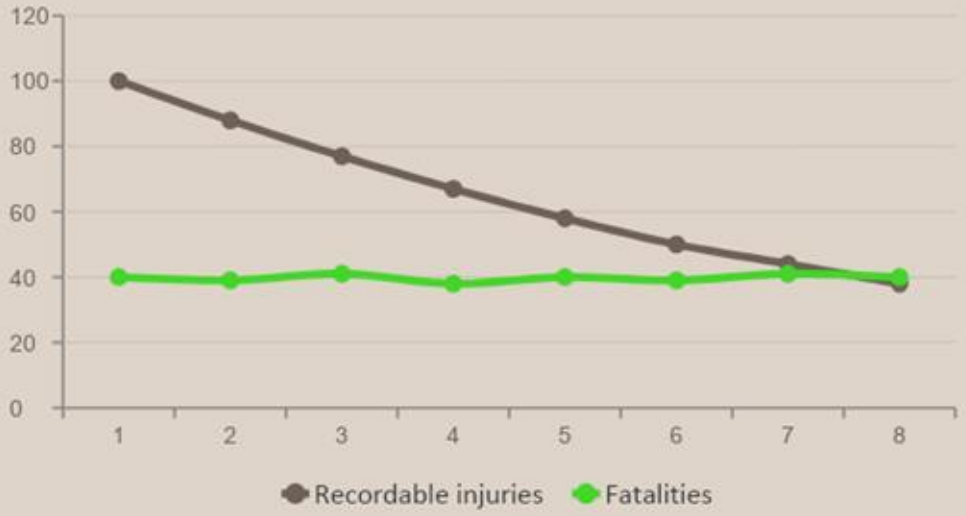
The assurance and engineering regime for the highest-consequence sites: Safety Critical Elements held to FARSI performance standards, independent verification, and a Safety Case that demonstrates the risk is reduced so far as is reasonably practicable (SFAIRP/ALARP).

THE BLIND SPOT — why it needs the others

Overlaps heavily with CCM and is regime-bound (process, oil and gas). Its gift to the others is the demonstration of adequacy: the structured argument that enough has been done.

WHERE WE ARE

We got good at the wrong scoreboard



Does this match what you have seen? Yes / No.

The SIF plateau

We got better at stopping the things that hurt people. We did not get better at stopping the things that kill them.

3.2 trillion worker hours: recordable rates show no link to fatalities (CSRA). The Baker Panel found the same at BP Texas City.

My promise

We manage safety as if all harm is the same.

How do I know? The data, and 25 years on site.

By the end you will have three lenses that, together, find what can kill, build controls that hold, and protect the moment it matters.

WHO IS TALKING TO YOU

I help you save lives at work

Christian Young

Founder & Director

Impress Solutions

25+ years across mining, rail, utilities oil and gas. Critical Risk Management is what we do.

HOW TODAY RUNS

Three things about how I run these

The UMM bet

My daughter charges me 5 push-ups every time I say umm. Help me out and count them.

We move fast

I will give you everything I can in the time we have.

I need you

The chat is the room. Speak up, react, rate.

Count my umms. Call them out.

WHAT WE WILL COVER

Three strategies, then your questions

1. Find the energy that can kill
2. Build controls that survive human error
3. Protect the moment of release

Then:

Q&A

"My all won't be enough"

Stick around

Stay to the end and you get:

- The slides
- The recording
- A bonus: the one-page Integrated Energy Framework you can take to your team on Monday

THE BIG IDEA

We did not invent this. We are finishing a 50-year-old idea.

