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The Rhetorical Art of Risk Assessment: Lessons from Risk Management in Rural and Tribal Communities

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THE RHETORICAL ART OF RISK ASSESSMENT: LESSONS FROM RISK MANAGEMENT IN RURAL AND TRIBAL COMMUNITIES

By

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For my children – you will face risks that I can’t begin to imagine.
You’ll learn from all of them, and some will definitely be fun.
I hope this work helps ensure that.

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Acknowledgements

I have been at least a part time student for over 40 years, and through all that time my family and friends have put up with me dividing my attention between them and my endless student status. I’ve also seen more than a few advisors and committee members retire before they saw me through to the end of this degree. To all these friends, family, and colleagues, I express deep gratitude for sticking with me and encouraging me to complete this journey, especially my current committee, who certainly saved me from abandoning this work.

List of Abbreviations and Definitions

This dissertation uses the following acronyms and terms specific to US federal, state, and tribal government and government-regulated groups. Please consider your own reuse of language related to social, political, ethnic, racial, and national groups from this and other work as these terms change and may become quickly outdated or even offensive.

AI/AN	American Indian and Alaska Native – A term to be used instead of Native American to differentiate from other Indigenous populations found in the Americas and to differentiate between those Indigenous to Alaska and those from the lower 48 states. These terms are used in US federal documents and other publications to refer to the Indigenous people from federally recognized tribal governments and Alaskan villages. AI/AN is often used interchangeably with Native American even in official government publications. An example of another Indigenous group is Pacific Islanders, who are Indigenous to areas of the United States but who generally have a different political relationship with the US government than the relationship between federally recognized tribes and the US government. Some Indigenous people find American Indian or Indian offensive as they are names incorrectly given to people who were assumed to be from the Indian subcontinent, while other Indigenous people embrace the term Indian.
ARTBA	The American Road & Transportation Builders Association is a trade association representing the transportation and construction industries in the United States
BIA	Bureau of Indian Affairs – the agency within the US Department of the Interior (DOI) responsible for implementing federal law and policies related to AI/AN people and governments. It is one of the oldest continuously operating federal agencies in the US. The BIA is also responsible for some transportation systems and infrastructure on tribal lands.
CDC	Centers for Disease Control and Prevention is a US federal agency under the Department of Health and Human Services with responsibility for public health. The CDC also supports and conducts research into health threats and public health.
DOT	Department of Transportation – used specifically or generically for a national (federal), tribal, state, or local agency responsible for transportation systems and infrastructure
EMT	Emergency Medical Technician – A trained and licensed medical first responder who usually responds to medical emergencies with an ambulance or other emergency vehicle/agency. There are three levels of EMT in the US: EMT-

	B(asic), EMT-A(dvanced), and EMT-P(aramedic). EMT-P are commonly called paramedics or medics without the EMT prefix. The scope of practice, licensing, and standards are established nationally through the USDOT and managed/modified at the state level through public health agencies.
FAA	Federal Aviation Administration - a part of the United States Department of Transportation responsible for air traffic and aircraft-related infrastructure of all types
FHWA	Federal Highway Administration – a part of the United States Department of Transportation responsible for road-based transportation, including many rural and tribal, non-highway roads
First Responder	The term first responder usually refers to pre-hospital emergency medical responders such as EMTs and paramedics, although it can also include law enforcement, firefighters, and other officially dispatched personnel who are first on the scene in an emergency.
HFG	Human Factors Guidelines for Road Systems (aka Human Factors Guide or NCHRP 600) is published by the National Cooperative Highway Research Program (NCHRP) for transportation engineers and other workers. The guidelines provide insights into how road users function in response to road design, markings, signs, and other roadway elements.
HSM	Highway Safety Manual – the manual which guides the safe design and operation of roadways in the US. "The HSM provides a science-based, technical approach to facilitate consideration of safety in roadway planning, design, operations, and maintenance decisions. This allows safety to be quantitatively evaluated alongside other transportation performance measures such as traffic operations, environmental impacts, pavement durability, and construction costs." ("Highway Safety Manual | FHWA" n.d., 2nd Paragraph)
K Crash, A Crash (K/A)	K and A are designations used by US law enforcement and transportation agencies and researchers for motor vehicle crashes where a fatality (K) or severe injury (A) occurred. The crash is designated according to the most severe injury, so a K crash may include severely injured or even minor or non-injured people.
KBIC	The Keweenaw Bay Indian Community of the Lake Superior Band of Chippewa Indians is a federally recognized American Indian Tribe in Michigan's Upper Peninsula.
MVC	Motor vehicle crash – The preferred term for what are also commonly called car accidents. Researchers and practitioners in transportation safety prefer the term crash to accident as the word accident implies that the event was

	unavoidable or unrelated to those involved, which is not the case: 95% of MVCs are related to human behaviors such as speeding, impaired and distracted driving, fatigue, and other avoidable behaviors.
MVT	Motor Vehicle Traffic is a term used to describe all roadway transportation vehicles, including passenger vehicles, trucks, busses, and other motorized vehicles.
NASA	National Aeronautics and Space Administration – the US federal agency responsible for space exploration and space-related research
NFIRS	National Fire Incident Reporting System – The US Fire Administration's (USFA) fire incident data reporting system for all firefighting agencies in the US.
NHTSA	National Highway Traffic Safety Administration is an agency within the US Department of Transportation that is responsible for traffic safety standards.
PCR	Patient (or pre-hospital) care report – The form used by all levels of medical first responders to collect information about a patient. This form has quantitative and qualitative data fields to collect health information and status about patients. There is no design requirement, however they typically contain health and demographic fields requested by a state EMS regulatory agency and may have additional fields for billing and accountability purposes.
RSA	Road Safety Audit – A practice that emphasizes a complete evaluation of all available data by a diverse group of experts and non-experts to identify traffic safety risks and recommend solutions to those risks. These can be completed before and after a project is built.
TPC	Technical and professional communication – the study and practice of communicating technical or specialized information and workplace communication. TPC is associated with practice and study in fields called rhetoric and technical communication, scientific and technical communication, technical writing, tech comm, business writing, and other variations that describe purposeful communication focused on well-defined audiences with a specific goal.
Tribe and tribal	Tribe and tribal with a capital T refer to specific American Indian or Alaska Native (Indigenous) governments recognized by state or federal governments. Tribe and tribal with a lower-case T do not refer to specific governments but do refer to the special legal status established through treaties between the US and tribal governments.
TTAP	The Tribal Technical Assistance Program is sponsored by the US Federal Highway Administration (FHWA) to provide transportation workforce training,

	technical assistance, and information to American Indian and Alaska Native governments.
TTP	Tribal Transportation Program – Policy and law related to transportation systems among federally recognized tribal governments and Alaska villages. The TTP is codified in US national transportation legislation and funded by the US national fuel tax.
UD10	Michigan's statewide standard crash reporting form – UD10 is based on the nationally recommended crash reporting form fields. Each state has its own form with similar fields to collect information about the vehicle, people, and circumstances involved in an MVC. Reports can be made on paper or digitally. Some crash reporting systems and practices include geolocation collected by electronic devices to better define the crash location.
VMT	Vehicle miles traveled – A term usually expressed in 100s of millions of VMT to track the cumulative miles traveled by all vehicles in a year.

Abstract

Risk assessment, mitigation, and communication rely on data from multiple sources to form a complete understanding of hazards and how to manage them. Experts can use these data to make informed decisions about the nature and extent of risks and inform the public to protect health, the environment, and economic welfare. However, in an effort to objectively make decisions, technical experts and policymakers increasingly rely on quantitative data as the most important determiner of risk, which can alienate the public, limit risk understanding, and delay or miss obvious signals of impending catastrophe. I examine several cases based on my experiences practicing and researching traffic safety, public safety, and technical and professional communication (TPC). The cases include a look at the impact of limited quantitative data in addressing motor vehicle traffic injuries and death in American Indian and rural communities; the challenge of collecting accurate data by first responders and firefighters to better understand and respond to health and physical hazards; and a recent history of failures to prevent airline and aerospace disasters due to an overemphasis on quantifiable data and devaluation of certain kinds of expert knowledge. The results of this study call attention to the weaknesses resulting from a quantitative imperative in risk management and a proposal for renewed focus on risk assessment using rhetorical practices and qualitative data readily available from expert and non-expert perspectives.

1 Introduction

Road traffic is in the top ten causes of death for most countries, resulting in over 1,300,000 deaths and injuring an additional 20-50 million people worldwide each year, and is the leading cause of death for people aged 5-29 years ("Road Traffic Injuries (2022)" 2022). Even in the United States, where high-quality infrastructure, exceptional technology and engineering, coordinated enforcement and emergency response, and a very new vehicle stock have helped move traffic fatalities out of the top 10 causes of death, nearly 39,000 traffic-related fatalities annually overwhelmingly affected young people and lower-income, rural, and tribal communities (National Center for Statistics and Analysis 2022b; "Tribal Road Safety: Get the Facts | Transportation Safety | Injury Center | CDC" 2021; "Rural Transportation Statistics | Bureau of Transportation Statistics" 2022; "The Top 10 Causes of Death (2020)" 2020).

These statistics and my interest in risk communication led me to investigate how governments and technical experts manage risk of all types, but I do not focus on statistics, specific risk mitigation measures, or technical solutions to risk in this work. Instead, this dissertation looks at how policymakers, risk managers, technical specialists, and the public generate, communicate, and understand risk-related data and the implications for the current quantitative imperative common in risk assessment. My research led me to propose a renewed focus on qualitative data and to explain how a rhetorical approach to data collection and risk communication can lead to richer interpretations of risk while also establishing the presence of risk where it might not otherwise be recognized. This work also makes a case for expanding authority and responsibility for assessing risk to people who are closest to the problem, even when they are considered non-experts or lack specialized education in statistics, engineering, science, and risk management. With this work I seek to answer these questions:

- What are the implications of a reliance on quantifiable data in risk assessment, communication and mitigation?
- How can we use practices from technical and professional communication (TPC) to improve decision-making about risk and risk communication?
- Who should be considered experts in understanding risk and what kind of data do they offer?
- Why is qualitative data about risk undervalued?

I will investigate these questions using several case studies that highlight problems and solutions in risk management. The cases involve the problems and implications of identifying and addressing risks in local and global transportation and an additional case involving risk data collection and assessment from emergency medical services and firefighters. For these cases, I will look at not only the opportunities and implications for risk assessment, communication, and mitigation, but also broader implications for the communities and groups affected by these risks, for when we fail to address risk locally, we endanger people and our whole planet, place people in a position of need and distress, exacerbate inequities, and don’t encourage people to discontinue risky behavior. However, if risk communicators and managers can empower individuals and groups to assess, understand, and mitigate risk, then they can promote self-reliance and equitable decision-making that builds resilience and self-determination, which can lead to greater recognition and engagement in addressing personal, community, and global risks. Answering these research questions can therefore solve not only imminent threats to life and the environment, but also reduce reliance on external powers and systems that impose their own imperatives.

1.1 Background

From 2000 to 2020 I worked at Michigan Technological University as a staff researcher and then director (principal investigator) in federally sponsored research, technical assistance, and technology transfer programs related to rural and tribal transportation infrastructure development. This work took me to rural and tribal communities throughout the US where I saw first-hand how traffic safety affected small communities. Motor vehicle crashes happen everywhere there are vehicles, but in these small communities, they happen figuratively and literally close to home. The people I worked with could tell me about crashes that happened to friends and relatives just down the road and how the whole community grieved when a cousin was struck down while walking to school. In towns with populations in the low hundreds, two young people killed and one injured in a single crash is not only a traumatic event for the whole community, it is also a statistically significant part of a town's population that can affect the community's social and economic future. These experiences affected me so deeply that I took over 500 hours of evening classes in my 40s while still a graduate student and working full time to become a volunteer emergency medical technician (EMT) and firefighter with the specific goal of directly helping car crash victims.

It was thrilling to read about theories and studies in a graduate seminar that directly applied to my day job and evening volunteer work, even though it did often drive my colleagues and family crazy. Children of academics everywhere might relate with amusement to being engaged in a fully referenced, journal-length explanation to an innocent question like "Daddy, why are there those bumps along the center of the road?" (The answer is that center-line rumble strips reduce head-on fatal and injury crashes by a whopping 44 percent! (Donnell et al. 2009)). My fire buddies are not always so easily engaged when I start turning training nights into conference-quality presentations. My work and hobbies did lead me to realize that the same education in technical and professional communication (TPC) that gave me the power to discuss, inform, understand, and teach difficult technical topics also applies to seemingly intractable, non-technical problems in public health and safety. I also realized that the methods used by technical and professional communicators are poorly understood and poorly utilized by both experts who study and seek to mitigate all types of risks and by the laypeople who are affected by these risks and dangers.

