RISK OF **HARM**

1,159 YEARS ON THE TOOLS:

What Risk of Harm Means to Experts

Commissioned by: Electrical Contractors Association of Ontario / International Brotherhood of Electrical Workers / Ontario Pipe Trades Council

Written by: Gavan Howe, PhD (in progress)

ELECTRICAL CONTRACTORS ASSOCIATION OF ONTARIO
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS

Ontario Pipe Trades Council

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EXECUTIVE SUMMARY

The men on tools who work at the *"sharp end"* of occupational hazard (Hollnagel, 2004, p. 62) understand what risk of harm means while on and off their jobs sites.

In fact, as reported in this *"On the Tools"* study, the 47 men who participated in this thematic analysis research, all of whom were employed in electrical and pipe trades, identified well over 200 situations or conditions of risk that can lead to harm for them, apprentices, other trade workers, the public, property, and equipment. One of the most prominent risks of harm mentioned by participants (72 written comments) was the risk of harm *"caused by workers who are unskilled, uninformed, untrained, uneducated, non-expert and un-certified"* in the pipe and the electrical trades. As noted in this paper, risks that can cause harms are related to perception. The perception of the workers who toil at the sharp end of the tools is that the unknown risks resulting from shoddy, poorly planned, poorly executed, and non-code work by non-experts is what truly worries these experts. They worry about the safety and health risks to themselves, their apprentices, the public, and property.

These workers stressed that risk and risk of harm are dynamic, as *"there is always risk of harm on the job site"* and *"the greater the lack of skill/training or ignorance, the greater the risk of harm at work."* Study participants also stressed the fact that there are four highly linked elements of learning a trade: (a) learning safe work practices, (b) learning how to work technically safe and sound, (c) learning hands-on work as an apprentice, and (d) recognizing that it takes 10 years to become an expert at anything.

Participants in this *"On the Tools"* study were comprised of advanced apprentices, journeymen, trainers, and contractors working in all the electrical trades (e.g., institutional, commercial and industrial, solar, alarms, security, telecommunications, nuclear, farm, and powerline), as well as journeymen and trainers in all the pipe trades (heating, ventilation, air-conditioning, and refrigeration (HVACR), gas, steam/boiler, compressed and medical gases, oil and gas, plumbing, steamfitting and sprinkler fitting).

Combined, research participants had over 1,159 man-years of experience on their tools, and the findings of this research suggests the view these men share on what *"risk of harm"* means on a modern construction site ought to be listened to and acted upon. These trade experts, who operate at Hollnagel's (2004) sharp end of tools, possess a sophisticated understanding of the known risks as well as a strong awareness of the unknown unknowns: the hidden, latent, and lingering risks, both old and new, that can and do arise on modern North American construction sites (Beck, 2009). Participants understand and have respect for how prevalent, systemic, and tightly linked construction risks are today and advocate on behalf of an expansive and systemic view of risk of harm, as opposed to a narrow definition, based on over 1,000 man-years of experience on the sharp end of the tools while working in hazardous construction trades.

> Hollnagel (2004) described the sharp end as: *The main implication of the sharp end–blunt end–view of accidents is that the performance variability of people at the sharp end, and in particular the failures they may make, are determined by a host of factors. This means that the backwards search for causes are more likely to find a complex network than to reveal a simple cause effect chain. (p. 63)*

Sparrow (2008) accurately stated, *"Harm is also the most general, provided it can be understood to include 'potential harms' and 'patterns of harm' as well as harms already done" (p. 10) when attempting to describe the risks, bad things, or harms that can befall a worker.*

Trade experts have argued that risk is persistent and ever changing, with new forms of risk appearing more frequently on North American construction sites as compared to 10 years ago. These risks are dynamically complex, highly interlinked with other trades and what is taking place across the entire job site. Pidgeon, Kasperson, and Slovic (2003) noted, *"Most contemporary risks originate in socio-technical systems"* (p. 24). As noted, participants of this *"On the Tools"* study understood clearly the tightly linked nature of construction risks and how they are but one part of a system of systems, working together on a job site to complete a project on time and on budget.

Photo and comments by Jason

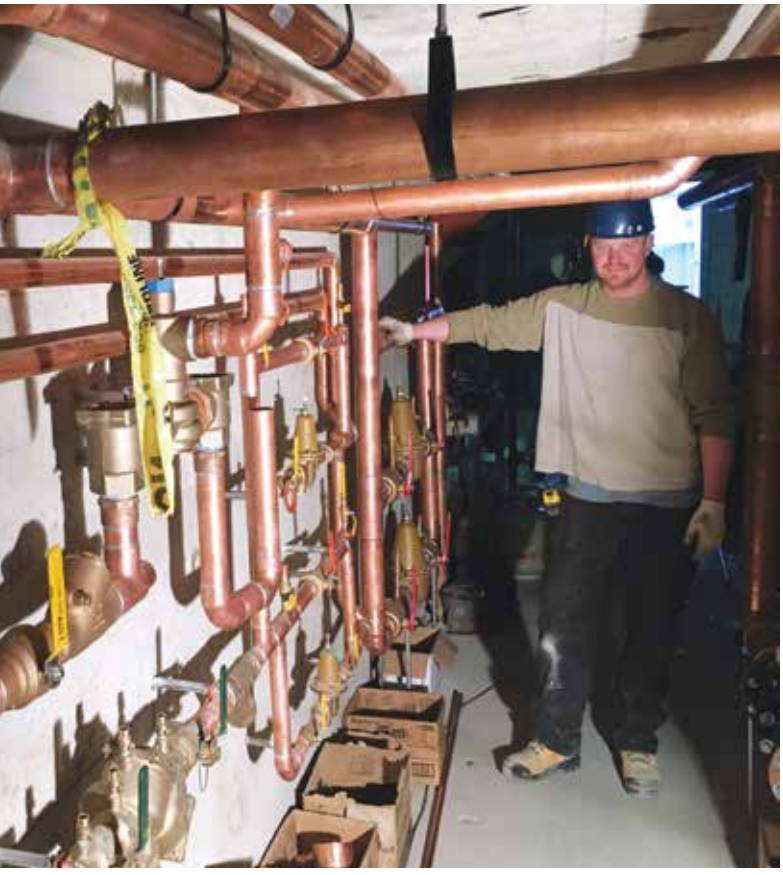
This photo shows a dangerous installation undertaken by an unauthorized worker: a six hundred foot cable run without any junction boxes as required by code. Note: the workers who installed this cable could not even get the pull rope through let alone the electrical cable which was to follow. This was a costly and potentially dangerous shortcut.