1961

Gibson

Energy is the agent of injury

1970s

Haddon

Ten ways to control energy

1991

Viner

The energy-damage model, and the bowtie

1990s

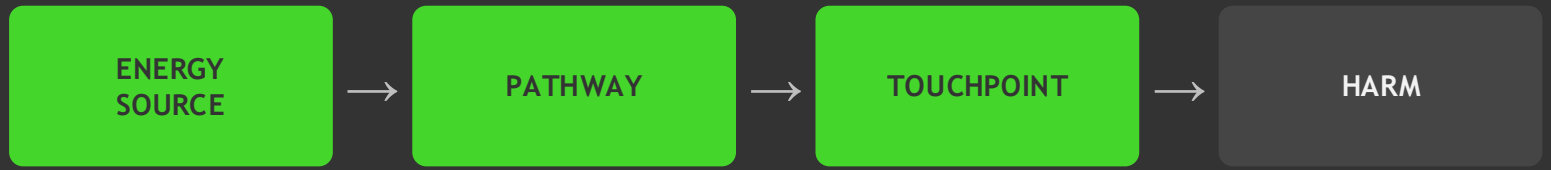
Reason

People err, defences fail

Every framework today descends from one insight: harm is a transfer of energy. The bowtie came from Viner's energy model; the same idea produced the major-hazard safety-case regimes after Piper Alpha and Seveso.

The physics, in one sentence

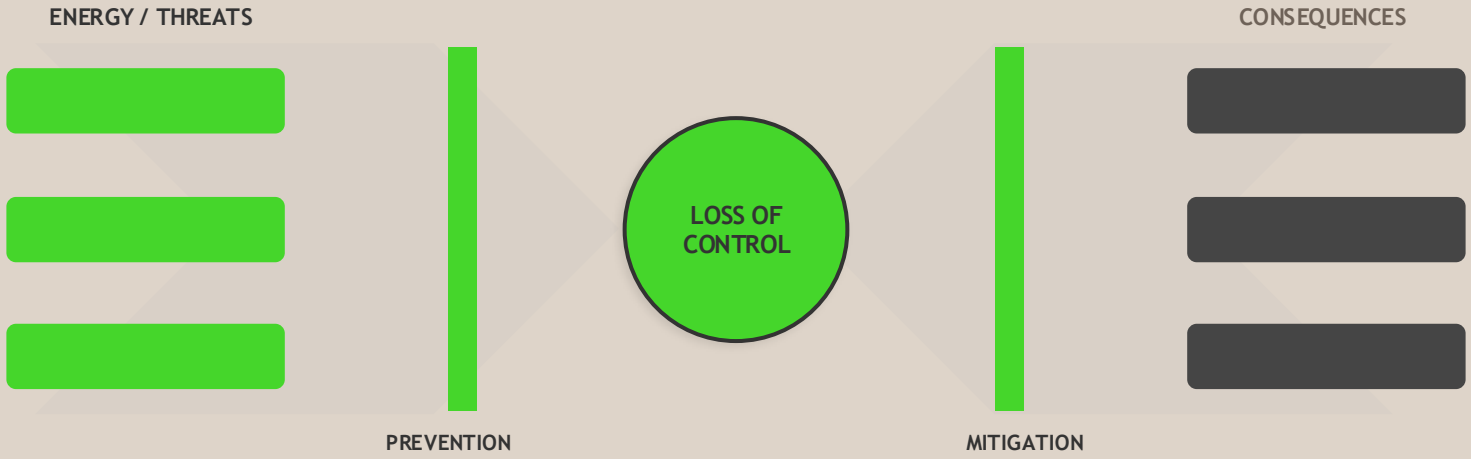
A source of energy reaches an asset by a pathway. A human action at a touchpoint releases it. If the energy at the point of contact is more than the body can take, someone is harmed.



EBS lives at the energy. Critical Controls live on the pathway. Critical Steps live at the touchpoint.

Any examples?

One MUE, seen through all lenses



Got a vehicle / loss-of-control risk on your site? Yes / No.

STRATEGY 1

Find the energy that can kill

Energy Based Safety: of everything on your site, what can actually kill a person?

STRATEGY 1

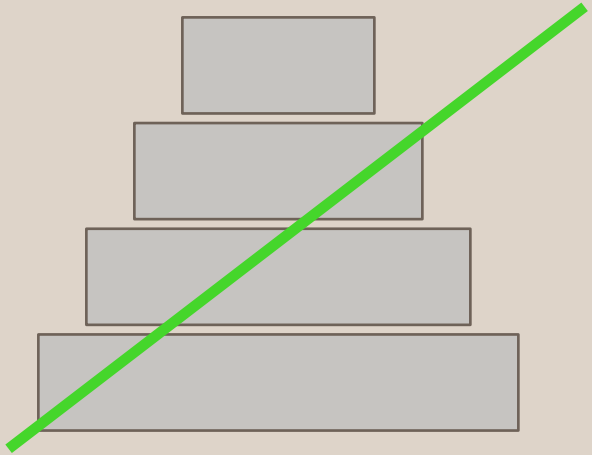
The question

Do you know, right now, which hazards on your site can kill someone, and which just hurt?