TPC involves the study of how to communicate difficult topics in a way that specific people can make sense of and use this information. The classic example of TPC prose is an instruction set for an appliance or other device used in daily life. To some, this may sound like a tedious or even boring way to make a living or use the gift of language, but as with all communications practices, technical communicators apply art and science to engage and persuade their audiences with passion and talent. While the typical instruction set may seem dry, concise, and lacking in passion and art, TPC authors do apply the power of emotional, logical, and authoritative persuasion to convince their audiences to follow their instructions quickly, safely, and confidently. TPC is also about teaching and learning, for every piece of TPC content is trying to convince the reader, listener, or viewer to do or believe in something. Technical and professional communication is therefore firmly grounded in theories of rhetoric, or the art of persuasion, with strong influences from pedagogy, literacy, and language studies. Because TPC always engages humans, I also found TPC to be intertwined with practices and theories from the social sciences, philosophy, literature, art, and, because the topics are technical, TPC of course engages the very human study and applications of science and technology (Longo 2000; Moran 1985; Pringle and Williams 2005). More recently, scholars such as Godwin Agboka (2014; Agboka and Dorpenyo 2022), Isidore Dorpenyo (2022), Natasha Jones (2020; 2016b; 2016a), Kristen Moore (2016; Jones, Moore, and Walton 2016), and Timothy Elliott (Moore and Elliott 2016) are recognizing that TPC can play important roles in addressing social inequities by engaging TPC experts who can directly bridge gaps between governmental and corporate systems and also teach non-experts to use TPC skills and knowledge to better engage, understand, and participate in these systems.

It can be argued that technical and professional communication as a field has grappled with documentation, instructions, and persuading people to behave in specific ways since at least the ancient Greek philosophers who documented and instructed others to use their skills. In their article about the future of TPC as a profession, Kathy Pringle and Sean Williams write that TPC could even be traced back to Babylon, where someone with document design skills in archival technologies inscribed messages on stone tablets, and certainly began to emerge as an intentional language practice since the Middle Ages when documentation took on a format to record scientific information and procedures in writing (2005). With the industrial revolution, TPC became an intentional practice to meet the need for educating workers, engineers, and the public about the procedures, instruments, and weapons being mass produced at industrial scale. Following World Wars I & II the pace of technological change and sophistication definitively established TPC as a specialized communications field (Pringle and Williams 2005), and technical communicators adopted practices and formats that are familiar today, including manuals, checklists, instructional audio and video, and by the 1960s, even hypertext, the precursor to the World Wide Web (Nielsen 1995).

With the development of the tools of the TPC trade, scholars also developed the theories, practices, and pedagogies surrounding this specialized realm of communications. As a relatively young field, TPC is still developing its identity and is alternatively known as or borrows scholarship from scientific and technical communication (STC), business writing, technical writing, rhetoric and technical communication (RTC), and other fields related to intentional communication in business and science. Of course, TPC theories are also based on the ancient arts and theories of communication generally, especially rhetoric, writing, literacy, semiotics, genre, and other fields linked to written, visual, and audible communications as a means to inform, instruct, or document rather than entertainment or pleasure.

Rhetoric in particular is a central theme in TPC and this work. As an ancient art, probably as old as language itself, rhetoric is still poorly understood and often described in disparaging words. The word rhetoric may have negative connotations because it is frequently used to describe political language, as in "empty rhetoric" (Rachman 2008) which alludes to deceptive, manipulative, or superfluous language that serves no practical purpose. This idea of the persuasive element of rhetoric as something negative goes back thousands of years, with Plato calling rhetoric "the art of ruling the minds of men" (attributed to Plato by Emerson (2006, 64) and others). Plato's criticism was linked to the use of rhetoric by talented speakers to influence people through language, which is not an inaccurate description of how politicians use rhetoric then and now. But, is this art of influence necessarily always a bad thing?

Even in ancient Greece, philosophers debated, using rhetoric of course, whether rhetoric was a power of good or evil. Aristotle also saw rhetoric as a tool for influence, but he recognized that this tool was something that could be used for good, or was at least useful as a means of defending oneself from the manipulative aims of others. For Aristotle, rhetoric was a tool of deliberation that could be effective in defense of manipulation and also a means of persuading others in good ways (Aristotle, Ross, and Smith 1908, 11:Book I). So, Plato wasn't wrong when he described rhetorical speech as manipulative, but we might understand ruling minds with more nuance and consider rhetoric as a tool to persuade minds rather than rule them.

Persuasion has negative connotations because it invokes an image of trying to convince you of something that you don't want to be convinced of, but in TPC, this persuasion should be a tool for good, for if you can be persuaded to wear your seatbelt, you are more likely to live through a car crash ("Seat Belts | NHTSA" n.d.; Thomas 1990). But how to persuade someone to wear a seat belt? For Kenneth Burke, rhetoric would clearly be the tool to convince drivers to wear seat belts, for rhetoric is "the use of words by human agents to form attitudes or induce actions in other human agents" (1969, 41). The technical data and calculations that lead to a decision to fly or not to fly are only supporting the engineer's ethos using rhetorical logos and are not themselves going to convince anyone to do or not do anything. The answer to how and why to persuade people to use seat belts, stop smoking, exercise more, and not to fly aircraft that have technical problems are therefore found in the field of rhetoric, and specifically, risk communication, a field that seeks to induce actions (or induce inaction, as in not doing something) by applying rhetorical skills of persuasion.

Rhetorical theories embedded in risk communication can help answer this work's central questions of who is an expert, how knowledge about risk is developed, how to engage more people in the risk management process, and how to convince more people to avoid risky behavior. These questions are strongly linked to participatory design and to Robert Johnson's descriptions of techne (1998, 24, 51–53), the art of knowledge, or in the case of this work, the rhetorical art of risk assessment.

The art of risk assessment is comparable to other skills and knowledge formed through experience. Just as a sailor fist learns to move a boat confidently in moderate winds, and with experience will know how to set sails for safe passage in a gale, drivers will first learn to navigate a curve at slow speeds, and eventually intuitively know to brake before a curve without ever having driven it. These experienced drivers can then tell a road engineer where the unsafe curves, intersections, and passing lanes are without making a measurement and without having crashed. When the engineer uses the art of risk assessment, they will be able to evaluate risk using more than their expertise in statistics and design and they will understand what is more or less safe using techne, allowing them to understand and control risk using their learned knowledge and expertise even in the absence of recurring crashes on a dangerous curve.

Risk communication/TPC scholars Craig Waddell (1996; 1995), Jeffrey Grabill (2012; 1998; 1998; 2007), Robert Johnson (1997; 2007; 1998), and Michelle Simmons (2007) had a significant influence on my approaches to improving risk communication and their ideas on participatory design should be evident throughout this work, particularly in Chapters 2 and 3, where I call for greater involvement of non-experts to define traffic risks and to influence the design of systems for collecting field data by first responders. Kristen Moore and Timothy Elliott describe participatory design as "approach[ing] projects through the cocreation of ideas and a flattened, rather than hierarchical, decision-making process" (2016, 60). Engaging participatory design could therefore democratize the understanding of risk and include all those affected by the risk in the risk mitigation process.

Burkean identification (Burke 1969) is also a relevant theory for this work, both for the questions of expertise and authority and for participatory design, for the recognition of expertise is intertwined with how individuals from different social, educational, economic, and political backgrounds can come to understand one another or ally or separate themselves with the concerns of the other. Rhetoric can help build connections between the engineer and the small-town citizen, allowing them to work together to solve a problem, even while each maintains their identities. Kenneth Burke describes this possibility as "Identification and 'Consubstantiality': A is not identical with his colleague, B. But insofar as their interests are joined, A is identified with B. Or he may identify himself with B even when their interests are not joined, if he assumes that they are, or is persuaded to believe so [through rhetoric]" (1969, 20). Identification is especially relevant to questions of authority when it concerns the validity of opinions (data) about risk, for if the government expert can identify with the citizen, then they may value the citizen's input as valid data. As described in detail in Chapter 4, the invalidity of data and opinions from outside the government regulatory system are central to the decisions that led to two modern passenger jets crashing.

As described in Chapters 2 and 3, I witnessed and organized many meetings where participatory design practices did and did not contribute to a more complete understanding of risks in rural and tribal communities, and it was clear that some groups were much more successful at truly engaging the public than others, whether by luck, ignorance, or design. Activities based in participatory design are specifically required by laws, executive orders, and policy for many activities that involve the general public and very specifically for governmental actions that impact American Indian and Alaska Native governments, yet it is not likely to be a common topic in the engineering curricula that most risk managers will have studied.

More recent work by Natasha Jones (2020; 2016; 2016b; 2016a) and Kristen Moore (2016; 2016; 2013) is concerned with the social and ethical impact of TPC praxis, especially participatory practices, on underrepresented groups. Even before I became familiar with these authors, it seemed obvious that my risk assessment work on tribal lands was complicated by the troubled historical, cultural, and political relationship between Indigenous people and the US government, especially the failure to engage in meaningful participatory work, a process called "consultation" when it involves a formal participatory process between tribes and the US government (Biden Jr. 2022). Their ideas about the impact of a failure to meaningfully engage the public will be reflected in the challenges faced by American Indian governments that I discuss in Chapter 2.

The cases in Chapter 2, "Traffic Safety in Rural and Tribal Communities," reflect my experiences working on a federally sponsored project to develop the local transportation workforce and infrastructure in rural communities and tribal lands throughout the US. These experiences brought to my attention the difficulties of collecting and analyzing data that met the expectations of federal agencies. In the US, transportation safety—really any topic related to safety—is dominated by science and engineering, for many of the risks that humans face are related to things that we ourselves have done or made, and doing and making are dominated by human science, engineering, and technology. This is not a bad approach, for the machines that humans have developed to enable us to survive all manner of natural and anthropogenic threats can also be made and operated more safely when properly engineered. Through engineering, science, and technology, engineers and scientists can make machines safer and make them tolerate our very human attempts to use them unsafely: We can literally make machines more human-proof/stupidity-proof. The advantage of a scientific approach to addressing risk is that engineers can and do apply this science to engineer faults out of machines and systems, or at least reduce the effects of human mistakes. This is how we came to have seat belts in the first place ("Automobile Seat Belt Standards: Hearing, Eighty-Seventh Congress, Second Session, August 17, 1962" 1962).

The disadvantage of relying on science, technology, and engineering to assess and mitigate risks is that science, technology, and engineering demand very clear and precise understandings of problems. How did we know that we needed seat belts? As soon as motorized vehicles started traveling roads, humans started to be killed and injured by motor vehicle crashes (MVCs) (Robbins 2012; Offaly History 2007). In the first years, many likely attributed these deaths to fate and human folly (they were not wrong about the folly part) and perhaps only intuitively understood that making a human body go faster than a walk is more likely to cause injury when sudden deceleration happens. By 1962, whether determined through intuition or science, MVC related injuries and deaths drew enough attention for the United States House of Representatives to hold hearings on seat belt standards in automobiles ("Automobile Seat Belt Standards: Hearing, Eighty-Seventh Congress, Second Session, August 17, 1962" 1962). By 1972, fatalities on US roadways peaked at over 54,000, which is over 13,000 more than in 2020 even though there were 2.3 times more miles driven per year in 2020 than in 1972 (National Center for Statistics and Analysis 2022b). By the 1960s and 1970s, government statistics were certainly giving us more than enough data to understand that a problem existed, and the government decided that it needed to do something about it. As with many problems identified in the era of the space race, the solution was to apply science and engineering to the problem.

With a problem identified, the mighty automobile manufacturing industry of mid-twentieth century America was tasked with making cars safer, and government agencies worked on policies and designs to improve road safety. A focus on engineering solutions like better roads, seat belts, air bags, and many other incremental safety improvements began to help humans survive crashes, and both the number and rate of MVC fatalities decreased through 2011. They have been slowly rising again, albeit still at historically low rates per miles traveled (National Center for Statistics and Analysis 2022b). In addition to engineering solutions, government and industry looked for behavioral solutions to transportation safety—after all, the seat belt doesn't buckle itself (some did buckle themselves in the 1980s and 90s, but these were not very popular with drivers and were replaced with automatic air bags and seat belt laws). With behavioral solutions, technical and professional communication came back into play, for the technical communicators might be able to change minds and persuade drivers to buckle up, slow down, and avoid alcohol before driving.

Traffic-related injuries and fatalities are on the rise again, and traffic safety experts don't have a very good explanation of why. Cars and roads are safer than they've ever been, seat belt and car seat use is up, there are more police out patrolling the roads, drunk driving deaths are going down, and the rate of drunk drivers involved in crashes is down (National Center for Statistics and Analysis 2022b). This is when engineering and technical solutions begin to have difficulty: All the vital crash contributors are telling us that there should be fewer crashes with fewer injuries and fatalities, but the opposite is true. Paradoxically, MVC deaths significantly increased in the US in 2020 when the US and much of the world's population isolated at home for many months to protect themselves from the COVID19 pandemic. As in much of the world, streets and highways were literally empty of vehicles and people for many weeks in mid-2020, with the vehicle miles traveled (VMT) decreasing by approximately 12% compared to each of the three years before the pandemic. At the same time, fatal crashes increased 6.8% from 2019, increasing the deaths per 100 million VMT by 17.2% and accelerating the trend of increasing death rates per VMT since 2011 (National Center for Statistics and Analysis 2022b). The reasons for this significant jump in MVC-related deaths while fewer vehicles were on the roads were not clear at the time of publication. The answer, as with the answers sought elsewhere in this dissertation, might only be found through qualitative investigation. It would be very difficult to use only statistics to determine the causes of increased deaths and injuries at a time of improved safety technology and reduced miles traveled. We would have to ask drivers, law enforcement officers, and first responders what is likely causing this paradoxical increase in deaths from MVCs.

In my work trying to understand and solve these problems, I realized that traditional engineering and technical approaches to traffic safety and many other health and safety problems could only work to a point. When the traffic safety experts I worked with looked for places to apply engineering solutions, they were perplexed by a lack of information that could help them decide the what, where, why, and when to apply those solutions. In urban areas with high traffic volumes, crashes happen in relatively frequent, predictable patterns and places, allowing for quantitative analyses to identify problem spots. In rural and tribal areas, traffic volumes are low and few crashes are recorded, making it difficult to identify problems and prioritize resources based on the quantitative standard of counting past crashes, so other data are necessary.