Table 1. *Fatalities in the Private Construction Industry in the US in 2014*

Cause of Fatality	Number of Deaths	Percentage (N = 874)
Falls	379	39.9%
Electrocutions	74	8.5%
Struck by object	73	8.3%
Caught in / between	12	1.4%

The majority of my *"On the Tools"* research participants (27 out of 47) were electricians and noted that job sites are safer today due to rigorous training, both in the use of tools as well as in safe work practices as compared to years past. Many cited the important role the Electrical Safety Authority plays in suppressing the underground economy and in helping to keep workers safe around electricity.

That being said, electrical contact was the number two most-common cause of death in the private construction industry in the USA during 2014 (United States Department of Labor, Occupational Health & Safety Administration [OHSA], 2015), at 8.5% of all fatalities, with falls being the number one cause of fatalities at 39.9% (see Table 1).



In the USA in 2014, these *"Fatal Four"* as OHSA (2015, para. 8) called them, *"were responsible for 58.1% of all construction worker deaths"* (para. 9). It should also be noted that 20.5% of worker deaths in the US in private industry were in construction, though only 7% of the US population is employed in the construction industry. In Canada, this figure is 7.7% (Buildforce Canada, 2016). The results of the 2014 OHSA study matched my *"On the Tools"* study very closely, except for the study findings that work undertaken by non- experts is the number one unseen or latent construction risk. Though my participants listed over 200 themes about risk of harm on modern construction sites, they rated the 10 top risks *"seen"* on job sites in the following order:

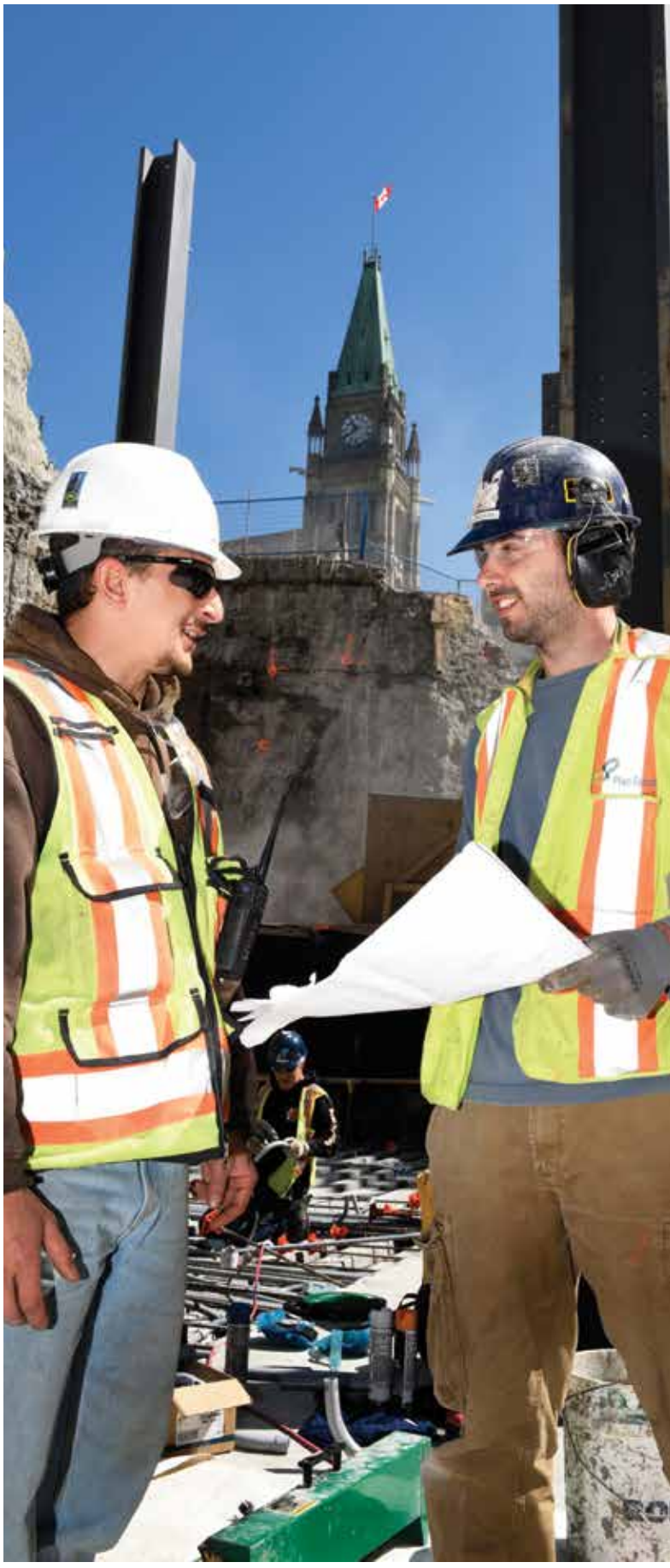
1) Falls/ Working at Heights
2) Electrocution
3) Stuck by Object
4) Working with Power Tools/Machinery
5) Slips/Falls
6) Fatigue
7) Explosion
8) Working in Confined Spaces
9) Live Electrical Work
10) Pinch Points

Lastly, workers understand and have great respect for hidden, latent, or lingering risks to themselves, apprentices, other workers, the public, and their property. The electricians involved in this survey appreciated the work of the Electrical Safety Authority (ESA) of Ontario in suppressing illegal, shoddy, and/or unlicensed electrical work, which was also noted in a recent fine the ESA levied against a contractor, Pro Teck Electric, for $537,500.00 (ESA, 2016). This is the largest fine ever levied by the ESA due to *"leaving an unsafe electrical condition"* (p. 1). The company had installed in-floor heating for the bathroom floor, upon which the homeowner, an elderly man, fell and suffered second and third degree burns from the overheated floor. He subsequently died as a result of these injuries (p. 1).