Honestly, yes or no in the chat.

IMAGINE IF

You ran your safety effort off the injury count



Fewer cuts and sprains, so we must be getting safer...

...then a fatality, out of nowhere.

It was never out of nowhere. It came from an energy we were not managing as lethal.

DOES THIS SOUND FAMILIAR?

Strategy 1: does this sound familiar?

- We report TRIR to the board every month
- Our hazard register has 400 lines, none ranked by what can kill
- We treat a paper cut and a fall from height in the same system
- We were surprised by our last serious incident
- We are busy, but are we focused on the right hazards?

How many are true for you? Type a number 0 to 5.

Wouldn't it be nice if...

...you could point to the handful of energies on your site that can kill, and put your best effort exactly there?

TEACHING

Severity is a physics problem

Under ~500 J

First aid most likely

500 to 1,500 J

Medical or lost-time most likely

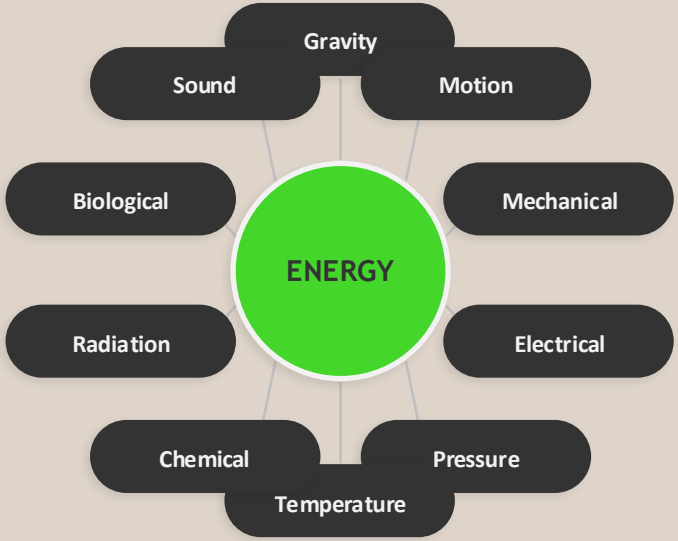
Over ~1,500 J

Serious injury or fatality most likely

More energy, more harm. Energy magnitude predicts severity. High-energy line: ~1,500 joules.