Traffic safety and other risk assessment and mitigation experts do understand that different types of data can help us identify and understand problems, but I found that many of these experts didn't understand how to do this data collection and interpretation. These experts are predominantly engineers and scientists and may have little to no training in communications practices or basic ethnography. This is not surprising, because engineering education, and indeed all primary and secondary education is increasingly focused on science, technology, engineering, and mathematics (STEM) (Mohr-Schroeder, Cavalcanti, and Blyman 2015; Xie, Fang, and Shauman 2015; Green 2014; National Research Council et al. 2011). The popular understanding of what makes a good engineer also reflects STEM skills and an analytical approach to problem solving (Derbidge 2018; "Essential Civil Engineer Skills (With Tips for Improvement)" 2022; "Civil Engineer" 2023). Therefore, the modern engineer is both expected to quantitatively analyze problems and educated to do so.

As I studied the techniques and theories behind communications and social sciences and became more comfortable applying these to risk assessment and mitigation, I understood that I could also teach these techniques to the people I worked with and communities I served. Over time, I also understood that these skills apply to any area of risk assessment and mitigation and not just data-poor rural and tribal communities struggling to gather any resources to address health and safety problems.

Another problem associated with data collection, particularly for problems being addressed by public agencies, is that the data collection tools are also lacking good technical and professional communication design. These tools include the paper and digital forms where risk assessment data are collected in the field, and in the systems available to capture, store, and process these data. These forms include police, fire, and EMS reports, engineering assessment tools, and public works maintenance and construction documents.

Most of these tools are likely created by someone who thought it was a good idea to collect this information but was not necessarily literate in the best document design and data management concepts. The forms and data collection practices also don't always accommodate the reality of data collection in the field, where environmental conditions, time constraints, and the stress of responding to fires, car crashes, and medical emergencies reduces even expert communicators to people of few coherent words. In short, these systems are not necessarily made to meet the needs and capabilities of the audiences that will use them.

The need to broadly and efficiently understand and communicate about natural and anthropogenic dangers may be increasingly important as humans develop technologies that have increasingly broad impacts and consequences. In addition to the mundane health, social, and economic threats that we intentionally and accidentally impose on ourselves and others, scientists and engineers are not only thinking about, but actually deploying aircraft, motor vehicles, financial tools, weapons and other systems that can instantaneously, irreversibly, and fully autonomously impact human life. Automated and intelligent systems are driving us toward automated decision-making using data easily parsed by digital systems to help us make decisions about risk. There is no doubt that these systems can quickly and effortlessly process enormous amounts of data and solve problems that would be difficult or impossible for humans to even contemplate in a reasonable amount of time, if at all. Furthermore, these systems are also increasingly relied upon to autonomously make decisions that protect us, and, sometimes, may decide to harm us or someone else when making these decisions (Awad et al. 2020; Bigman and Gray 2020).

One of the problems with a decision-making process that increasingly relies on machine-manageable data is that decisions are often made with whatever machine-manageable data is available, even when that data is inadequate. Other times, which might be worse, decisions might not be made at all because evaluators have decided that there is not enough data to proceed. The decision processes also might not accommodate decision-making that is inconvenient for a machine or a machine-driven process, leading to disregard for or disrespect of alternative approaches. The result can lead to decision making without due consideration of the implications for all those affected: The answers achieved may be correct, but not for everyone involved.

If risk managers do not accommodate the opinions, concerns, and decision-making abilities of all those affected by a technologically driven risk assessment, risk communication, and mitigation process, then they can create problems greater than the direct impact of a single drunk driver or even several commercial airliners that fall from the sky. By insisting that risk analyses follow processes and protocols that may sideline citizens through design or circumstance, then risk managers can expect these same citizens that will be asked to change their behavior after the risk analysis is complete to be less than eager to do so. This may be due to a perceived lack of respect for their opinions, simple misunderstandings of language, or more complex social factors that lead citizens to resist external authority actively or passively. The entire point of the risk analysis and mitigation process can become an exercise in futility and make those affected ignore or even undermine well-designed mitigation measures.

How do we further improve our decision-making capacity in questions regarding risk while embedded in a society with a strong rational and technological imperative? I posit that we have readily available tools and practices that can improve risk assessment and mitigation, and that using these approaches can more fully complete the full understanding of risk. These approaches are not new, and the data collected is not invisible, but our standards for using this data have been either forgotten or discounted. The approaches are uniquely human and perhaps uniquely capable of solving both human behavior problems as well as technical problems that affect humans. These approaches also seek to maximize consideration and inclusion of non-expert opinions, underrepresented expertise, and alternative solutions.

These approaches lie in the realm of humanities and social sciences and are commonly used to search for and collect data that is not readily interpreted through digital processes. They are based in ethnography and rhetoric, which lend themselves to low-cost, low-technology collection and processing that are easily taught and used without involving the technological imperative of quantifiable datasets. These human-centric processes of telling stories, observing our surroundings, listening, writing, and reading can provide us with rich datasets to solve seemingly inexorable problems. By re-evaluating vexing problems with an eagerness to broaden our interpretation and potential solution of a problem, rather than narrow it to as discrete a problem and solution as possible, we might make faster progress toward a more humane society for all of humanity and the non-human world.

Many of my arguments focus on the inclusion of under-valued opinions as data so that we can establish or enhance an understanding of risk. This provides data where none may have existed or been recognized, contributing to expert decision making where it may have been difficult or impossible before. These arguments are closely related to participatory design and work collecting data for transportation projects by Kristin Moore and Timothy Elliott, who noted that "numeric data can obscure other important types of knowledge created through narratives and experiential knowledge sharing, thus losing the strength of participatory design" (2016, 61). This conflict between numeric data generated and demanded by experts and qualitative data available but undervalued is central to the challenges discussed in Chapter 2 and 3.

There is also a more nuanced and more powerful impact of this consideration of non-expert data. What is happening when a tribe or small community is empowered to evaluate and prioritize risks faced by the citizens who live there? The most immediate impact of local risk assessment and mitigation is that those directly affected are directly addressing a problem. A longer-term impact is that the people involved in such a direct risk assessment learn to do this kind of work and can do it again and again. They are literally empowered to make decisions that impact their own lives, health, and destinies. But this power does more than improve future risk assessments, it can *usefully* empower communities by demonstrating that decisions *can* be made using local knowledge and resources.

When a community relies on visiting experts to help them do anything, they are relinquishing some amount of power to make that decision themselves. This process of inviting an outside expert to help make decisions might impart some skills to locals, but visiting experts are probably not focused on helping impart those skills. They are paid to go into a community, wield their expertise, and move on to the next project as quickly and efficiently as possible. In fact, the visiting expert has an explicit motivation for not imparting knowledge to others so that they can protect their own valuable knowledge resources for future sale. Why teach someone to fish when you can sell them more fish?

Tribal governments and Indigenous people in the US have been subject to federal oversight and management ever since the federal government began making treaties with Indigenous people that promised to assume responsibility for health and welfare in exchange for land and peace. These treaties were made both willingly and by force, and were often ignored or violated by the federal government ("Sioux Treaty of 1868" 2016; Landry 2018; "Milestones: 1830–1860 - Office of the Historian" n.d.; Cutlip 2018). This process surrendered some or all of a tribe's sovereignty and power of self-determination in exchange for survival: Tribes explicitly surrendered the power to make some decisions so that they could continue to exist. It is therefore no wonder that a tribe depends on the federal government to send experts and money to solve local problems, after all, federal trust responsibilities still require it ("American Indians and Alaska Natives - The Trust Responsibility" n.d.).

When a group decides to take matters into their own hands, they are learning to wield autonomy and power. For tribes, taking matters into their own hands not only empowers them to solve their own problems, but it demonstrates that they can do so. This process builds trust between the tribal government and its people while simultaneously establishing the tribe as an authoritative actor. Such actions are tangible demonstrations of sovereignty and self-determination, which is important for any government, especially those with a history of having their sovereignty questioned.

Each tribe is an independent government representing its people. These governments and their people have fought for generations for their very existence. Without sovereignty and self-determination, the tribe and its people may cease to exist by being assimilated into the dominant culture and even genetic pool of non-native America. Today, the federal government expects tribes to assume responsibility for their affairs and, at least superficially, encourages them to do so. However, the federal government also continues to insist that the federal government has the expertise and resources to improve conditions for tribal people. They do this by imposing laws and regulations on tribes and also by enculturating tribes into the federal way of doing business. The federal way of doing business insists on "hard" data to make decisions, and in traffic safety, that hard data is called crash reports (a large part of this dissertation will examine problems of crash report data). In summary, by insisting on "hard" data in the form of crash reports to substantiate a need for addressing traffic safety mitigation efforts, tribal and rural communities will always be disadvantaged when competing for resources with metropolitan, state, and even county governments. This leads to the problem our society currently faces: Rural and tribal people die more often in MVCs.

I do not think that it is a stretch to say that a tribe that identifies traffic safety problems, proposes solutions, allocates resources, and makes safety improvements all on its own will be a stronger, more independent tribe. They will be seen by both their own people and the federal government as a competent and independent actor that is worthy of peer-level cooperation with state and federal governments. In fact, I believe that traffic safety problems and a poor state of transportation infrastructure are some of the most visible symptoms of poor government, yet these problems may be some of the easiest to fix with the right data and knowledge. There is a huge range of low-cost safety improvements that even the poorest governments can implement, and they tend to be things like signs, line painting, lighting, and traffic enforcement that people can see with their own eyes every day.

Addressing problems identified by locals also builds trust within communities, between citizens and their governments, and in government policy. Social groups form and connect through a shared sense of identity, culture, worldview, and beliefs. Trust helps maintain these connections and lack of trust separates social groups internally and externally. In the negotiation of understandings about risk, interpersonal and institutional trust is a critical value for helping groups build consensus about risks and react to a perceived threat. Social scientists Wildavsky and Dake identified trust in institutions, business, and government as more important to individuals and groups when making decisions about risky behavior than the information about the dangers of a potential risk (Wildavsky and Dake 1990). In a study of an aboriginal Metis settlement in Canada, Christianson et al. identified trust between group members as a critical factor in decisions about preparing for wildfire risks, and indicated that a distrust of outsiders could interfere with acceptance of information or programs presented by external groups (Wissenberg et al. 2013).

This concept of identifying problems and addressing them as a means of demonstrating competence, establishing self-worth and self-determination, and reinforcing independence obviously applies well beyond tribal politics in the US. Any group that can competently identify and resolve their own community's problems will be more respected, more trusted, and more powerful than a group that fails to help themselves by design or circumstances. These groups will also garner more resources and earn political capital for use in future endeavors. Problem solving also builds and unites communities through common efforts.

1.2 Document Overview

This dissertation will look at the ways that risk-related data is collected, analyzed, and communicated and consider the implications for current practices and proposed changes to risk-management. I use several cases from my own experience and others based on publicly available information.

The first cases in Chapter 2, "Traffic Safety in Rural and Tribal Communities," are based on my experience identifying and mitigating traffic safety problems in small communities. This introduces the reader to the methods used to collect risk-related data and to the problems associated with a focus on quantitative data for risk management. I also explore the implications of failing to collect the data, implications which go beyond the high cost in human lives and involve political and social challenges of Indigenous people in the US. I end the chapter by critically evaluating the problems associated with failing to address traffic safety in tribal and rural communities and make proposals on how and why to value qualitative data and local citizen input.

In Chapter 3, "Data Collection Practices in Public Safety," I examine my personal experience collecting and processing data as an EMT and firefighter. This experience highlights the problems associated with systems that are not user-centered and makes suggestions on how to improve these systems using practices common in TPC – usability testing and critical literacy training.

Chapter 4, "Opportunities for Expanding Rhetorical Risk Assessment, Communication, and Mitigation Methods – The Boeing 737 MAX Case," analyzes several cases of aerospace catastrophes through the critical lens of rhetorical risk assessments. I use public documents as the primary sources for these cases to identify patterns of quantitative imperatives leading to disaster and suggest that a return to the art of risk assessment could help avoid these types of disasters. I also introduce the concepts of what

I call risk-friendly and risk-averse systems to describe current and potential future approaches to risk management.

Chapter 5, “Conclusion,” summarizes this work and proposes future study and cases using the methods and theories described throughout this dissertation. I also reflect on how risk literacy can impact individual lives in ways beyond protection from imminent life threats.

Overall, the results of this study call attention to the weaknesses resulting from a quantitative imperative in risk management and a proposal for renewed focus on risk assessment using rhetorical practices and qualitative data readily available from expert and non-expert perspectives.

2 Traffic Safety in Rural and Tribal Communities

2.1 Position Statement Regarding Topics Related to Tribal Communities and Peoples

This chapter is based on my own experiences living and working in the communities I discuss, including work in American Indian and Alaska Native communities. I worked as a staff researcher and program director in a civil engineering department at a US university on projects funded by the United States Department of Transportation (USDOT), which was not inherently academic or research work in the traditional sense, but rather more like engineering consulting and workforce development. These projects sent me to rural and tribal communities throughout the US where I helped transfer and develop knowledge and skills among the local transportation workers and agencies. However, I did not grow up in an Indigenous culture, I do not have any known American Indian or Alaska Native heritage, and I have never lived on a reservation. I am a white male who grew up in a solidly middle-class family in rural areas of the upper Midwest of the USA, and my perspective will clearly be influenced by this position of privilege.