My research participants talked often and at length about the hidden dangers due to workmanship provided by unlicensed, untrained, and non-expert workers. Participants also noted that the dangers and risk from this type of work can lie dormant for years, or they can kill and injure the public and other workers at any time.

My study will be of interest to apprentices, journeymen, foremen, supervisors, contractors in hazardous construction trades, lawmakers, regulators, OHSA experts, insurers, colleges and trade schools, rehabilitation and medical professionals, and all who work as first responders, such as fire, police, emergency responders, to name a few.

Key words: *risk, harm, danger, hazard, accident, incident, risk of harm, apprentices, journeymen, hazardous construction trades*



INTRODUCTION

The purpose of this research study, "1,159 Years on the Tools," was to determine what the notion risk of harm means to those employed in hazardous construction trades such as the electrical and pipe trades (almost all construction trades are hazardous).

This study was commissioned by the International Brotherhood of Electrical Workers Construction Council of, Ontario (IBEW CCO), The Electrical Contractors Association of Ontario (ECAO), and the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United Sates and Canada (UA Canada) in order to help explain what risk means to construction experts and how these risks could harm them, apprentices, and co-workers while on the and off the job.

As Sparrow (2008) noted, *"Harm reduction work remains widely unrecognized and poorly understood"* (p. 124). Sparrow advised regulatory practitioners to organize around *"specific knots of harm"* (p. 63), and my study confirmed and built on his views, as my participants identified 200 specific knots of harm these experts face daily while at work.

The purpose of this *"On the Tools"* study was not to develop a definition of risk and harm that is carved in stone given this was beyond the scope of this paper due to limitations of time and space. Rather, this paper will inform those who are involved with the construction trades and will serve to frame what risk of harm means to those who are directly exposed to life-and death-situations regularly on the job site. This paper is a report on the stories of risk of harm based on over 1,000 man-years *"on the tools."*

This current study involved conducting a focus group and in-depth interviews with 47 trade journeymen, apprentices, contractors, and trainers in the electrical and pipe trades, including steam fitting, plumbing, fire/sprinkler alarm, gas fitting, heating ventilation cooling, and refrigeration HVCR. Combined, these participants have over 1,159 years of experience on the tools and represent a vast body of knowledge, experience, and training on what risk of harm means to an apprentice or journeymen on a modern, dynamically complex, and ever-evolving construction site.

This current study does not attempt to explain theory nor develop theory around risk taking, risk bearing, or risk perception by apprentices and expert tradesmen. The risk literature has benefited from the work of scholars such as Beck (2009), Hollnagel, (2004), Leiss (2001), Pidgeon et al. (2003), Sandman (2003), Sparrow (2008), and Van Poortvleit (1999) in so far as what risk and harm means. Rather, this current study explored the stories of individual perceptions of risk of harm on a job site, what risk and harm means to groups, and how the distinct cultures of highly trained expert tradesmen, apprentices, trainers, and contractors view the concept of risk of harm.

The impetus behind this study was the release of a report in Ontario by Tony Dean (2015), where he stated that risk of harm to apprentices (and journeymen) will become a critical and central guiding principle in the goal of keeping apprentices, journeymen, equipment, and property safe on construction sites in Ontario and, in fact, across Canada. In his review, Dean rightly noted that risk of harm to workers will be the number two criterion, after apprentice training, used to assess whether a trade is deemed voluntary or compulsory. He further noted that risk of harm will be the number one criterion utilized to assess whether the apprentice-to-journeymen ratios are increased or decreased in a regulated trade.

In speaking to risk law, Finkelstein (2003) asked the following question: *"Is the imposition of risk a harm to the person on whom it is inflicted?"* (p. 965). In this same paper, she went on to successfully argue it is (p. 965). Beck (2009) also noted that *"acceptable risks are those that are accepted"* (p. 13), but what about those risks not accepted? Would these be outside a risk contract? Risk is a perception-based exercise, and perception is inextricably linked to risk: What looks like a risk to one worker, may not be viewed as risky by another worker.

Table 2. *Electrician's Proportional Mortality Rates*	
Illness	**Proportional Mortality Rates (PMR)**
Leukemia	115
Brain Tumors	136
Melanoma Skin Cancer	123
Asbestos-Related Diseases:	
Lung cancer	117
Asbestosis	247
Malignant mesothelioma	356
Fatal Injuries, particularity electrocution	1180
Prostate Cancer	107
Musculoskeletal Disease	130
Disorders of Blood Forming Organs	141
Suicide	113
Note: Compiled from Robinson (1999).	

As a risk scholar, practitioner, communicator, and researcher focusing on the hazardous construction trades such as the electrical trades for over 14 years, I whole-heartedly agree with Mr. Dean's (2015) position. I have advocated strongly in research papers, speeches, presentations, and articles that risk of harm, not economic issues, should be the number one criterion for evaluating whether the ratio of apprentices to journeymen in hazardous trade should be increased.

The risk literature has grown substantially over the past years, with a host of definitions of risk. The notion of risk of harm has been utilized in the children's safety literature and in the study of pathological behaviours, yet it has not been addressed adequately in either the risk literature or the organization literature on the subject of occupational health and safety. The purpose of this study was to assess the perceptions of risk of harm, a phrase poorly defined insofar as it pertains to healthy, well-adjusted, highly skilled, and well-trained tradesmen and safe work.

In order to assist the reader in understanding how risky the electrical trade is (e.g., latent, hidden or unknown risks, as well as known risks), one only needs look at the research work of Robinson (1999), who found that compared to the general US population, electricians had elevated proportional mortality rates (PMR) or in laymen's terms: a greater risk of death from exposure to the risks as detailed in Table 2. Robinson concluded, *"Results suggest that more detailed investigations of occupational risk factors and evaluation of preventative practices are needed to prevent excess mortality in this hazardous occupation"* (para. 3).