TEACHING

The energy wheel

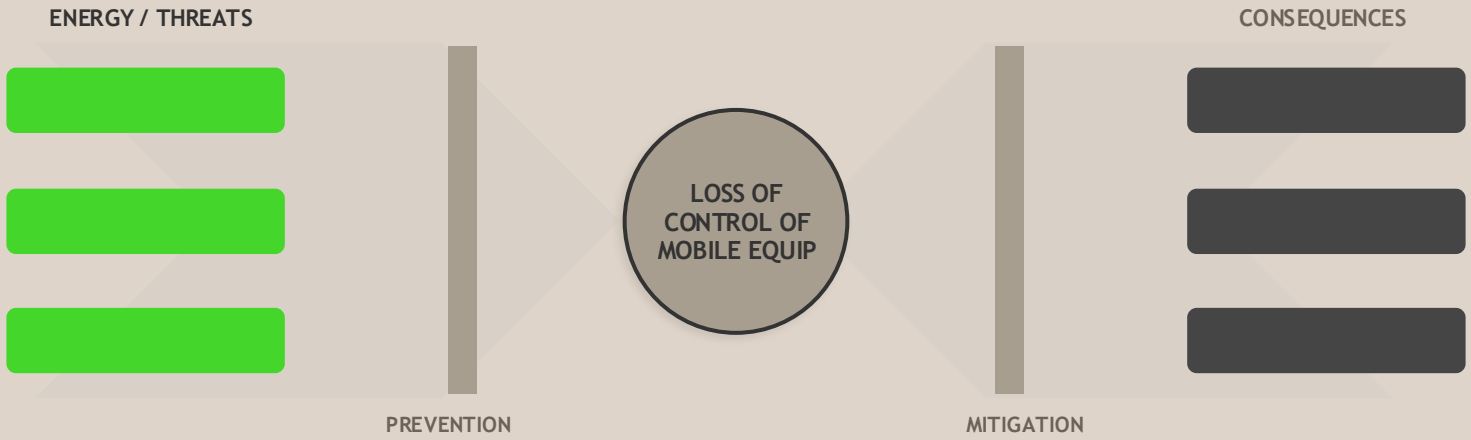


What energy caused your last serious near miss?

Scan source by source

Every injury is undesirable contact between a person and a source of energy. Without a structured prompt, people recognise only about half the hazards present. The wheel forces the scan.

This is not a 'be careful' hazard. It is lethal energy.



Motion and mechanical energy: a light vehicle and a 200-tonne haul truck closing is well above the high-energy line.

FOR YOUR SITE - Applied in the Broad-Brush Risk Assessment

Description of Unwanted Event	Release Mechanism / Scenario	Magnitude of Energy (EBS)	Hazard Classification (Energy Wheel)	Max Consequence (no controls)	Material Unwanted Event (Y/N)
Loss of control of surface mobile equipment	Brake or steering failure; operator fatigue/microsleep; loss of traction on a wet/steep grade; overspeed on descent; runaway on a ramp; loss of control of an autonomous/assisted function	A 220 t haul truck at 40 km/h carries tens of millions of joules of kinetic energy; a rollover, impact or fall into a void releases energy far above human tolerance (>>1,500 J)	Mechanical	5: Critical	Yes
Tyre and rim failure / explosion	Zipper failure; pyrolysis / thermal runaway; rim component separation during inflation or heat	A large earthmover tyre (e.g. 63-inch) holds roughly 2-3 m^3 of air at ~650-700 kPa; the stored pneumatic energy is of the order of 1-2 MJ (about 0.3-0.5 kg of TNT equivalent), released explosively with rim/lock-ring fragments on a zipper or rim failure — thousands of times the ~1,500 J threshold, before adding the thermal energy of pyrolysis.	Pressure	5: Critical	Yes
Highwall / lowwall / dump slope failure (ground failure)	Geotechnical instability; batter or tip-head collapse; dump-edge failure; burial or engulfment	Gravitational potential energy of the failed mass (E = mgh). Even a small failure of ~100 m^3 of rock (~250 t) with a centre-of-mass drop of ~10 m releases ~25 MJ; larger highwall or dump-edge failures reach hundreds of MJ to several GJ — tens of thousands of times the ~1,500 J threshold, with burial and engulfment fatal well below this.	Gravity	5: Critical	Yes
Inrush / inundation	Pit flooding; breach of old workings or a water source; failure of a water dam or low-density material	inundationThe energy of a large moving water or slurry mass. About 1,000 m^3 (~1,000 t) released down a ~10 m head holds ~100 MJ of potential energy (mgh); even a fast-moving 10 m^3 slug at 5 m/s carries ~0.1 MJ — orders of magnitude above the ~1,500 J threshold, with drowning and engulfment requiring only a fraction of it.	Gravity	5: Critical	Yes
Explosives — unplanned initiation or flyrock	Stray current / static; misfire handling; exclusion breach during firing	Chemical energy of the explosive. Bulk explosive (ANFO) releases ~3.9 MJ per kg, so a single blasthole of tens to hundreds of kg liberates hundreds of MJ on unplanned initiation. Even flyrock is high-energy — a 5 kg fragment at 30 m/s carries ~2,250 J — above the ~1,500 J threshold.	Chemical	5: Critical	Yes

STRATEGY 1

Self-assessment

How well do you know which hazards on your site can kill?

1	2	3	4	5	6	7	8	9	10

Type your number, 1 to 10.

KEY LEARNING 1

The things that hurt people are not the things that kill them. Find the lethal energy first.