Although my perspective on native cultures will always be from the outside, I have collaborated with American Indians and Alaska Natives for over 20 years to address educational, technical, and social needs. Working for the Tribal Technical Assistance Program (TTAP), a program sponsored by the USDOT's Federal Highway Administration (FHWA), I navigated the attitudes and systems that continue to contribute to challenges and opportunities for American Indians and Alaska Natives on and off the reservation. This gave me the wonderful opportunity to learn about the heritage and difficult historical and social circumstances of Indigenous people in the Americas. These experiences made me want to go beyond my role managing a federal program that helps tribes develop and maintain transportation infrastructure, leading to my studies and this body of work. I hope that my perspective and the work related to this dissertation will improve lives for all people everywhere without perpetuating the arrogant mistakes of outsiders who think that they are helping when in fact they might be doing more harm than good. Although the cases are related to my work with tribes, the lessons learned apply to any groups attempting to assess and mitigate risks, especially if those groups have limited technical, financial, and political capital.

2.2 A Very Limited and Very Brief Introduction to the Relationship Between Tribes and Other Governments in the United States

The cases described in this chapter are linked to historical and cultural factors that have contributed to the current relationships between local, state, tribal, and federal governments and agencies in the US. By describing historical and current practices and experience, the reader may begin to understand some of the challenges that AI/AN people face as they seek to solve social, economic, natural, and technological problems of many types in Indian Country,[1] and also serve as a case study for the impact of power relationships between any groups when deciding how to value expertise and authority.

Before Europeans came to what is now called North and South America, there were of course many nations throughout the Americas with their own citizens, rules, policies, procedures, customs, and beliefs. These Indigenous nations formed unions, made agreements, had disputes, and behaved as the independent governments that they were. Soon after Europeans arrived, the Indigenous nations recognized the need to make formal agreements with the newcomers to avoid conflicts and forge social, economic, and political relationships for mutual benefit (*Tribal Nations and the United States: An Introduction* 2020). When these agreements occur between governments, they are called treaties. Through these and other treaties, governments recognize each other's existence, establish rules for collaboration and separation, and validate the sovereignty of each party of the treaty. Treaties can't be made between non-governmental entities. These treaties were made between the European governments and Indigenous governments, and eventually, between the United States government and tribal governments.

[1] I use the term "Indian Country" in the same way as the US federal government, many AI/AN people, and the National Congress of American Indians (NCAI), which describes itself as "the oldest, largest and most representative American Indian and Alaska Native organization serving the broad interests of tribal governments and communities" ("Home | NCAI" n.d.): "What is the difference between 'Indian country' and 'Indian Country'? 'Indian country' is the term for the area over which the federal government and tribal nations exercise primary jurisdiction. It is a term with a distinct meaning in legal and policy contexts. 'Indian Country' (both words capitalized) is a broader term used to refer more generally to tribal governments, Native communities, cultures, and peoples." (*Tribal Nations and the United States: An Introduction* 2020, 28)

Treaties don't just go away; they remain in force so long as the sovereign governments agree to abide by them, and even if they don't always abide, the treaty remains until both sides agree to change or eliminate it. Throughout the Americas, Indigenous nations continue to exist as sovereign nations in part because they maintain intergovernmental agreements with their neighbors. The US government maintains treaty relationships with at least 574 (as of February 2020) Indigenous nations, providing them with rights established under those treaties and recognizing the right of these sovereign tribal nations to make decisions and be responsible for their own citizens. This is why tribal nations in the USA continue to have different rules and rights than states and why tribal nations work directly with the US federal government rather than with states on many issues.

The US government, states, local governments, and individuals have violated treaties between the US and tribal governments, and continue to do so. Legal battles between states and tribes continue, and even armed conflicts over treaty rights have occurred in living memory, such as those between tribal and non-tribal anglers in Wisconsin (Vaisvilas n.d.) and Washington state (Pailthorp 2020). These conflicts occur because individual non-tribal people and entire local, state, and federal agencies do not understand or don't agree with treaty rights, so they feel that they can abrogate centuries of legal precedent between sovereign governments. Of course, these are minor conflicts compared to colonial and genocidal practices that nearly wiped-out Indigenous populations throughout the Americas (Prucha 2000; Edwards and Kelton 2020; Madley 2016; Newland

2022), so it is no wonder that many tribes and tribal people have little trust in local, state, and federal government.

Nevertheless, because of these treaties, tribes do work directly with the federal government in areas like transportation, healthcare, and law enforcement, just like states do. The federal government collects taxes on the states' and tribes' behalf and then distributes some of this money to these governments to build and support a transportation system shared by everyone. The fact that the federal government has direct agreements with tribal nations in areas like transportation is a continuing validation of tribal sovereignty. Because of this sovereignty, and as with states, tribes can make decisions about how to use that money to best benefit their citizens and communities. For tribes and for states, exercising the right to decide what happens in their own jurisdictions is an exercise of sovereignty and self-determination. For tribes, this sovereignty is essential to making decisions for their citizens as they see fit and contributes to their continued existence as tribal nations. The problems discussed in this chapter are intrinsically linked to issues of sovereignty and self-determination, making these problems more than risk and safety problems; they are also problems of social justice, human rights, and politics.

2.3 A Traffic Safety Problem in Rural and Tribal Areas

Motor vehicle transportation systems are planned, designed, run, and operated by humans, and we can only expect that humans will be one of the biggest problems with these systems. The following statistics from 2020 reflect a recent reversal in traffic safety performance improvements in the USA, leading to 38,824 traffic fatalities, the highest number of traffic fatalities since 2007 (Stewart 2022). This increase in fatalities occurred even as 2020 and 2021 saw a pandemic-related decrease in vehicle miles traveled compared to 2019.[2]

- *Traffic fatalities increased by 6.8% over 2019.*
- *Alcohol-impaired driver fatalities accounted for 21% of all crashes – 8,643 for 2020*
- *The number of fatalities among unrestrained passengers (those not wearing seatbelts) increased 14% in 2020*
- *Fatalities among drivers aged 15-20 increased by 14% to 4,405.*
- *Distracted driving was reported in crashes that killed 3,142 people (8.1% of all fatalities) in 2020.*
- *In 2020 there were 11,258 people who died in speeding-related crashes (29% of all fatalities).*

[2] A worldwide pandemic led to a decrease in travel by all modes in 2020 and 2021, with a near complete stop in travel for several weeks in 2020. The number of vehicle miles traveled returned to pre-pandemic levels by early 2022 ("Travel Trends - March 2022 - Policy | Federal Highway Administration" n.d.).

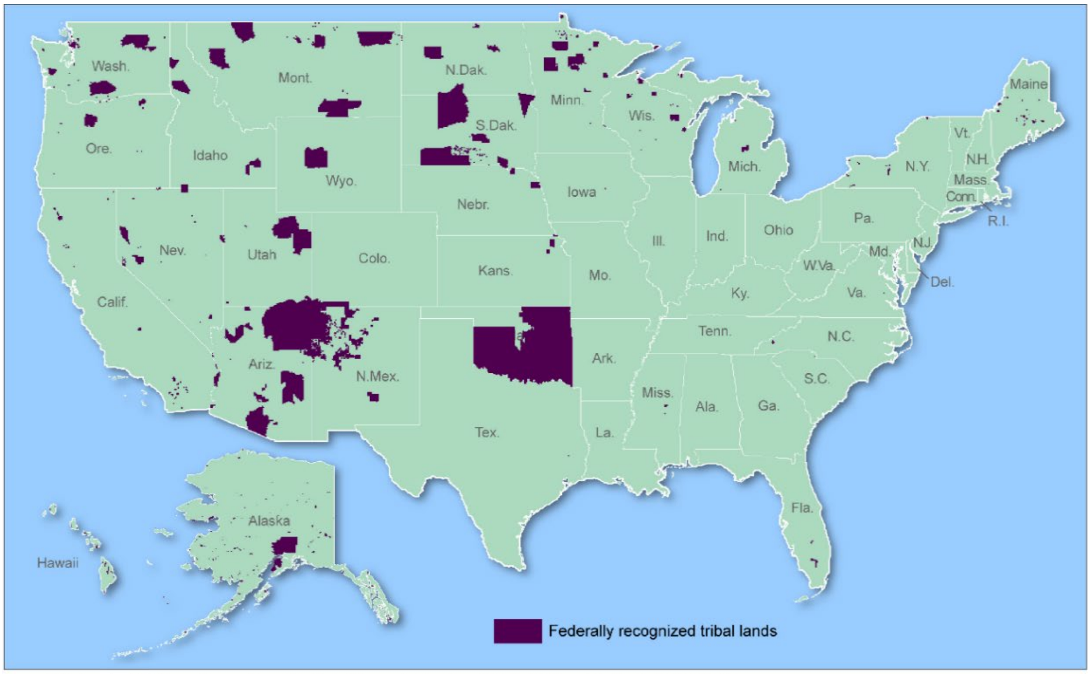
- *The rate of fatalities in rural areas is nearly 60% greater than in urban areas, and increased 11% compared to 2019 (National Center for Statistics and Analysis 2022b)*

Traffic safety experts know why most crashes occur: Traffic safety researchers have identified "human factors" as the contributing factor in 95% of crashes, along with road environment (e.g. weather conditions and road design), and vehicle factors (e.g. tire or brake failure) (Herbel et al. 2010; "'Road Whys' Speeding Module Presenter's Booklet 'Regret Is Such a Short Distance'" 1996). The fact that humans are the major contributing factor to MVT crashes in the USA should not be surprising, considering how remarkably resistant humans are to rational behavior, particularly while driving.

Despite the widely acknowledged fact that behavior is nearly the entire reason for vehicle crashes, safety resources and research remain focused on engineering and construction solutions to safety problems: The entire 2016 budget of $2.2 billion for the US Highway Safety Improvement Program (HSIP) was *prohibited* from being used for educational or behavioral activities (American Road and Transportation Builders Association (ARTBA) 2015). To be fair, all design, engineering and construction activities include major elements of behavior-related improvements (examples include signing, marking, rumble strips, traffic calming, and road designs that reflect human capabilities to safely navigate roads in all weather and at reasonable speeds), but *prohibiting* allocation of

HSIP monies to 95% of the problem reflects a remarkably poor understanding of the underlying reasons for and likely solutions to nearly all crashes.

According to data collected by the National Highway Transportation Safety Board, traffic safety experts know that motor vehicle traffic (MVT) crashes disproportionately affect rural and tribal areas of the United States ("Tribal Road Safety: Get the Facts | Transportation Safety | Injury Center | CDC" 2021; National Center for Statistics and Analysis 2022a). Figure 1 shows American Indian/Native Alaska lands (shaded in purple) in the USA ("BROADBAND INTERNET - FCC's Data Overstate Access on Tribal Lands" 2018), and Figure 2 shows data from the Centers for Disease Control (CDC), locating deaths by MVT per 100,000 people in the USA, as identified by the county where the death occurred ("2011-2020 MVT Deaths per 100k" 2023).



Source: GAO, based on U.S. Census Bureau data and the Federal Communications Commission's definition of tribal lands. | GAO-18-630

Figure 1: American Indian/Alaska Native Lands (Shaded In Purple) ("BROADBAND INTERNET - FCC's Data Overstate Access on Tribal Lands" 2018, 7)

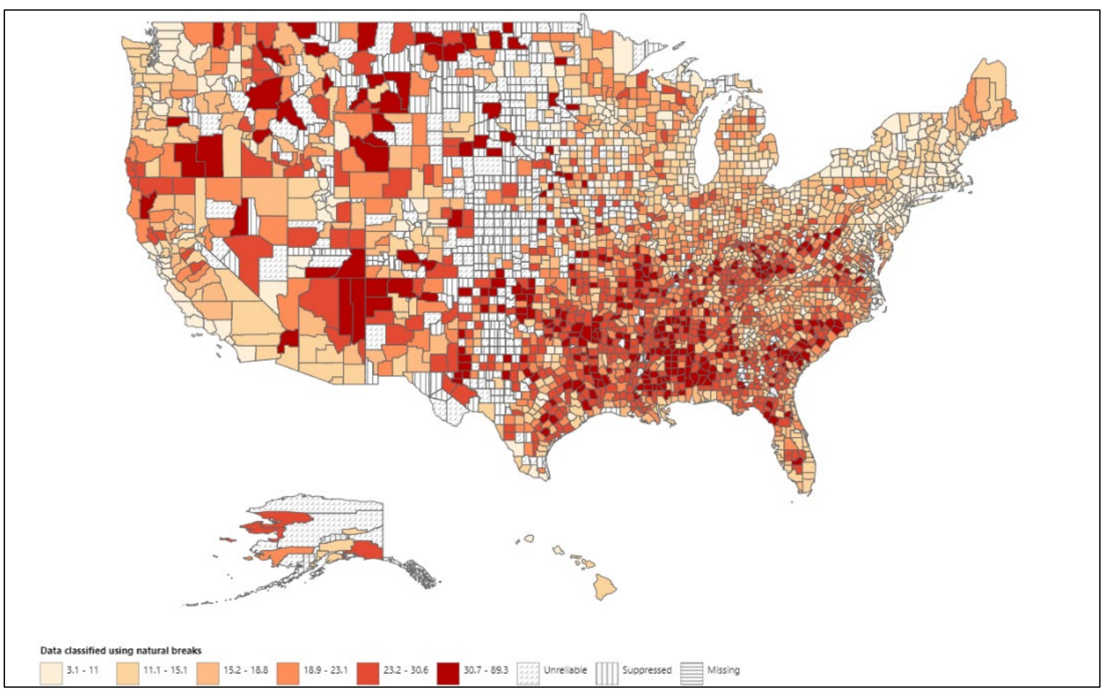


Figure 2: Death Rates By Motor Vehicle Traffic Per 100,000, Located By County 2011-2020 ("2011-2020 MVT Deaths per 100k" 2023)