The electrical trade is a hazardous trade. **As noted by Howe** (2010), *"Occupational injuries by electrical contact were up 45% between 1998 and 2006, when in fact there was a 20% drop in other types of injuries over the same time"* (p. 1). Additionally, *"79% of all workers injured by electrical contact are not licensed electricians . . . [and] over 50% of death by occupational electrocution was due to 'working live'"* (p. 2).

TERMS/DEFINITIONS

So, just what does this phrase risk of harm mean?

In the limited time and space allowed for this paper, I reviewed several bodies of literature to help answer this question. There is little mention of *"risk of harm"* in most literatures, other than dealing with pathological habits and pursuits and in the medical literature on harm to children. The word risk *"came to the English language from French in the 1660's, which had been adopted from the Italian word 'riscare' . . . [meaning] to navigate among dangerous rocks"* (Pidgeon et al., 2003, p. 64).

In order to best approach unpicking this phrase, I looked to the classical and modern risk literature as well as organizational, insurance, and legal literatures and, in doing so, examined risk separately from harm. First, Pidgeon, et al. (2003) described the factors behind risk in this manner: *"Most contemporary risks originate in sociotechnical systems"* (p. 24), and based on my research findings, my participants agreed: Construction risk has a social face, a cultural, and a technical face.

Risk means two things to noted European risk scholar Ulrich Beck (2009). Simply put, risk has two faces: *"chance and danger"* (p. 4), and *"risk means the anticipation of catastrophe . . . [and that] risks are always future events that may threaten us"* (p. 9). Beck's view was that *"risks are social constructions, and definitions based upon corresponding relations of definitions"* (p. 30). Further, he noted, *"Risks always rest on decisions; they presuppose the possibility to make decisions. They are the result of the transformation of uncertainties, and threats into decisions (and they necessitate decisions, which in turn generate risks)"* (p. 9).

Sandman (2003) suggested harm is defined as: *"Risk is a multiplication of two factors: magnitude (how bad it gets) times probability (how likely it is to happen)"* (p. 6). He further proposed that *"magnitude x probability should be called hazard"* (p. 7). Sandman noted a difference between voluntary and coerced risk, stating,

> It shows up in the literature as much as three orders of magnitude greater. . . . [or, simply put:] Voluntary risk is up to 1,000 times more acceptable as compared to being coerced into risky behavior. (p. 14)

Hollnagel (2004) reflected on the complexity of events that lead to incidents such as death and injury: "*Indeed, every event that contributes to an accident rather than just the last one can be seen to being at the sharp end*" (p. 59). He further stated, "*It had become generally accepted during the 1980's that most if not all failures made at the sharp end were determined by the working conditions and the nature of the tasks*" (p. 62).

> Sparrow (2008) noted, *Some scholars chose to distinguish danger (meaning a recognized but actual risk) from risk (by which they mean perceived risk). . . . [However,] the distinction between actual and potential (risk) is not as clear or clean as one might imagine at first. (p. 11)*

Sparrow also stated, "*The risk literature has so far not given us a well-developed organizational theory for risk-control. Neither conversely has organizational theory paid explicit attention to the distinctive character of the harm reduction task*" (p. 15). He also discussed the harm-reduction task:

> Navigating the texture of harms is distressingly complicated. Who is to decide how big or how small a problem to take on? Who is to decide in what dimensions a problem should best be defined? Answer: practitioners! It is they who must decide these things, as a part of ordinary operational practice. (p. 79)

When commenting on risk, Pidgeon et al. (2003) posited, *Risk is a situation or an event where something of human value (including humans themselves) is at stake and where the outcome is uncertain. … It seems impossible to talk about risk in the absence of the notion of uncertainty.* (p. 56)

Additionally, Pidgeon et al. stated, Risk, therefore, cannot be distinguished from risk perception. One of the most explicit statements of this position comes from Scharder-Frechette who argues, "In sum, there is no distinction between perceived risk and actual risk because there are no risks except perceived risks. If there were hazards that were not perceived, then we would not know them. …

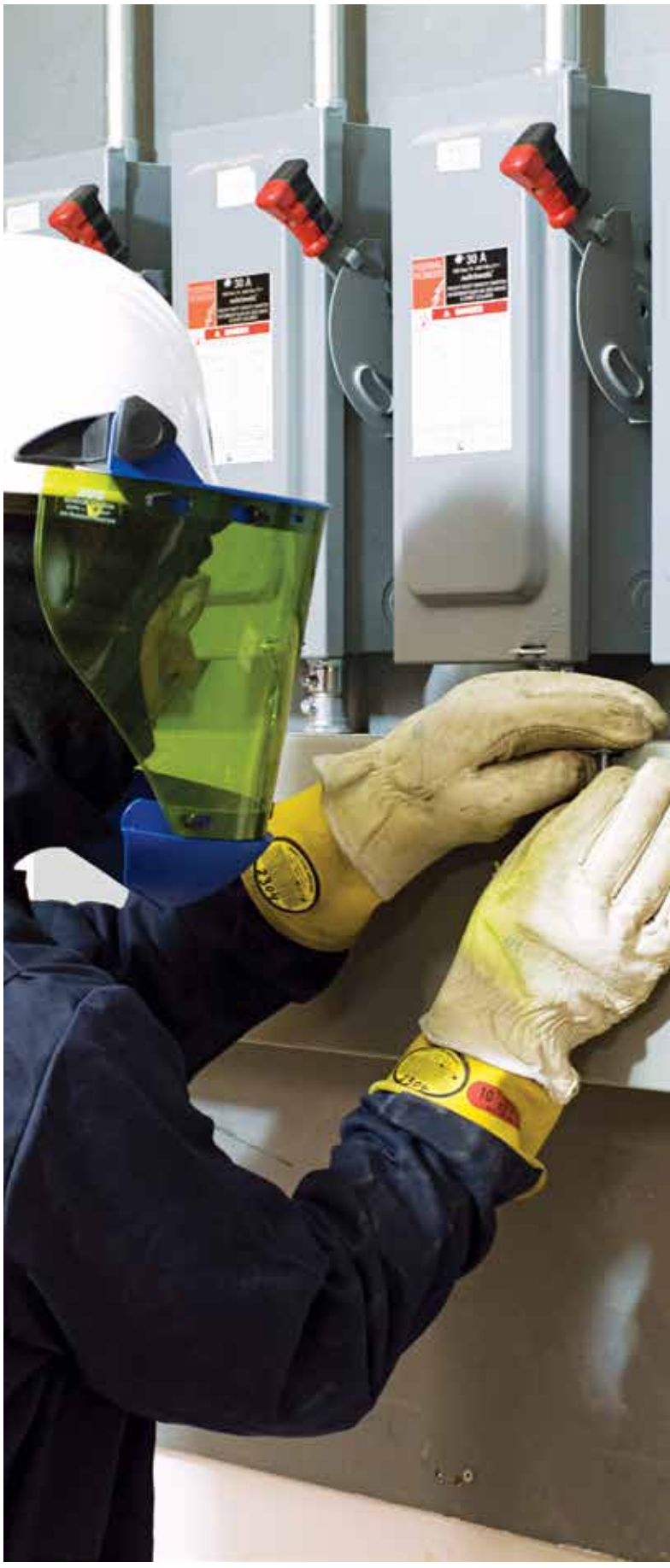
It is only when conditions in the world are dangerous and are perceived to be so, that risk has meaning. (p. 67)