STRATEGY 2

Build controls that survive human error

Critical Control Management: what actually holds the lethal energy back?

STRATEGY 2

The question

Would your critical controls still work if a competent person had a bad day?

Yes / Not sure / No.

Imagine if...

...half your critical controls were training, signs, awareness, and being careful. Controls that only work if every person, every time, is perfect.

DOES THIS SOUND FAMILIAR?

Strategy 2: does this sound familiar?

- We have 300 critical controls
- Half of them are really training or procedures
- Our verifications are broad and generic
- The frontline cannot tell you which controls are truly critical
- If everything is critical, nothing is

How many critical controls does your site have? Type a number.

Wouldn't it be nice if...

...you had a short, defensible list of controls that hold the lethal energy even when someone makes a mistake?

What is a control, really?

An act, object or system that, of itself, directly prevents or mitigates. Specifiable, measurable, auditable, defined in a management system.

CONTROL

Directly prevents or mitigates

SUPPORT

Enables the control (e.g. training)

VERIFICATION

Checks the control works (e.g. inspection)

The direct control test

1. **Targeted** at the lethal energy
2. **Effective** when properly installed and used
3. **Holds under error** works even when the worker makes a mistake

All three.

In or out.

The third criterion is the one most controls fail. Given enough time, the chance a worker makes an unintentional error approaches 100%.

THE BIG IDEA

Four frameworks. One test.

"will the control function even when there is human error?"

ICMM reliability

"effective even if there is unintentional human error"

CSRA direct control

positive control is built on the fact that people are fallible

Critical Steps

a barrier must be effective, independent, and survive the event it mitigates

MHF barrier test

A control that needs a person to be perfect is not a critical control.

Type TRUE if this changes your critical control list.

TEACHING

Strip out the comfortable controls

Holds under error (keep)

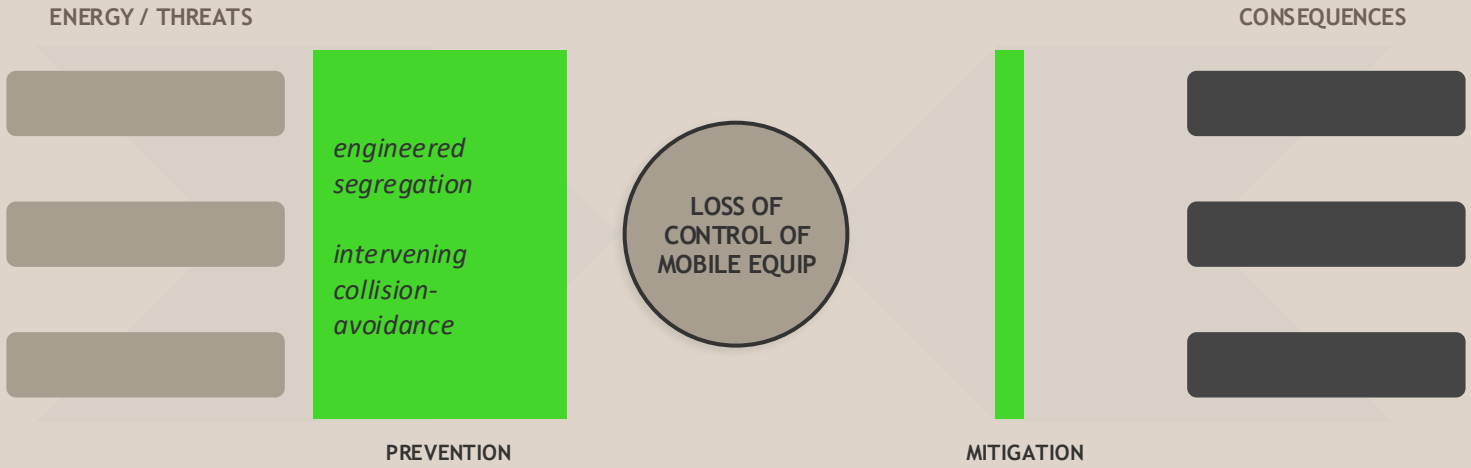
- Elimination, isolation
- Engineered barriers, machine guarding
- Properly rigged fall arrest
- Collision-avoidance that intervenes

Needs perfection (downgrade to support)

- Training, awareness
- Signage, procedures
- Ordinary PPE
- “Be careful”

Which column has more of your 'critical' controls? Left or Right?