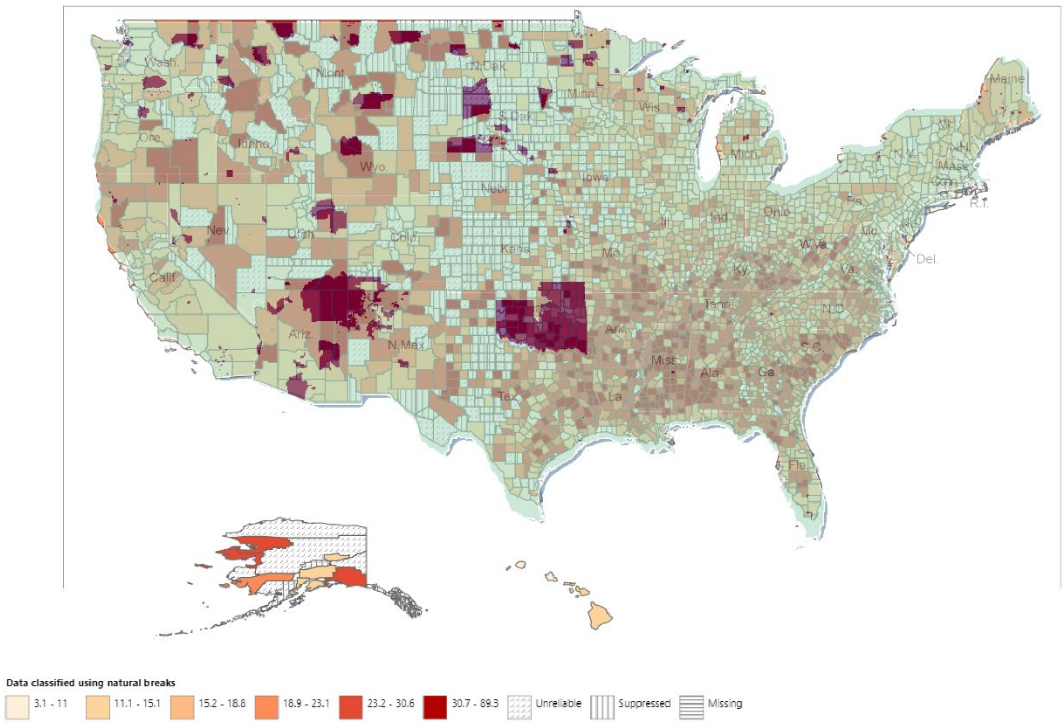


Figure 3: Tribal Lands Superimposed over MVT Deaths per 100k Population (Alaska and Hawaii are not shown in the overlay due to map projection differences)

The correlation between rural and tribal areas and death rates by MVT is clearly visible when Figure 1 and Figure 2 are superimposed in Figure 3. Research by epidemiologists (Murphy et al. 2014) provides further evidence of the concentration of MVT fatalities in tribal lands: From 1990-2009, American Indian/Alaska Natives (AI/AN) died from motor vehicle traffic at three times the rate of whites, and for pedestrians killed by MVT, AI/AN died at over five times the rate of whites for all ages, and at nearly eight times the rate of whites in the 25-34 age group. We can thank engineers, statisticians, and other scientists for collecting this very important data, but although we know who is dying, we don't know exactly where and why: On AI/AN lands, data collection by state agencies may be complicated by multiple jurisdictions, lack of local resources, and other social or political barriers, which can limit the quantity and quality of MVT crash data collection (P. Quick and Bailey 2007). In other words, there is a failure to collect or understand data about where and when crashes occur in the areas where they occur at the highest rates. Traffic safety professionals know this, yet their response is to demand data on where crashes and injuries occur in order to fund safety programs in those areas, and those programs often involve very costly construction and engineering solutions.

Traffic safety researchers from both inside and outside science and engineering (S&E) fields have published volumes of studies on human behavior, human performance, and human failures, and used this data to compile the best information available on designing and constructing safer roads. However, the human side of traffic safety is often focused on the human machine rather than the social, political, and emotional impact of humans on traffic safety. The 319 page *The National Cooperative Highway Research Project (NCHRP) Number 600: Human Factors Guidelines for Road Systems (HFG)* addresses human factors in road design, ensuring that humans understand and can usually safely navigate the entire road network:

> *The HFG is a new roadway design resource that provides data and insights from the scientific literature on the needs, capabilities, and limitations of road users, including perception and effects of visual demands, cognition*

and influence of expectancies on driving behavior, and individual differences including age and other factors (Campbell et al. 2012, V).

The traffic safety community is clearly aware of human contributions to safety problems, yet their ideas for addressing the problems of human behavior lean toward humans as machines. The traffic safety experts, including those who authored the HFG, have analyzed and identified human-related safety issues by analyzing large groups of humans performing driving tasks, and used these analyses to design safer vehicles, safer roads, and better rules for ensuring that most commutes end the same every day, with drivers and passengers safely reaching their destinations, but this is not the same as determining why humans don't buckle up and continue to look at their cell phones while driving.

The HFG has analyzed human *factors,* which include physiological, psychological, and other human performance metrics that can be measured with instrumentation, quantified, and accounted for in road design (Campbell et al. 2012). These factors lead designers to making road signs with large, white text on dark green backgrounds (much more legible at high speed and at night), and making curves on fast roads with larger radii and greater superelevation (tilted road that assists a driver in overcoming lateral acceleration) than curves on slow roads. Through these types of recommendations, the HFG offers road safety experts with exactly what it was designed to do:

> *The purpose of Human Factors Guidelines for Road Systems (HFG) is to provide the best factual information and insight on the characteristics of road users to facilitate safe roadway design and operational decisions (Campbell et al. 2012, 1–1).*

> *The Human Factors Guidelines for Road Systems is intended to provide human factors principles and findings to the highway designer and traffic engineer. It will allow the non-expert in human factors to more effectively bring consideration of the road user's capabilities and limitations into the practice of design, operations, and safety (Campbell et al. 2012, 1–1).*

Unfortunately for these analytical studies and the HFG, no two humans are perfectly identical in all aspects, and even though individual people generally have similar performance *characteristics*, even identical twins behave differently on similar roads, particularly when one has had "just two beers" and is texting his buddy to find the next watering hole, and the other is firmly grasping the steering wheel at nine and three with plenty of sleep last night, both eyes on the road, and the cell phone turned off. In addition to humans occasionally (usually?) behaving poorly and always differently from each other, they don't always congregate in places where data is readily collected and analyzed. In populated, affluent areas, humans provide a rich pool of data that is statistically significant and easy for nearby government researchers to collect. In rural, poor, and tribal areas, humans spread out, avoid the government, and rarely offer statistically significant numbers of data points.

If the HFG is doing what it is supposed to do, and it's doing it very well, then what is it leaving out? The HFG addresses "factual information" (Campbell et al. 2012, 1–1) about behavior as a function of physiological capabilities, but it does not address the social, cultural, and emotional side of humanity. It calls for the engineer to design and build for the road user—"There is great value in bringing road users' needs, capabilities, and limitations into roadway design and traffic engineering" (Campbell et al. 2012, VI)—even as it tells the engineer that the user must understand what the designer and engineer wants from them: "The purpose of this chapter is to remind users of the HFG that road users must read and comprehend from the roadway what the highway designer and traffic engineer intend for them to do" (Campbell et al. 2012, 3–1). The HFG is a guide for engineers to consider the proper functioning of the human machine, but it is not a guide to human behavior. To summarize, the HFG skips most of the social sciences and humanities, or, as engineers have identified, it skips 95% of the problem.

One of the problems with the HFG is that by being such an expert volume with such good data, advice, guidance, and instruction, it leads many in the safety community and the government to believe that the human side of things has been taken care of through the very existence of a guidebook with "human" in its name. It focuses the attention of the safety community on those things that some experts have been able to measure in human behavior, but in the process, it leaves out the people, ideas, and solutions that might not be so easily measured and quantified. By using the analytical language of engineering and statistics, it leaves little room for the qualitative aspects of the human condition. Yes, my eyes can be monitored to determine where I am looking as I approach an intersection with pedestrians nearby, but how do I feel about safety officials and activities in my community, and do I see them as helping me, or simply continuing historical injustices?

The HFG and other design guides tell engineers and designers what designs are likely to perform more safely. For the HFG, this is implicit – the research which led to the HFG showed that if signs are too small, then people don't see them in time to react to the curve that can kill them. Other guides, such as the excellent *Highway Safety Manual,* tell us to look directly for the body count to decide when and how to make improvements:

> *"The Highway Safety Manual (HSM) is a resource that provides safety knowledge and tools in a useful form to facilitate improved decision making based on safety performance. The focus of the HSM is to provide quantitative information for decision making. The HSM assembles currently available information and methodologies on* ***measuring, estimating and evaluating roadways in terms of crash frequency (number of crashes per year) and crash severity (level of injuries due to crashes)*** *(National Research Council (U. S.). Transportation Research Board. Task Force on Development of the Highway Safety Manual, American Association of State Highway and Transportation Officials. Joint Task Force*

on the Highway Safety Manual, and National Cooperative Highway Research Program 2010, xxiii). [Emphasis mine]

What these guides tell us is that if people are dying and injured, then the road is not meeting safety expectations. This also implicitly tells us that the more people dying and injured, the more money the government will commit to solving the problem. So, unless there are records to prove that a particular intersection (or at least a very similar one) is "underperforming" from a safety perspective, then you can forget about money to build a roundabout.

Traffic safety in rural and tribal areas is treated the same as traffic safety anywhere else in the US: Various data collection practices provide the information to rank priorities for improving traffic safety. Such a uniform approach provides governments and their constituents with fair and objective risk assessments and subsequent allocation of resources to make improvements where they are most needed. In theory, this means that most dangerous locations will receive the most attention from traffic safety professionals. In practice, the highest rates of people die and are injured in motor vehicle crashes in locations that receive the least resources:

- The fatality rate for American Indian and Alaska Native adults age 20 years or older is two times greater than for non-Hispanic White persons ("Tribal Road Safety: Get the Facts | Transportation Safety | Injury Center | CDC" 2021).

- There are approximately 157,000 miles of roads in the US National Tribal Transportation Facility Inventory (NTTFI), which represents approximately 3.8% of the US road network ("Operation and Maintenance | Indian Affairs" n.d.).
- In 2019, tribes received approximately $495 million to support the NTTFI, or 1% of the $47.8 billion in federal transportation funding for FY2019 ("Office of Tribal Transportation | FHWA" n.d.).

2.4 A Traffic Safety Case in a Rural Tribal Community

In a perfect world, every crash would be reported and evaluated for opportunities to improve traffic safety. Because rural and tribal areas have the highest rates of MVC deaths and injuries, there should be plenty of data to substantiate significant investments in traffic safety. However, in our imperfect world, rural and tribal areas receive fewer resources than more populous areas because there is little data supporting traffic risk mitigation. The reasons for a lack of data to make risk assessments and subsequent investments in risk mitigation are the subject of my investigation. Based on this research, I will propose solutions that may resolve this problem.

Based on my experience, I consider the case of the Keweenaw Bay Indian Community (KBIC), a small tribe in northern Michigan that occupies only a few thousand acres. The tribal lands are interspersed with non-tribal lands. The broader community includes both American Indian and non-Indigenous populations with similar socio-economic statuses. Neighboring communities are predominantly non-Indigenous and of similar geography, population size and density, and socio-economic status. United States Highway 41, the only federal highway within 50 miles, passes through these communities and carries local and transient traffic in increasing density. As a typical two-lane rural highway, this roadway presents the same traffic safety problems as nearly every other rural road in the nation: Speeding, impaired driving, low seatbelt and car seat use, low intensity enforcement, poor maintenance, distracted driving, and an aging vehicle stock (Raymond 2022). The majority of crashes involve single vehicles that run off the road, and the most severe crashes involve head-on collisions as well as roadway departures (Raymond 2022; National Center for Statistics and Analysis 2022a; National Safety Council 2022). Increasingly, pedestrians are being struck and killed, which may be linked to distracted driving, increased use of roadways by pedestrian traffic, distracted walking, and increased traffic density (Macek 2022). Nationally, AI/AN drivers face death and injury rates up to 3x the rate of the general population, and AI/AN pedestrians are dying at two times the rate ("Tribal Road Safety: Get the Facts | Transportation Safety | Injury Center | CDC" 2021; K. Quick and Narváez 2018). KBIC members are rightfully concerned about traffic safety on the busiest road that runs across tribal lands (*The Mining Journal* 2016; *The Daily Mining Gazette* 2016a; *The Daily Mining Gazette* 2016c).

Communities north and south of the Keweenaw Bay Indian Community are also concerned about the busy highway. These towns have population and business densities along the US41 corridor that are similar to each other and the KBIC. They face similar weather conditions, maintenance practices, and have the same law enforcement patrolling this highway. The non-tribal towns north and south of the KBIC also worry about their citizens and have speed limits of 35MPH and 45MPH to help improve traffic safety in their towns. The speed limit through the KBIC is 55mph, and a traffic study showed that the average travel speed exceeds 60mph (*The Daily Mining Gazette* 2016b). The KBIC asked the state to lower the speed limit because they also worry about their citizens, and even placed speed limit signs on the stretch of road, which the state subsequently removed (Anderson 2016). While the state was adamant about their jurisdictional and legal authority to determine how and when speed limits were set, tribal officials were adamant that they and their citizens did not feel safe and took action to address those concerns (*The Mining Journal* 2016; *The Daily Mining Gazette* 2016a; *The Daily Mining Gazette* 2016c).