Beck (2009) ruminated on the complexity of risk, noting that *"risk concerns the possibility of future occurrences and developments; they make present a state of the world that does not (yet) exist"* (p. 9). Pidgeon et al. (2003) commented on risk as seen through the eyes of experts:

> Experts and laypersons perceive risk differently. Experts see risks as possible chains of cause and effect. They regard risks as indications of hazard potentials. Risk assessment involves answering four questions: Is there a potential hazard and what is its nature? What dose will induce a harmful effect? Who is exposed to what dosage? How significant is the risk? (p. 286)

As one can see, there are numerous definitions of risk and harm, though there is truly no adequate definition of risk of harm, save and except the following appropriate comment from Sparrow (2008):

> The risk literature still focuses, for the most part, on exposures and outcomes which are still probabilistic in nature, rather than deterministic or predictable. Some scholars have used a distinction between risks–the by-products of human decision making adoption of technology–and hazards, which occur naturally. Others choose to distinguish danger (meaning recognized but actual risk) from risk (by which they mean a perceived risk). I prefer the word "harm" for its freshness and for its generality, and for the fact that scholars have so far not prescribed narrow ways to interpret it. I'd like to find one word to cover the broadest set of bad things, and so far harm seems less spoilt by particular usage and less monopolized by specific disciplines than the alternatives. Harms is also the most general, provided it can be understood to include "potential harms" and "patterns of harm", as well as harms already done. (p. 10)



FINDINGS

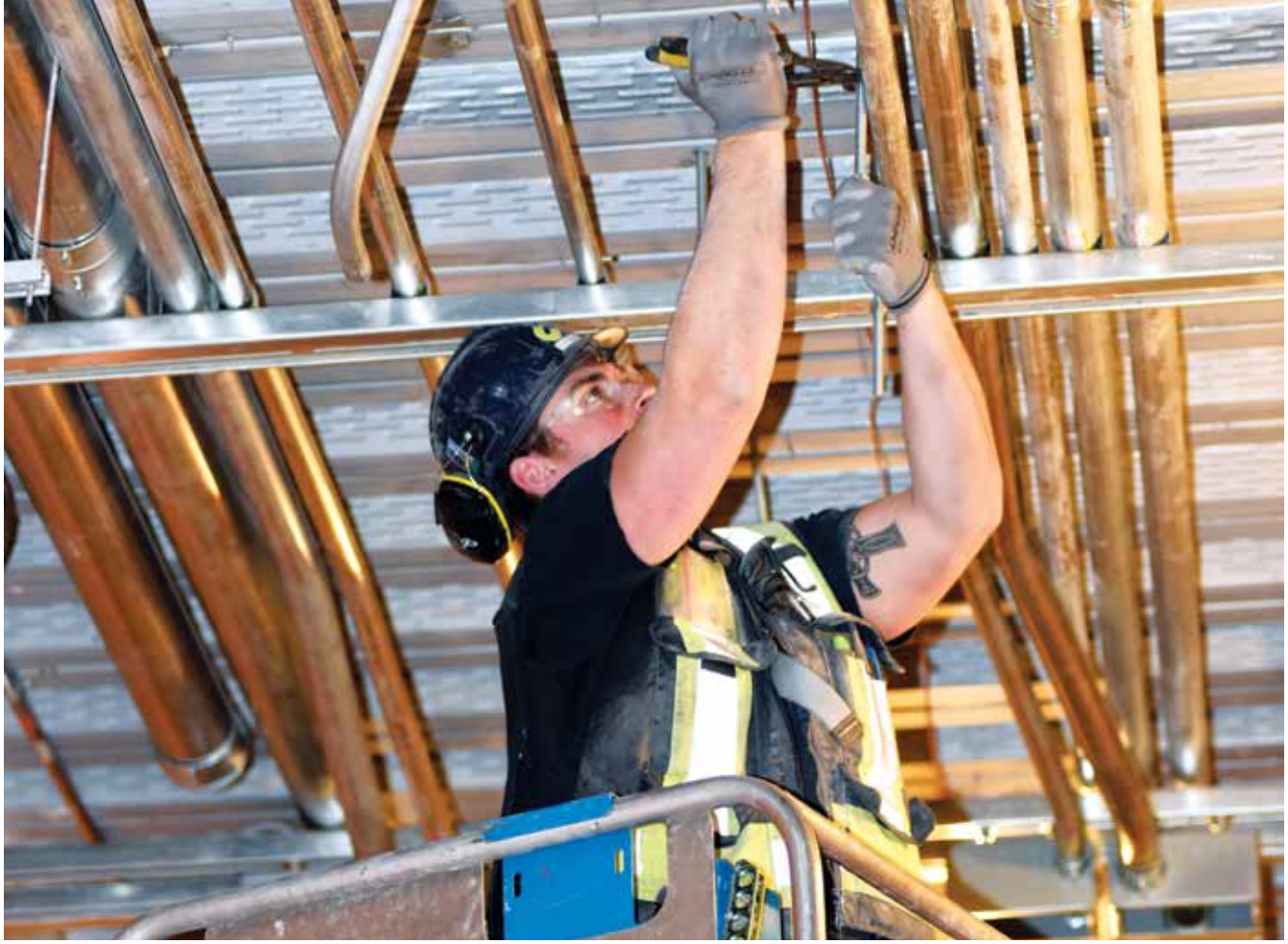
My study's research participants listed over 200 distinct risks that can cause harm or death from working on the job site.