Two real controls. Several comfortable ones.



PASS: engineered segregation, intervening collision-avoidance. FAIL: 'give way' rule, driver awareness (need the driver to be perfect).

TEACHING

Keep the binary test and the scale in their lanes

Binary test

Is it a critical control at all? In or out. Decides membership of the list.

Effectiveness scale

Green / Amber / Red. How well is it performing over time? Tracks health, not membership.

Do not let an 'amber' control sneak onto the critical list.

STRATEGY 2

Self-assessment

How many of your critical controls would hold if a competent person made a mistake?

1	2	3	4	5	6	7	8	9	10

Type your number, 1 to 10.

KEY LEARNING 2

A control that depends on a person being perfect is not a critical control. Demand controls that survive human error.

STRATEGY 3

Protect the moment of release

Critical Steps: someone, on a real shift, releases that energy. Who protects that instant?

STRATEGY 3

The question

You have a beautiful Critical Control performance standard in the binder. Who has control at the exact second the energy is released?

Who is it on your site? Type the role.

Imagine if...

...the system was perfect on paper, fully documented, fully verified, and a worker was still hurt at the point of work, because the one human action that mattered went wrong.

Strategy 3: does this sound familiar?

- Our procedures are thorough, but people still improvise at the critical moment
- We brief the job by reading the procedure aloud
- We do not know which single step must go right first time
- Our pre-job briefs do not name the point of no return

How many are true? 0 to 4.

Wouldn't it be nice if...

...every crew knew the one action that must go right, and had the tools to keep control at that exact moment?

TEACHING

What is a Critical Step?

A human action that will trigger immediate, irreversible and intolerable harm to an asset, if that action or a preceding action is performed improperly.

Immediate

harm happens at once

Irreversible

past the point of no return

Intolerable

unacceptable injury or loss

TEACHING

The action before the action

Risk-Important Action

Rigging the parachute correctly. Still reversible, you can check it.

Critical Step

Jumping. Irreversible. The point of no return.

Get the actions before the point of no return right, while you still can.

TEACHING

Find the touchpoint: Critical Step Mapping

- Walk through the activities step by step
- Find where energy is released
- Compare each step to the three I's
- That is your Critical Step

The step CCM usually skips

It is the step that connects the paper bowtie to the worker's hands. Like an FMEA, but focused on consequence, not error.

CRITICAL STEPS IN EVERYDAY WORK

The Critical Step in common fatal risks

Every Critical Step is the same shape: a person crossing a line past which the outcome cannot be undone.

Common single-fatality risk	Critical Step (the point of no return)
Fall from height	Moving past, or unclipping from, the last point of fall protection at height
Energy isolation (stored or live energy)	Breaking into the system (the first break or cut) before zero energy is proven
Vehicle / mobile plant interaction	Entering a heavy vehicle's operating zone without positive, acknowledged communication
Loss of control of mobile equipment	Committing the machine to motion on a grade or descent without confirmed braking
Lifting / suspended loads	Entering the load's fall zone as it takes weight or is lifted
Confined space entry	Breaking the plane of the space before the atmosphere is confirmed safe
Contact with electricity	Contacting or approaching a conductor before it is proven de-energised
Excavation / trench collapse	Entering an unsupported or unbattered excavation
Fire / explosion (hot work)	Striking the ignition source before a gas-free clearance is confirmed
Uncontrolled release of hazardous substances	Breaking containment before purge, drain and isolation are confirmed