The process for changing speed limits in Michigan is similar to most other states: The state will review crash data and the speeds at which drivers currently use the roads. When there is no high concentration of MVCs, the state will focus on current speed patterns. DOT officials will collect traffic speed data to establish an average and then set the speed at the 85th percentile of the average. This could mean that a speed limit might be *raised* if the 85th percentile exceeds the current speed limit. There are some additional criteria such as crash frequency, road geometry, driveway density, proximity to schools, and other factors that may override a speed study, but speed studies are the favored method to establish speeds in Michigan. Methods of deciding speed limits should not include community concerns about high speeds, pedestrians' concerns about safety, noise, or any other factor that is not based on quantifiable data such as the 85th percentile or numbers of crashes ("Speed Limits" n.d.). So, to change a speed limit, the community must collect data about crashes or current speed patterns, but how do you do that if the data that you have is not recognized as appropriate for adjusting speed limits, or if the data that does exist does not reflect the community's concerns?

2.5 Where the Data Is (and Isn't)

Data is essential to understanding risk in rural and tribal communities. If a statistician identifies a number of crashes involving older drivers that is greater than the average number of crashes for that age group at a specific intersection, then she can point out that anomaly to an engineer. The engineer can evaluate the intersection design and construction and determine whether most of the drivers should be able to safely navigate that intersection most of the time. If the intersection meets the specifications, then there may be a problem of unusual traffic patterns, weather conditions, or poor maintenance practices. What is the solution in this situation? For the engineer, the solution will probably involve an increase in the margin of safety with turning lanes or signals to make it even more likely that most of the drivers will successfully navigate that intersection most of the time, or if the design is impossible or too expensive to change, then she might consult with the local sheriff to find out if the older drivers have been enjoying one too many refreshments during senior night at the local restaurant, and ask him to increase patrols to see if the seniors are in a particularly big hurry to make it to their social engagements.

What if the problem persists? We can expect an ever-increasing concentration of engineering and law enforcement activities on that intersection, perhaps culminating in the intersection being changed to a roundabout, the sheriff permanently posting a patrol car, or other reactive responses.

What if the statistician only discovered that an unusually large number of older drivers in a certain region were dying in crashes, but didn't have the information necessary to identify a specific road, much less a specific intersection? In this case, the traffic safety engineers will struggle with a solution because there is inadequate data to help them determine where to apply effective traffic safety measures: When the available data is inconclusive as to where and when problems are happening, then it is difficult to decide whether and where to apply scarce traffic safety resources. The lack of data does not mean that there isn't a problem, it just means that engineers cannot narrow down the focus enough to decide what to do.

2.6 No Data, No Problem

In risk analyses and risk communication, risk managers seek to determine what factors contribute to what levels of increased or reduced risk and attempt to communicate that information to experts and non-experts. Analyzing risk usually engages a quantitative assessment based on past experiences to identify those factors which increase or decrease risk, and communicating risk often revolves around helping those potentially affected to understand data risk factors. Through this interpretation of data and education of those affected, risk communicators hope to modify human behavior to decrease the risk of sickness, injury and death. In the analysis and understanding of MVC injuries and fatalities, risk managers use risk analyses to identify specific factors that increase or decrease the possibility of crashing, becoming injured, and dying due to motor vehicles, and attempt to communicate those factors to engineers, politicians, and road users to improve road safety and driving behavior.

The US government works with tribal, state, and local agencies to address traffic safety problems at macro and micro levels. Using funds generated by the national fuel tax, the USDOT funds research, planning, development, and action by all levels of public and private agencies to address the 38,824 fatalities and 2.3 million injuries caused annually by MVCs (National Center for Statistics and Analysis 2022b). In the case of tribal governments, the USDOT funds research, planning, and development of safer roads through the Tribal Transportation Program (TTP) and other federal transportation programs, which are also paid for by payments into the federal Highway Trust Fund through vehicle fuel taxes.[3]

As part of a nationwide effort to reduce the startling statistics on MVC injuries and deaths among American Indians and Alaska Natives, the US government promotes proven safety assessment and improvement methods in Indian Country. One of the processes used

[3] Some funding comes from other sources, including a tribe's own funds generated through economic activities on tribal lands, bonds, tribal taxes and levies, state funds, and/or in cooperation with non-tribal agencies. A completely separate topic of research and exploration is what the implications are for electric, hybrid, and other alternative fuel vehicles that do not pay into the Highway Trust Fund through fuel taxes, and therefore do not contribute to road construction and maintenance of tribal roads, but are nevertheless free to use these public transportation facilities.

by road safety experts to identify and reduce roadway risk is to conduct road safety audits (RSA) and safety planning. An RSA is defined as a "formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users." ("Road Safety Audits (RSA) - Safety | Federal Highway Administration" n.d.). This process has been standardized through federally guided educational and advisory activities. RSAs should help us quantify and systematize resource allocation to meet the most critical safety improvement needs. These activities are led by tribal, federal, state, or local transportation safety experts, or by other public and private experts funded through transportation projects.

The RSA process can be initiated at will by local authorities or it may be mandated based on a number of crashes or as standard policy for certain projects. The RSA team will use data collected by law enforcement, road maintenance personnel, the RSA team, and other available sources to determine the past severity and frequency of crashes, or in the case of pre-construction RSAs, will anticipate the likelihood of crashes on a proposed project. The RSA team is encouraged to collect data from citizens to enhance the understanding of why crashes are occurring or might occur, which is a qualitative source of traffic safety. However, when an RSA cannot collect sufficient data, whether as crash reports or through public input, then it becomes difficult to identify specific locations where scarce safety resources should be allocated. Even when the RSA team does collect qualitative data, final decisions about specific safety improvements usually depend heavily on crash reports or other quantitative data to ensure fair and objective resource allocation.

When there are few data to point toward a need for an RSA, then one is unlikely to take place. RSAs, like all safety initiatives, require time, personnel, and financial resources. If a state agency must decide where to allocate resources, then it is likely to choose areas where existing data point to a problem. This need for data to substantiate an RSA that could collect data is a paradox: If there are no data pointing to a problem, then is there a problem? In my experience, if the data show few crashes, even when the known rate of deaths and injuries is high for communities of that type or within that region, then it is very difficult to substantiate the time and money for an RSA, particularly an RSA that would engage the multi-jurisdictional and mixed-expertise members that make an effective RSA team.

2.7 Another Traffic Safety Case in a (mostly) Typical Small Town

Mashpee is a small town on Massachusetts' Cape Cod. The area is a popular vacation destination for tourists from around the world, with a permanent population of approximately 200,000 and a transient population that exceeds 500,000 seasonally. Mashpee is also home of the Mashpee Wampanoag Tribe, which was recently re-recognized by the US federal government as an independent, sovereign American Indian nation. The Mashpee Wampanoag have maintained a thriving community on Cape Cod since creation, and are seeking to improve their economic, social, political, and public health by planning, building, and improving transportation infrastructure on Cape Cod ("Public Works" n.d.).

The Mashpee Wampanoag Tribe engaged the Eastern Tribal Technical Assistance Program (Eastern TTAP), the federally funded program where I worked for over a decade. As a program designed to develop expertise among tribal governments, provide technical assistance, and facilitate partnerships, the Eastern TTAP was positioned to help Mashpee Wampanoag Tribe conduct road safety audits (RSAs) on roads that serve their community. These roads have shared jurisdiction between state, county, town, and tribal governments, and serve all users regardless of where they are coming from or where they are going. An RSA helps analyze specific sections of roads for documented or anticipated safety issues and provides advice on how to mitigate contributing factors for MVCs.

Because of the mixed jurisdictions and wide variety of drivers traveling the area, in Mashpee, federal, state, and local governments also participated to help improve road safety for the tribe and all other users. Town and state partners collected crash data from state databases, federal partners sent traffic safety experts, and tribal partners helped coordinate the activities and provided local knowledge of the road sections under review. As a representative of the Eastern TTAP, I provided technical expertise, promoted collaboration, and helped prepare reports for the Mashpee Wampanoag Tribal government. Relative to many other RSAs that I have seen, the cooperation, process, and results were exceptional. Other RSAs struggled to garner participation from local, regional, and federal partners, which impacts the range and depth of experience, knowledge, and expertise. The reasons for lack of participation can include apathy and lack of resources, but might also include politics: When there is a conflict between two jurisdictions, members of one jurisdiction may avoid contact with the other. In Mashpee, all the partners not only eagerly participated, but brought data and expertise to help assess and solve problems.

I observed the partners cooperating willingly, and all participants acted with exceptional professionalism. Despite this exemplary RSA process, all the partners experienced the deficiencies of a scientifically oriented, data-driven process that seeks a maximum of objectivity. From the beginning of the Mashpee Wampanoag RSAs, partners disagreed over the significance of recorded crash data, whether the data matched the perceived risk, and what data qualifies as justification for prioritizing investments in road safety infrastructure. For example, the state representatives correctly pointed out that there were no roads in the study area that met the state's criteria for a high-crash area, so no safety study would be required; however, the Tribal representatives also correctly pointed out that the roads in and around the Tribe's land should be ranked relative to each other because the Tribe was not necessarily concerned with a high-crash area elsewhere in the state. Ultimately, the group did agree to follow the recommended federal process and collect what data was available, and then further examine the data against field observations in an attempt to gather qualitative and quantitative data for a stronger report.

Even when data is available and when following best practices of careful reporting, crash data is still only as good as the individuals involved in the data collection. Most crash data is collected by professional law enforcement officers at the crash scene soon after the crash occurred. The most severe crashes, generally those involving fatalities, severe injuries, and/or complex circumstances, might be investigated and reported on by specially trained teams. Earlier in this chapter, I noted that deaths are recorded by coroners and analyzed by the CDC. Police are rarely coroners. A coroner reports on the death far from the crash scene, and the crash report may or may not become part of the coroner's report. In the case of deaths, injuries and property-damage MVCs, many independent agencies involving multiple people may be recording information about one incident, but widely separated in time, training, and physical space. Many crashes are not recorded; instead, they are only known by locals through stories or evidence left behind when someone skids off a curve.

Based on my own observations and experience, the reality of crash data collection doesn't always comply with best practices. A responding officer, if there is one, subjectively evaluates a crash scene and decides what information shows up in the official report. Except in the case of contest by a driver involved in the crash, a crash report is usually unverified, uncontested, and unassessed. In real life, outside the realm of perfect data collection and analysis, the following circumstances can lead to incomplete or missing data. During the course of several RSAs in which I have participated, I encountered situations such as the following:

- The responding officer noted the wrong location, or the data analyst misunderstood the description, and the crash was erased from a curve that could use some crash risk reduction (Michigan).

- A driver called his buddy to pull him out of the ditch, and the crash was not recorded (Michigan).

- An older vehicle driven by an impoverished owner rolled over, but nobody was seriously hurt, so the dollar threshold may not have been met to require a report (New York).

- Someone died, but the paperwork was lost in a bureaucratic labyrinth of multiple agencies and jurisdictions, so the only people who remembered the tragedy were the victim's family members (New York).

- Community officials fear that providing reports of alcohol related crashes will give their community a bad image, so those crash reports might not be provided to the RSA team (Michigan).

- A regional planning authority complied with a local statute requiring traffic safety mitigation efforts when three or more crashes of any severity occurred three years in a row at the same location on roads in its jurisdiction. This is an exceptionally strong and laudable measure to mitigate crash risks. But there was debate over the question: What is the definition of "same location"? (Massachusetts)

- It was determined that the top 50 crash locations each year in a state shall be investigated and mitigation efforts undertaken but the significant terms were not defined. Again, what is the definition of "location"? Is a "top" crash location one where the most people have died, the most crashes have happened, or the greatest rate of crashes per number of vehicles occurs? (Massachusetts)

- A group of traffic safety experts observed an intersection and identified a potential risk of severe crashes occurring on an expected regular basis, but debated: is the risk elevated when the crash data does not match the expectation? (Connecticut)
- A twenty-year veteran police officer told the traffic safety experts that a road is so risky that he does not stop his patrol car on the road or allow his own kids to walk or bike on the shoulder, but the road had few recorded crashes. Does the road warrant an urgent redesign? (Massachusetts)
- Tribal members complained about speeding vehicles on their streets, but the political and historical relationship between the tribe and the state prevented deputization of tribal law enforcement officers. Neighboring law enforcement did not patrol the streets because they are outside their jurisdiction. Therefore, according to government-collected data, there were no speeding problem on the road because there were no citations. (New York)

These points of contention are not theoretical: These are actual arguments that I observed over the course of RSAs in several communities. When data does not meet the expectations of the scientists and engineers who have determined the rules for collecting and analyzing that data, then the data might not exist.

The problem of recognizing data and valuing science-related opinions of others is linked to a social construction of science and knowledge described by philosophers and sociologists. In *Science in Action*, Bruno Latour proposes that the validity of scientific processes and the data produced by them are intrinsically linked to the norms and standards used in the scientific community where they are created, and validated only when accepted by peers in that community (Latour 1987). He draws attention to the need to present science according to norms developed within a scientific culture if we expect an audience from that culture to accept the information as valid. The implications for failing to meet the expectations of a community of experts when presenting and evaluating data resound throughout my experience working in traffic safety: Engineers will understand and value data which fits their expectations, and non-engineers will be confused by engineering information that was intended for an engineering audience. Likewise, data and opinions from those who do not regularly participate in a community of science and engineering, even when presented in a format familiar to scientists, may be suspect and undervalued.