These are performance risks, and the number one performance risk identified was working at heights causing falls. The number two risk was electrocution, which was not surprising given over half of the participants were in the electrical trades. Participants went on to share *"the broadest set of bad things"* (Sparrow, 2008, p. 15) they had witnessed on the job site, and they described 198 other situations of risk of harm to themselves, their apprentices, other trade workers, and clients.

A surprising finding was that hidden or latent risks resulting from work performed by those untrained in the electrical or pipe trades were viewed as the overall number one risk of harm on modern construction sites, with 72 written comments from study participants. These risks include harm to oneself, apprentices, other trades, the public, and property.

The findings of this current study agree with scholars such as Beck (2009), Hollnagel (2004), Pidgeon et al. (2003), and Sparrow (2008) that risk of harm, as seen through the eyes of tradesmen, apprentice trainers and contractors, is systemic, dynamically complex, and swiftly evolving. New technologies such as solar and LED as well as tighter timelines, tighter budgets, the use of unqualified and untrained workers, engineered drawings that are only 50% complete, and a new cohort of workers who are always on (referring to cell phones of this cohort always being on) changes what risk of harm means. *"On the Tools"* study participants believe these new dynamics bring new risks to the job site, such as distraction, lack of focus, lack of training, and such, and that these emerging risks are dynamically coupled with traditional risks that have existed in these hazardous trades for decades.

To build on the work of noted risk scholar Malcolm Sparrow (2008), the nature of risk and harm has changed for the electrical trades. However, the organizational literature has not dealt with these new forms of risk of harm, nor has the risk literature *"provided meaningful guidance"* (p. 5) on how to deal with a multitude of risks and harms.



These include the many traditional drivers of occupational risk on construction sites, such as organizational, behavioral, technical, social, economic, regulatory policy, and such. However, they do not factor in new drivers, such as the differing values and goals of millennials, and how these impact the notion of career advancement amongst apprentices who are always on.

Participants described risks as harm to oneself, fellow trade workers, and associated trade workers, as well as to the public, materials, buildings, and equipment due to work being performed by unqualified workers as being particularly dangerous. They described risk of harm as being now, a close future, and a distant future. They described harm as being seen and unseen, known and not known, present and latent. As noted previously, they also saw new and emerging risks of harm due to technical and social change.

The findings of this current study suggest that it would be a grave error to simplify the definition of risk of harm for those employed in hazardous trades. The risk and organizational literatures confirmed that risk of harm is dynamically complex and tightly interlinked with many other moving parts and many other actors on modern construction sites, such as other trades and unlicensed workers.

Risk of harm has social, technical, and cultural aspects to it and is very difficult to control due to the dynamic complexity of this construct. Study participants agreed with the literature that *"accidents today rarely happen just because one thing goes wrong, i.e. there are very few cases of single cause failures"* (Hollnagel, 2004, p. 2). Additionally, *"most contemporary risks originate in sociotechnical systems rather than natural phenomena"* (p. 24).

THEMES ABOUT RISK OF HARM ON CONSTRUCTION SITES

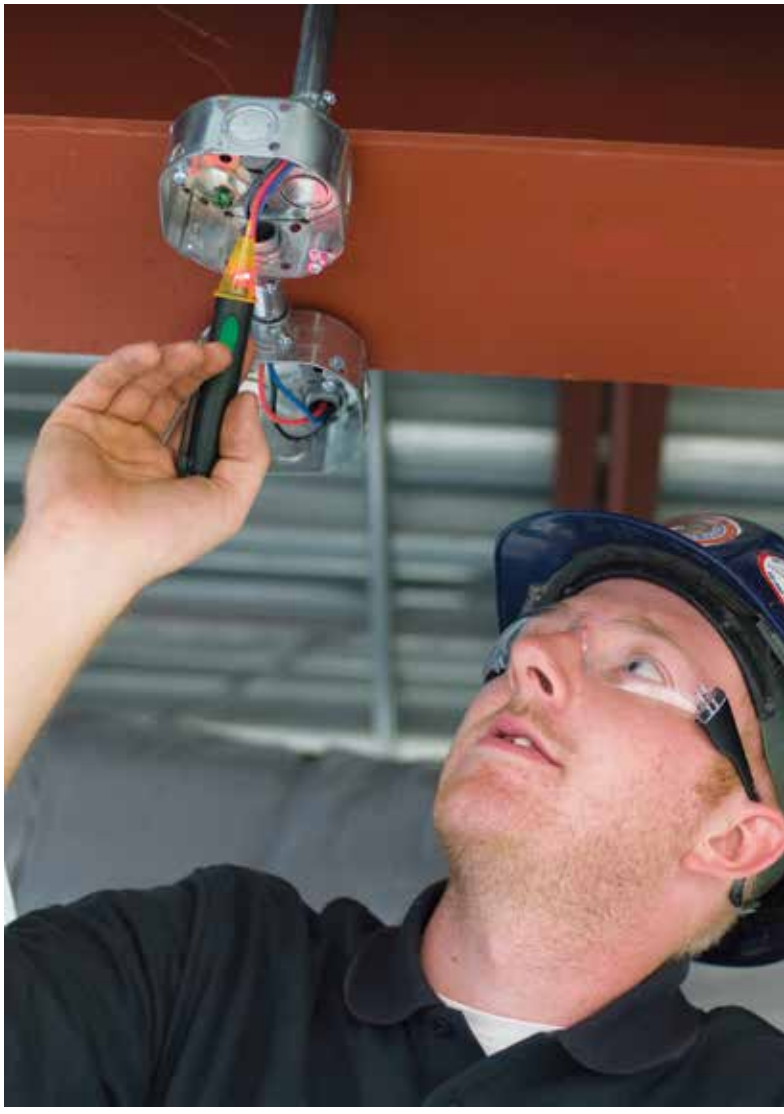
Additional themes arose from this research study on the notion of risk of harm and are, as noted, complex and tightly linked to each other.