TEACHING

Positive control and the worker's tools

Positive control: *what is intended to happen, happens, and only that.*

RU-SAFE two-minute drill before the task

STAR Stop, Think, Act, Review at the step

Hold points stop before the irreversible action

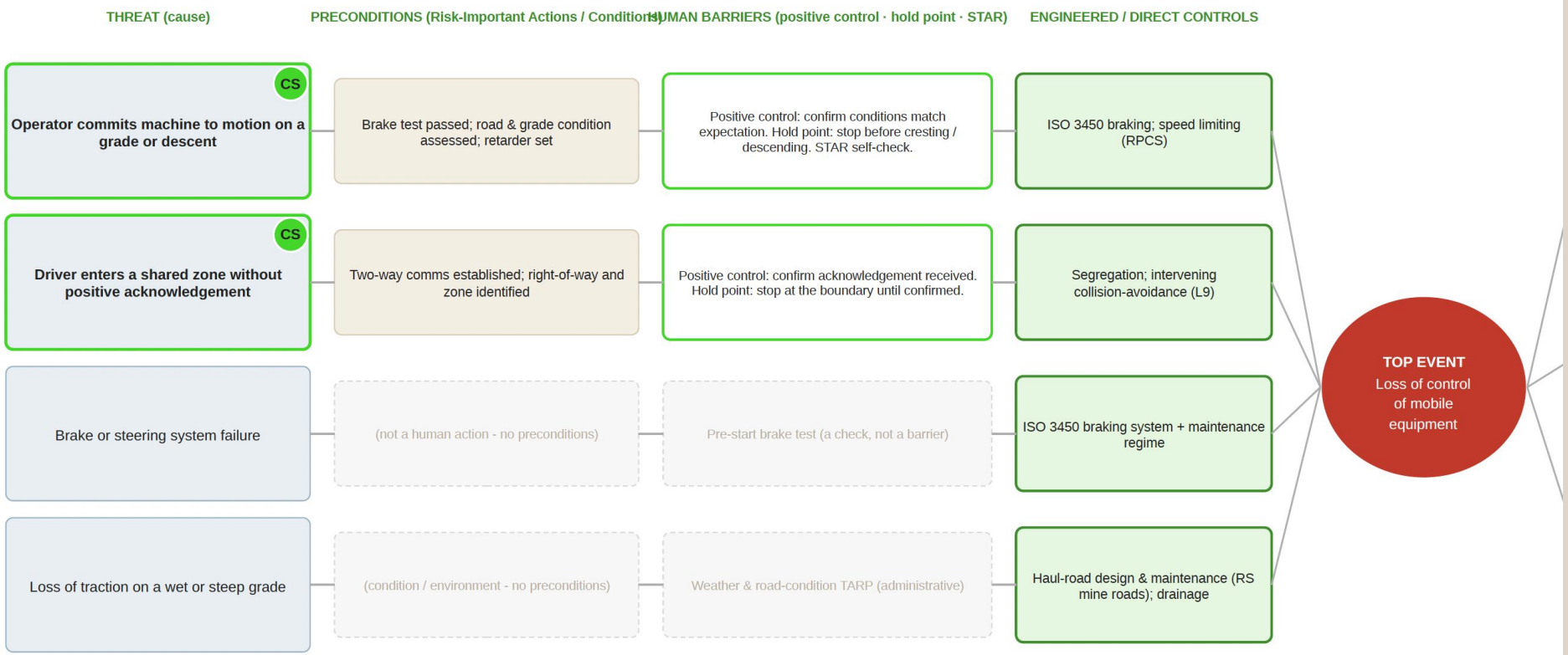
Never proceed in the face of uncertainty

Which of these does your crew use today? Type them.

BOWTIE TEMPLATE - CRITICAL STEPS AS HUMAN-ACTION THREATS

Loss of control of surface mobile equipment

A Critical Step is a specific human action at the point of no return. On the bowtie it is a flagged THREAT, with its barrier stack on the line to the top event. Not every threat is a Critical Step.



And if control is lost?

Design the job so the energy stays below what the body can take.

Prevention

exercise positive control

Mitigation

fail safely

STRATEGY 3

Self-assessment

How well do your crews protect the moment of release on your highest-energy jobs?

1	2	3	4	5	6	7	8	9	10

Type your number, 1 to 10.

KEY LEARNING 3

The binder does not hold the energy. A person does. Protect the moment of release with positive control.