Latour also explores the role of culture and context in our identification of information as scientific, which complement Heideggarian concepts of enframing (Heidegger 1982). Martin Heidegger emphasizes the scientific culture as a boundary of understanding of science, a boundary that can serve as a prison of understanding. For Heidegger, and less so for Latour, if engineers and scientists use science and technology to frame their understanding of the world, then they will be inclined to only understand the world in this way. This applies to the understanding of every available resource as a

Heideggarian “standing reserve” waiting to be exploited for scientific and technological needs, as well as the understanding of information only in terms of how it can be used to support the programmed needs of scientific discovery and application (Heidegger 1982). The inverse of this concept is that when these data are not conforming to the expectations of a quantitative data imperative, then they may simply not exist: Traffic safety professionals will see data and contributing factors as risk only when they match their expectations of what risk is to an engineer.

For the Mashpee Wampanoag Tribe’s RSA, the tension between a culture of engineering and the emotional impact of traffic injuries, fatalities, and near misses was exposed in the disagreements between local road users and external safety experts. The Tribe asked external experts to quantify their perceived risks so that they could access funding which could improve road safety, and the experts discounted local perceptions of risk as failing to meet the criteria for “data” to justify expenditure of government resources. Even while following a process defined by the FHWA’s own Office of Safety, a failure to meet an engineer’s understanding of valid data can discount the findings of a formal process, and potentially delay or prevent safety improvements. How do we overcome this gap in understanding of a problem?

2.8 Defining a Culture of Safety

The definitions used to describe the problem of deaths and injuries from MVCs are strongly linked to statistics and are a very positivist representation of the problem. Risk managers quantitatively evaluate the problem of MVCs, which provides us with an explicit measure of progress or failure in addressing the problem. This approach of defining safety in terms of numbers of reported crashes may be convenient and easily repeatable, but as already shown in the Mashpee case, the *valid* data do not tell the whole story. This definition also does not lead us to a culture of preventing crashes, instead, it is a reactive process that eliminates known (or documented) risks.

Defining a culture of safety on our roads using numbers of fatalities and injuries is a measurement of failures. As the bodies pile up, traffic safety experts look back and say, "Well, that didn't work, let's try something else." This matches with the trial-and-error process of the engineering method (Koen 1985), but this only leads to prevention of future crashes when a researcher can identify similar circumstances to past failures. This method does work to fix known problems, but it does not create a culture of safety, it creates a culture of reaction, which fits the methods that engineers are comfortable with.

Risk managers need to define a culture of safety in the terms which make sense to those who are experiencing the problem. The vast majority of road users are not engineers, scientists, and mathematicians, and even though non-engineers may understand that 35,000 deaths is more than 30,000, the numbers simply lose significance. Furthermore, reducing personal tragedies to numbers might alienate those who do not understand how important a 7% decrease in fatalities is, which can lead to withdrawal from the culture of safety and a complete disregard of the messages seeking to sway the public toward safer driving habits.

Changing the culture of road safety to something familiar to non-experts could help encourage someone besides experts to worry about the problem. Some states are attempting exactly this with a campaign called "Towards Zero Deaths" (TZD). TZD's idea is to work toward zero MVC fatalities. The marketing campaign includes video interviews of passersby that ask, "What is a good goal [of traffic fatalities] for our state?" The answers vary from thousands to single digits, until the interviewer asks, "What is a good goal for your family?" ("Marketing Collateral: Expanding Toward Zero Deaths" n.d.). The answer is always zero when you ask someone if a death from a motor vehicle crash in their own family is acceptable. The campaign lets us view the problem from a standpoint of something that affects us individually, and even makes the goal reasonable, unlike something that seems impossible for an individual, such as, "Let's reduce deaths by 10,000 this year."

In spite of the TZD campaign's simple message and wide adoption by state departments of transportation, I have heard engineers question the reasonableness of such a laudable goal. Engineers view this campaign from a frame of what they consider to be reasonable reductions, and an engineer may not see a reduction in fatalities by 35,000 annually as a reasonable goal. The engineers are making an honest and fair assessment, because they cannot simply reduce fatalities by 35,000, but changing the perspective from one of an engineer to one of a family member shifts our understanding of the problem from impossible to possible. It is this kind of culture shift that is required to change our understanding of traffic safety and many other anthropogenic problems.

From the engineer's standpoint, eliminating traffic deaths is impossible. An engineer will see perfection in terms of an approach toward zero imperfections, but never absolute perfection. But, from an individual's perspective, I can drive safely, teach my children not to text and drive, and insist that everyone in my vehicle wears a seat belt. I do not need perfection as the individual; I only need to recognize that I can do a small thing that will help ensure my survival. While this is not a guarantee that nobody in my family will die in a crash, it improves my family's odds considerably over those who don't buckle up.

This is a problem that has solutions in social construction and rhetoric. Traffic safety professionals come predominantly from an engineering and science background. This makes sense because roads, bridges, cars, trucks, and buses are technological systems whose performance can be influenced and managed through engineering. The result of this emphasis on engineering solutions is that problems in the transportation system become intrinsically linked to engineering failures. Road safety professionals look at safety problems through the lens of engineering concepts, and they attempt to communicate these problems from that perspective. An engineer is more likely to see engineering problems to be solved by engineering processes.

A rhetorical approach would focus on users, who are predominantly not engineers or scientists. To define an effective culture of road safety, risk managers might look at the problem of traffic safety from the perspective of the road users. This is a user-centered approach as described by Robert Johnson (1998). As road users, we can identify locations, features and behaviors that seem risky to us. The opportunity for this approach is that the users can also propose solutions that make sense to them and are therefore more likely to be popular among their peers. This does not leave the engineer out of the equation; instead, it lets them use their equations to find the most efficient and effective means of reducing the risks that the users identify. Data collection is also part of this equation, but it shouldn't be used to exclude other metrics of understanding; it should complement and refine those understandings.

2.9 Opportunities for Usability, Social Sciences, and Humanities

Engineers will look at safety problems from an engineering perspective, just like hammers will find nails to be pounded. Traffic safety should require us to look at human beings and human behavior much more humanely, if for no other reason than humans themselves are at risk when cars and trucks crash into each other. Engineers, policymakers, and citizens can improve the state of traffic safety if they apply human and social sciences *in addition* to the excellent engineering already in place, and consider a broader look at how and why humans do not understand that the well-designed curve should not be departed from.

Behavioral and social research can discover many things that are left out of the engineering side, and some of those things may surprise an engineer: Behavioral and social sciences can even *predict* who will crash and where they are likely to do so *before* there is a pile of bodies. In their articles on human behavior, psychologists Krahe and Fenskey (Krahe' and Fenske 2002) and Hennesy and Wiesenthal (Hennessy and Wiesenthal 2001;

1999), determined that traffic conditions, gender, social norms, and social conditions could affect when and where drivers might become aggressive. This is not necessarily news to engineers who have a pile of crash reports to review, but without those crash reports, engineers need other ways to identify high-risk locations and actors. It's better to identify problems before they occur, and in places where data quantity and quality might not be statistically relevant.

The social sciences, behavioral sciences, and humanities are quite good at asking humans what they do, why they do it, and how to change behavior. Psychologists Quine, Rutter and Arnold have investigated how to convince children to wear helmets (Quine, Rutter, and Arnold 2001) and how to predict and change driving behavior among motorcyclists (Rutter, Quine, and Albery 1998). These *sciences* can even get people excited about traffic safety, or at least get them interested enough to hear what a government representative might have to say (Lewis et al. 2007). Psychologists have been working on human behavior problems in traffic safety for some time, which is not a big surprise because their quantitative methods are very familiar to engineers and physical scientists, and therefore their data are considered "valid."

Moving along the spectrum from quantifiable to qualitative data, we approach more humanistic methods of assessing and solving engineering problems. Earlier, I pointed out how the Human Factors Guidelines (HFG) say that "road users must read and comprehend from the roadway what the highway designer and traffic engineer intend for them to do" (Campbell et al. 2012, 3–1). By another name, this is called usability and technical communication. Usability is an entire field of study that is not new to philosophers, humanists, and the users themselves, as Aristotle pointed out a couple of millennia before the HFG was published, "the knowledge of the house is not limited to the builder only; the user, or, in other words, the master of the house will even be a better judge than the builder, just as the pilot will judge better of a rudder than the carpenter" (Aristotle, in Ross and Smith 1908, 11:141). Shouldn't we be looking at how humans *use* roads based on what technical communicators already know about usability? Won't it help if engineers know who is using the roads, how they are using them, why they chose that path of travel, and what they expect out of the trip?

For more openings in the field of traffic safety engineering for humanities and social science majors, researchers can keep looking at the problem of data collection and analysis that form the analytical core of the HFG, Highway Safety Manual (HSM), and other engineering-based safety tomes and programs. Tom Fronk, a safety engineer involved with evaluating proposed safety projects for the federal government, emphasizes data as an essential foundation of identifying safety problems, and a critical component when making decisions about funding the solutions to those problems on tribal lands (Fronk 2015). Unfortunately, traffic safety experts already know that specific data on where and when those crashes are occurring in rural and tribal communities is exactly what is missing in the areas that need it most. There are some good engineering methods that can help solve this problem, for example by outfitting rural and tribal police agencies with more equipment and better data collection systems. There are even systems that can help predict dangerous roads through system-wide analysis of road characteristics, ranking roads by similarity to other roads that have already proven to be dangerous ("United States Road Assessment Program (UsRAP)" n.d.). Road agencies can throw more money at the problem and send more government experts to areas inundated with government officials addressing known social problems, or they can use humanistic skills and knowledge to collect the data almost exactly as the engineers and government require it, and it doesn't require another highly technical intervention or even stacks of quantitative reports.

To meet the need for understanding where and why crashes occur in all areas, traffic safety experts do recommend accessing data about local traffic patterns, road conditions, road maintenance, and crash locations using interviews (ethnographic methods) and observation of patterns and crash scenes (visual anthropology) (Allred 2013). In spite of these recommendations, local knowledge of crashes remains under-collected, misunderstood, and underutilized. In her book on the rhetorical risk communication of coal mine safety, Beverly Sauer explored how data from miners was undervalued or dismissed because it did not meet the expectations for expert information by mine inspectors (2002). Sauer's work showed that when mine workers can contribute data and it is valued, mine safety improves. This is the same problem that I witnessed during RSAs. The reasons for failing to collect data using ethnographic methods may be related to the same complicated jurisdictional, political and resource issues that already limit data collection in tribal and rural areas, but it may also be related to a lack of training, a lack of understanding of the data available, and lack of value placed on data that some engineers and policy makers see as informal or hearsay.

Qualitative data is a cornerstone of research in the humanities and social sciences, and it works in traffic safety as well. The problem of collecting data in rural and tribal areas is not based on lack of crashes, it is based on a lack of reporting. Even with adequate reporting, the small populations don’t help the statistical needs of crash analysis, so tracking every crash is that much more important. By using qualitative methods in rural and tribal areas, traffic safety experts can find out about crashes that were not reported by law enforcement, whether or not law enforcement was even available to take a crash report. If engineers ask local residents where the dangerous roads are, and look at crash scenes to complete a picture of what happened, then they can effectively create a crash report where none existed, or correct one that was hastily written up by hand on a cold and snowy night.

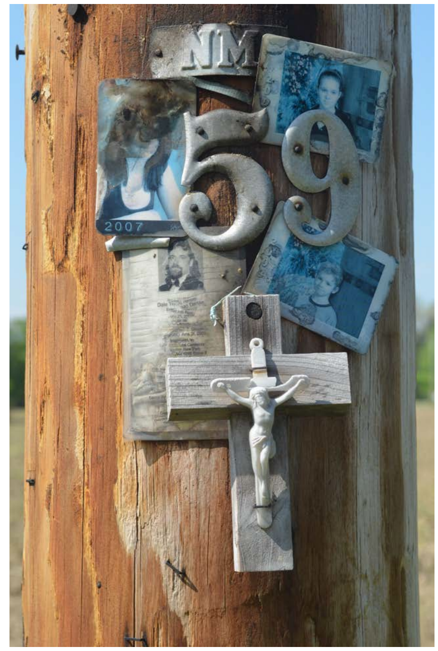


Figure 4: Memorial to a Motor Vehicle Traffic Fatality in Seneca (Velat 2013)

During an RSA in New York, I noticed a small memorial stapled to a utility pole in the right of way of a state road (Figure 4: Memorial to a Motor Vehicle Traffic Fatality in Seneca) (Velat 2013). The memorial consisted of a photograph, newspaper clipping, and small cross. These types of memorials can be found throughout the world, and some states even install small memorial markers along roads to show where people have died. Although many people do not notice these markers, most people will notice them when there are groups of these markers. The intended function for the state-sponsored memorials is of course to memorialize a lost citizen, but more so to help represent statistics in a way that ordinary people will understand.

When these memorials are not state-sponsored, they can be a source of data for the public, government officials, and traffic safety experts. In New York, the memorial of a traffic fatality stapled to the utility pole was the only evidence that I could find of this event. I searched the state databases and could not find records, even though New York, like all states, spends significant resources on fatal crash investigations. I never did discover if the crash was never recorded, recorded incorrectly, or if I simply did not access the databases properly. Regardless, it was a useful piece of information that ended up in the tribe's RSA and helped substantiate a need for improved data collection and review procedures.