Think of the harms and the risks attendant to these themes as causal loops (i.e., themes of risk and harm interlinked with two or three other linked harms) to best describe new and existing risks of harm on the construction site. Such themes and links are presented by:

- System of systems (the tight coupling of all trades on a site) and new technology
- Changing demographics (millennials) and cell phone "always on"
- Unseen and unknown risks due to unqualified people doing the work
- Need for continual training to keep up with new technologies
- Apprentice ratios and safe work/quality work
- Need to be visually available (apprentices to be "seen" on the job by their journeymen) and apprentice training and technology
- Changing worker values and reluctance by youth to take on supervisory roles
- "My trade is tightly linked to all other trades on the site"
- Notion of qualified workers, including red seal, apprentice training, C o Q, ongoing education
- Trust, and the importance of work done properly and by only qualified workers
- ESA inspections and trust in the work being performed safely
- Many diverse trade workers on the site; assume the worst in regards to quality work

- Quality work in hazardous trade and C o Q and trained apprentices
- Unknown unknowns and human error: prevalent on sites
- Speeded up workflow and unqualified workers
- Tighter budgets and unqualified workers
- Congested work sites and tight timelines/budgets
- Engineered drawings only 50% complete and tight budgets/timelines, requiring more on-the-spot improvisation by journeymen
- "Being a supervisor screams risk of liability"
- Workflow in jeopardy with unqualified workers
- "Need more MOL inspectors, with greater training in our trades"
- LED and solar represent new risks for all trades
- Actual time allowed versus "hurry up world"
- Fatigue and stress
- The vital importance of on-the-job-learning, recognizing that tradespeople learn by sight
- Standard Operating Procedures (SOPs) are becoming more, not less, complex, thus the need for qualified people
- Only fully trained and certified trade people have the ability and experience needed to be able to "see the big picture": how all the parts are connected into a risky situation or safe situations
- Underground construction economy in Canada is a $14 billion/year business, and the unknown risks of this work are real
- Stacking of trades and unknown risks
- Workers say job sites more risky, while management says they are more safe today as compared to previous decade
- The critical link that exists between apprentice, journeymen, and foreman and trust in quality and safely executed work
- Seen and unseen hazards
- Known and unknown hazards
- Past, present, and future risks of the work
- Different trades view risk differently and lack knowledge of other trades' work
- Harm to the environment and excellent SOPs
- Accepted risk and risks not accepted

The risk of harm themes noted here confirm the swiftly evolving nature of risk and harm and the fact that risks leading to harm on modern construction sites are tightly linked to all other elements involved in modern construction. Thus, the need for fully qualified, trained, and certified workers is more pressing today than it was 10 years ago.

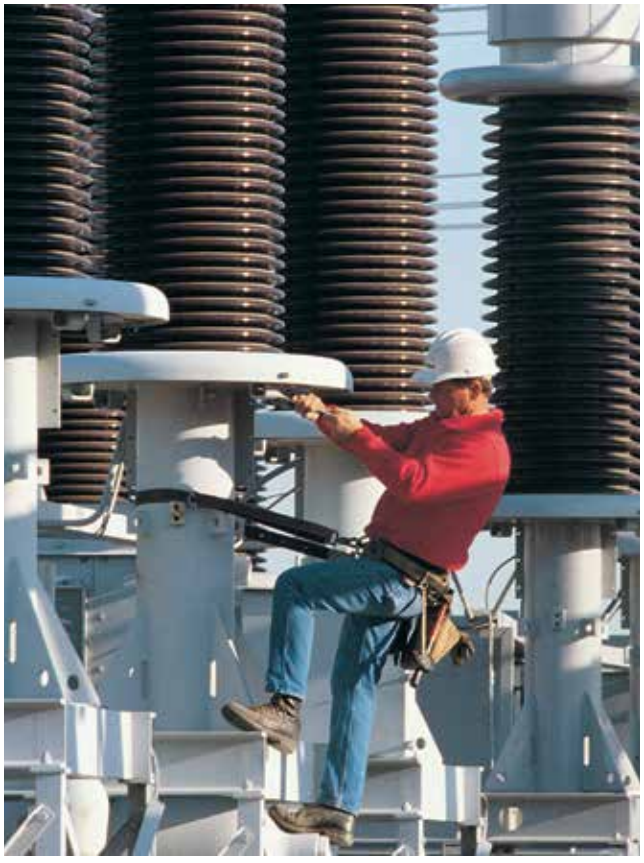


METHODS AND METHODOLOGY

Three focus groups were conducted in this thematic analysis study in March 2016: one in Mississauga, one in Toronto, and one in Mt Tremblant, Quebec.

The first group was comprised of 11 electricians and apprentice electricians. The second group was conducted at Mt Tremblant and involved 21 experts in the pipe trades, who also served as trainers of experts in the various pipe trades. The third group involved 14 contractors in the electrical trades, who also had significant experience as electricians involved in industrial commercial, high voltage, fire alarms, and residential electric work.

Upon completion of the paper-and-pencil survey of 13 questions, which took approximately 30 minutes, a round table discussion ensued on what risk of harm meant to these trade experts A final in-depth interview was held with a training leader in the pipe trades. Data were aggregated across all focus groups and the in depth interview.



Each participant group was informed only that they were called upon to state their beliefs around what risk of harm means to them as apprentices or experts in their trades. Each participant was asked to complete a written survey containing 13 questions on the notion of risk of harm and to not discuss the survey questionnaire until all surveys were handed in. Participants had 30 minutes to complete these surveys. After completion, a round table, open-ended discussion took place on what the concept risk of harm means to these expert and apprentice trade workers, trainers, and contractors. A final in-depth interview was held with a training leader in the pipe trades. Data were aggregated across all focus groups and the in depth interview.