BRING IT TOGETHER

1. Use EBS to find the energies that can kill

3. Use Critical Steps to protect the moment of release

2. Use frameworks to build controls that survive human error

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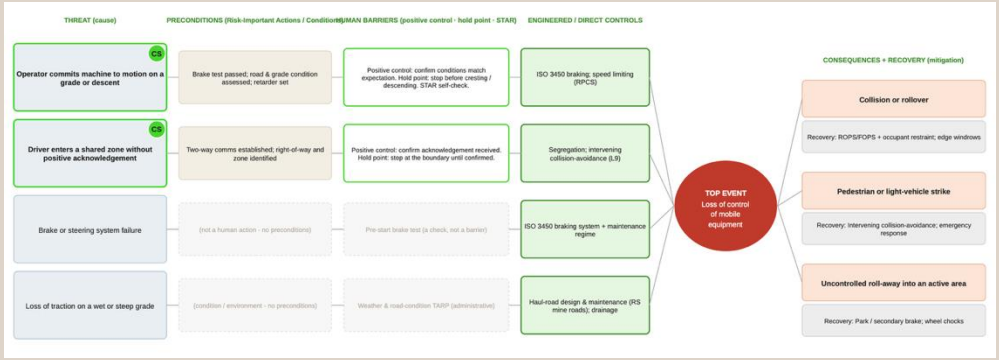

Why four beats one

- **Energy Based Safety** finds what can kill
- **Critical Control Management** manages the controls
- **Critical Steps** protects the moment of release
- **Major Hazard Facility rigour** proves the controls are adequate

Alone, each has a blind spot. Together they cover the whole path from energy to harm — and prove it.

The fourth lens: the assurance wrapper

A good control programme is not the same as a defensible one.

The Major Hazard Facility regime assembles the bowties, the critical controls, their performance standards and the verification into one Safety Case: a structured demonstration that all reasonably practicable measures have been taken. On a regulated site this is the law. On any site it is the strongest assurance you can give a board.

THE FOURTH LENS

The adequacy test, and the standard

SFAIRP / ALARP — have we done enough?

Reduce the risk so far as is reasonably practicable. A control is only 'not reasonably practicable' if its cost is grossly disproportionate to the risk it removes — not merely greater.

SCE + FARSI — written to a standard

Each critical control is a Safety Critical Element, written to a measurable standard: Functionality, Availability, Reliability, Survivability, Interactions and dependencies — then independently verified.

This is the rigour you saw in the worked CCPS and verification.

OVER TO YOU

What was your biggest ah-hah moment?

One line each, in the chat.

BACK TO THE START

Self-assessment

Rate your confidence integrating the four, 1 to 10, now.

1 2 3 4 5 6 7 8 9 10

Type your number, 1 to 10.

THE TAKEAWAYS

Your three key learnings

1. Find the lethal energy first
2. A control that needs a person to be perfect is not critical
3. The binder does not hold the energy. A person does.

The obvious question

How do I do this in my business?

TWO PATHS

Slow, or fast?

Slow

- Three separate programmes
- Trial and error
- Years of drift
- A blind spot between them

Fast

- One integrated approach
- Built into your CCM process
- End to end
- No blind spot

It's not for everyone

If you are happy with where you are at, that is fine

But if you want to find what can kill, build controls that hold, and protect the moment, there is a next step.

THE NEXT STEP · CRM MASTERCLASS

Two days to build the fatal-risk program your business needs

You carry the weight of keeping people alive, with your frameworks in silos and controls that look good on paper. This is the room where you change that.

WHAT YOU WILL WALK AWAY WITH

- Run an integrated CRM program: energy, critical controls and critical steps in one method
- Build your own bowties, critical controls and performance standards on a real site risk
- Take home the templates, workbook and toolkit to keep doing it without us
- Show a board or regulator your controls are adequate

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We only take a handful each fortnight.
It's not for everyone, and that's the point.

Your questions

Drop them in the chat now.

AS PROMISED

Resources and your bonus

- The slides
- The recording
- Bonus: one-page Integrated Energy Framework
- Free: The Safety Professional's Guide to AI

Thank you

Let's save lives at work.

impresssolutions.com.au

1300 024 482 | admin@impresssolutions.com.au

linkedin.com/in/christiannyoung