The study results were analyzed utilizing thematic analysis, with a constructionist perspective, along with an inductive approach to search for themes arising from the data. In other words, the researcher attempted to code the data with no intent to locate, or position, the data within any preexisting framework. I identified themes at a latent and interpretive level, in the hopes of identifying underlying typologies, ideas, concepts, and assumptions about what risk of harm means and what risks can lead to harm.

CONCLUSIONS AND QUESTIONS FOR FURTHER RESEARCH

The number one theme arising form this research was a worry on hidden or unseen risks: namely, those caused by the work of people who are untrained in the tightly linked, dynamically complex, and hazardous pipe and electrical trades.

Participants made 72 written comments on the theme of dangers of unqualified work and how they worry that shoddy craftsmanship can lead to explosions and fires, causing injury and death to themselves, their apprentices, other workers and the public.

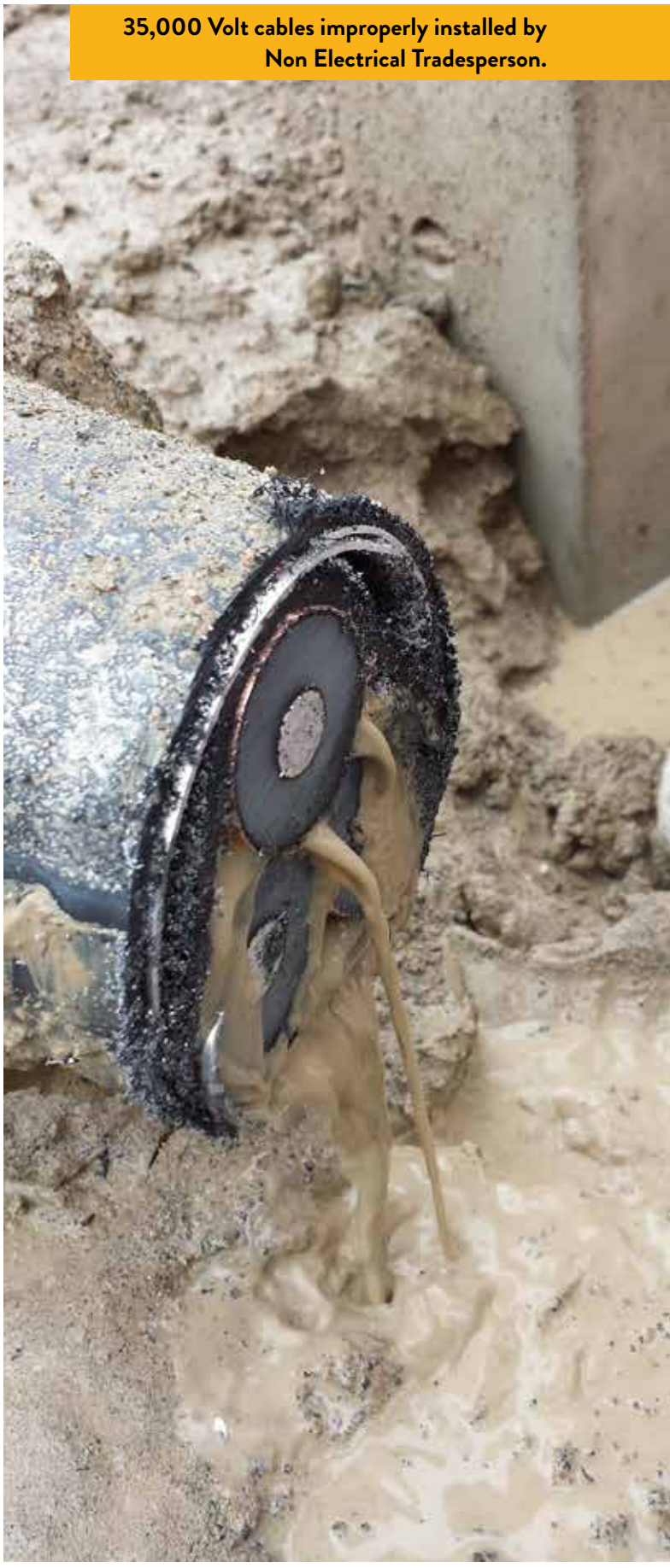
This *"On the Tools"* research study agrees with the findings of the giants in the risk and organizational fields, such as Beck (2009), Hollnagel (2004), Pidgeon et al. (2003), and Sparrow (2008) on the notion that risk of harm is dynamically complex, as it is tightly coupled with the social, cultural, technological, and perceptual backgrounds of the actors on modern construction sites. Any attempt to limit or simplify what the concept of risk of harm means would only serve to limit the worldviews of regulators, law makers, educators, and code makers regarding what new and old risks and harms exist on today's construction sites. A broad and systemic view of the definition of risk of harm is required in

order to help keep the men and women who work on the sharp end of construction tools safe from risk of harm.

This study has simply scratched the surface on the dynamic complexity that rests behind the notion of risk of harm as seen through the lens of over 1,000 man-years of construction expertise. Further research is required to *"unpick the important harms"* (Beck, 2009, p. 15) specific to two hazardous trades: the pipe trades and the electrical trade, in order to build a comprehensive taxonomy of what risk of harm means in its entirety to those trade experts who work on the sharp end of the tools. Further research from a lens of organizational and risk disciplines would help unpick these difficult to scope new and existing forms of construction harm.

Risk of harm is a dynamically complex notion as it relates to job site safety. This phrase has over 200 harms associated with, both seen and unseen, through the eyes of those in the electrical and pipe trades. Based on this research, further study is required amongst those employed on the *"sharp end"* of hazardous trades, focused on the theme of risk due to untrained workers, to identify what steps those employed in hazardous trades such as the pipe and electrical trades could take in order to keep themselves, other workers, and the public safe from this very real, yet unseen risk of harm.

35,000 Volt cables improperly installed by Non Electrical Tradesperson.



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Gavan is an independent risk scholar-practitioner and researcher in occupational risk taking and risk bearing. He is an Associate Professor at Humber College in the Business Faculty teaching: Insurance, Marketing, Marketing Research, and at the University of Guelph Humber in the Digital Media Faculty, teaching Marketing Communications and Transition to Work, and he mentors fourth-year students taking their Internship Course.

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