This qualitative method of collecting data on-site is one of many recommended activities in RSA data collection, and it has led to improved system-wide risk assessments for at least one tribe. This method does not require extensive training, can be performed by non-experts, and doesn't need computers, databases, or the Internet. It also has the added benefits of creating a personal connection between the data collectors and the data sources, which itself is a form of risk education for the data collectors and the wider community.

In addition to helping rural and tribal communities understand and apply qualitative methods to collect the requested traffic safety data, I expect that empowering these communities with tools to assess their own problems and address the needs that reflect local values will help draw these communities into a culture of traffic safety with external safety experts. Aaron Wildavsky and Karl Dake, political scientists who examine risk perception from a cultural perspective, identified trust in institutions, business, and government as more important to individuals and groups when making decisions about risky behavior than the information about the dangers of a potential risk (Wildavsky and Dake 1990). In the case of tribal and rural communities, external institutions, business, and government may already be regarded with skepticism and met with resistance, so external safety expertise may already be seen as intrusive and unlikely to be trusted. A history of government intervention in local politics, social issues, and culture do not contribute to trust and cooperation on any issue, including those affecting the lives of local citizens.

If data collection and reporting norms are adaptable to local social and cultural systems and centered on local values, local practitioners can be empowered to make decisions on a local level, potentially embedding a level of expertise within the community and providing for future, consistent decision-making based on locally available processes. This empowerment does more than create self-reliance, it can build trust between community members and external institutions seeking to help. In a study of an aboriginal Metis settlement in Canada, Amy Christianson, Tara McGee, and Lorne L'Hirondelle identified trust between group members as a critical factor in decisions about preparing for wildfire risks, and indicated that a distrust of outsiders could interfere with acceptance of information or programs presented by external groups (Christianson, Mcgee, and L'Hirondelle 2014).

2.10 Social Impacts of Finding Your Own Data

These examples of how data is and is not collected, how users interpret and understand instructions given to them by road designers, and how local communities react to external authority provide only a brief look at the possibilities for applying non-engineering approaches to a very specific engineering problem. The arts, humanities, philosophy, social sciences and other non- S&E fields can help identify, analyze, and act on data normally excluded from traffic safety programs, at the same time generating the data that government agencies and engineers require, and they can even expand on how problems are analyzed and solved using techniques and theories unfamiliar to S&E. Add to this the building of trust in external experts and processes, local investment in saving lives, and establishment of stronger self-reliance and governance, and we may see improvements in traffic safety or any other public health issues that are killing thousands and maiming millions.

Engineers are no less passionate about saving a child's life than any other parent who buckles their child in for a ride to school. Every public health and social issue can use more engineers, physical scientists, and much more technology to identify and resolve threats to human welfare, but there is a lot of room for all of us to look at all problems from a much more human perspective. If experts in the field of humanities, arts, and social sciences are willing to explore problems outside their comfort zones, and engineers and physical scientists can consider the skills, knowledge, and experience of the humanities, then I believe that we can save quite a few more human lives.

In addition to looking at the problem of traffic safety through a humanistic lens, all risk managers must consider that there may be more ways of examining these problems. My perspective of data, risk, and safety is not an Indigenous one, and even though I think my perspectives are valid, there are certainly those who will not trust me or my perspective. It is an understatement to say that the Indigenous people of the Americas have been subject to over five centuries of turmoil following "discovery" by European explorers (Madley 2016; Newland 2022; Edwards and Kelton 2020; Cutlip 2018; "Sioux Treaty of 1868" 2016). I will avoid a lengthy discussion of this history with the following summary: American Indians and Alaska Natives have reasons to be skeptical of any government agency, official, policy, or data.

When an expert from a government agency tells us what to do, even without a troubling history, it is not surprising that we offer some kind of resistance. This is a normal reaction to perceived or real intrusion into personal affairs. Most people do not deal with the federal government on a regular basis, nor do they directly rely on federal benefits for their community's existence and wellbeing. Resistance to government for most of us is second or third hand through far less powerful local and state agencies, so we can safely protest federal policies at a distance and not worry too much about losing personal security. For American Indians and Alaska Natives, resistance to government policies and officials is very direct. The federal government is directly engaged in the day-to-day affairs of tribes and tribal members and resisting federal initiatives may directly affect individual economic security, health, and community welfare.

When the full weight and power of the US government looms over you, your people, and your community, you are likely to surrender, whether by complying with a polite request, or simply giving up. In either case, you aren't likely to enthusiastically embrace the idea, and you probably won't go out of your way to understand the justification.

Resisting authority can be passive, as in failing to buckle up, or active, as in installing speed limit signs without the state's permission. Resistance can also take the form of minimal compliance – the protestor does the absolute minimum to avoid a more rigorous response from authority. Passive resistance and minimal compliance are symptoms of a long history of exclusion or punishment. Cultural theorists such as Douglas, Dake, and

Wildavsky offer explanations for the inexplicable behaviors of resistance, reticence, and empty compliance in the face of seemingly logical and convincing arguments and data (Wildavsky and Dake 1990; Douglas and Wildavsky 1983; Douglas 1992; 1986; Dake 1991; 1992). Dake argues that we are placed into cultural patterns, either by ourselves or external forces, and these patterns help explain our behavior, even if they don't make much sense. American Indians and Alaska Natives are likely to find themselves in Dake's fatalist group relative to the US government; within a tribe, individuals may find themselves in other socially constructed groups, but individuals can exhibit different social behavior in different situations (Dake 1992). Indigenous groups have been suppressed by social, economic, and political means, and a given group's expected reaction can be one of passive resistance or simple non-compliance even when confronted with annihilation (Dake 1992; 1991). Even with polite and friendly cooperation, the group's members are unlikely to truly embrace ideas and change their behavior beyond the minimum required to avoid punishment.

With this knowledge, government representatives should not be insisting that a tribe understand and adopt external definitions of risk, data, and rationality. To gain more than minimal compliance, external agencies need to empower tribes with the authority to decide for themselves what risk is and who is affected. In the end, risk will be mitigated, and even if it's not at the location best defined by government-collected data, it will engage the community and help avoid the fatalist reaction of self-annihilation. There may also be an even better outcome: Perhaps the available data defined as valid by external agencies isn't accurate, and the local knowledge turns out to be the best indicator of risk. This could raise the community's level of risk perception from fatalist to egalitarian, where members still question authority but feel empowered to make sense of risk on their own terms (Dake 1992).

At the beginning of this chapter, I introduced historical and cultural issues that have led to the unique relationship between AI/AN nations and federal, state, and local governments. This is important for technical experts and policy makers at all levels to understand so that they can better work with tribes. It also helps the public understand why tribes end up receiving transportation resources directly from the federal government and why tribal and federal governments may bypass state and local governments when addressing risk in their communities. The implications are that tribes may receive fewer resources because of a potentially more complicated tribal/federal relationship, may alienate neighboring jurisdictions, and may not have the knowledge to negotiate federal rules and procedures. Another, more positive implication, is that by using federal programs on a government-to-government basis, tribes are asserting their unique status as sovereign nations and exercising self-determination.

Few state or local officials know that tribes maintain sovereign status and what that means for how they do business with neighboring jurisdictions. Even federal agency representatives who do not work with tribes (and some that do) can be ignorant of the federal/tribal relationship. In the process of conducting RSAs and other activities in the transportation realm, I have seen how a short introduction to the history of tribal/federal relations can significantly improve cooperation between state, local, federal, and tribal governments and officials. This also contributes to greater respect and status for tribes as they exercise their sovereignty. The act of successfully accessing resources is itself a means to strengthen tribal governments, and when those resources address acute community health problems, both tribal and non-tribal citizens' benefit. It additionally supports "Indigenous data sovereignty," a movement to place the responsibility and authority for data about Indigenous people with Indigenous people and governments ("Indigenous Data Sovereignty Networks" 2020).

2.11 The Argument for Qualitative Data and Community Engagement

Risk managers need data to understand and make decisions about addressing risk. In these cases, data are available to tell us that there is a problem, but data are lacking to first identify specific opportunities for risk mitigation and then subsequently to justify resource allocation to undertake mitigation measures. In the course of several RSAs, I recognized that the data did exist to identify specific risks, however it was not collected and may not have been recognized as legitimate. The argument of data legitimacy can be partially overcome by collecting and presenting qualitative data consistently and accurately.

Teaching citizens and officials to consistently and accurately collect qualitative data should be easy. It does not require strong computer skills, advanced statistics, or extensive training: Most people can tell a story about what they see, read, hear, or feel, and when done systematically and consistently, these data will be useful. When I identified a memorial of a traffic fatality by observing, photographing, and retelling the person's story, I established a data point that can now be used to argue for traffic safety measures on that road. Using this data, local authorities could justify spending time and money on further evaluations and improvements.

Qualitative data might also be more readily understood by non-experts. Upon showing someone a standard crash report, most people will have difficulty extracting meaningful information; however, if I tell you the story of a driver skidding off a sharp curve, you will understand that some drivers may have trouble driving safely through the curve. Even if you don't know why a crash has occurred, you can still tell me where they are occurring near your home, and using engineering and driver behavior knowledge, I can interpret the crash scene and your story to determine what may have contributed to the crash.

Qualitative data can also provide information that literally does not fit in the box. When a standard crash report form is generated, the responding officer must interpret many data points for entry into pre-defined spaces. Standard crash reports do have a space for narrative entries; however, most reports include just one or two sentences to describe non-serious crashes. To be proactive about crash risk reduction, traffic safety experts should review all reports, including those without fatalities, serious damage, or injuries. If these low-level reports had rich narratives, traffic safety experts could interpret a lucky escape as an otherwise serious crash that should have resulted in serious injuries. In my work I have driven up on terrible crashes where I expected to see many severe injuries or deaths, yet the vehicle occupants walked away and didn't even go to a hospital. Months or years later, a traffic safety engineer will run a database query and look for crashes with serious injuries or fatalities, known as K and A crashes. When the database returns no K/A crashes at a location, then the engineer will likely not even realize that there have been several lucky escapes. If my story could be recorded and interpreted, I could tell the engineer that a certain curve or intersection had many near misses that could be avoided with simple improvements.

Applying qualitative risk analysis to the question of traffic safety like the KBIC case or anywhere else would look very much like the work already done by this Tribe: Tribal transportation workers heard complaints about speeding and installed speed limit signs. The difference between what the Tribe did—collect qualitative evidence in the form of public complaints, observation of the effects of speed limits in neighboring towns, and personal experiences navigating these roads on a regular basis—and what the state expects—speed studies and crash reports—is really only semantic. The state and Tribe are both using legitimate risk analysis processes, but the state only gives meaning to its own method. The solution would be for the state to accept the fact that not every risk analysis must fit its quantitative model and to provide communities with alternatives. These alternatives would not only avoid the need for catastrophe to prove a problem but would also engage the public as partners in addressing risk locally. Properly designing alternatives would require the responsible authorities to apply proven user-centered design, public engagement, and other rhetorical practices, which the agency representatives would also have to respect, understand, and competently use. Technically, this is not a difficult task, but practically, it could be a long and complicated process of changing engineering education, policy development, and a systemic revision of safety culture at multiple levels of government and academia.

The process of involving the public, valuing their data, and acting on their concerns is the essence of participatory design described in Chapter 1. Risk managers can further enhance participation by providing citizens with the skills and knowledge that will help them see and collect data in ways that help experts make sense of it. This also helps develop a sense of personal responsibility and authority that builds community cohesion and confidence in the social and political structures that can provide resources to solve local problems. Furthermore, educating the public to critically evaluate risks can develop risk literacy, which I cover in greater detail in Chapter 3. Improving citizens' risk literacy can therefore help them expand their perception and understanding of risk far beyond the focus of a specific study and lead to a culture of risk awareness and prevention that leads to proactive risk avoidance.

3 Data Collection Practices in Public Safety

Documentation is an essential part of assessing and managing risk locally, nationally, and globally. Experts, usually engineers, scientists, and statisticians, use data collected and entered by first responders, law enforcement, firefighters, and hospital staff to understand trends and trouble spots, identify possible solutions, and advocate for resources to mitigate natural and anthropogenic threats. As with data collected for analyzing MVCs to make decisions about traffic safety, similar reports are generated and compiled for decision-making in pre-hospital emergency medicine and fire response and prevention. This chapter looks at how these reports are generated, used, and processed, followed by an exploration of how traditional and expanded ideas of literacy affect data collection and processing for public safety, as well as the effects of usability on data quality, and it concludes with suggestions for improving data collection through training in rhetoric and ethnography.

My entrance into the field of traffic safety introduced me to the so-called four E's of traffic safety – Engineering, Enforcement, Emergency response (EMS), and Education. I was already working on the engineering and education part through my work in transportation research, and knew about the enforcement side from my father's career as a sheriff's deputy, so I decided to explore more about how emergency response affected traffic safety. Being familiar with engineers through my work and law enforcement officers through my father, I decided to seek out the people who worked in emergency response to gather evidence directly from those who practice it. I quickly discovered that our rural area, like all rural areas, has an acute need for first responders, so I took the illogical path of deciding to become an EMT and firefighter late in life to and in the midst of my PhD studies to see first-hand what was going on in the fourth E of traffic safety. Although I admit to a certain amount of academic interest in becoming a first responder, the camaraderie and sense of community contribution and belonging quickly overcame my initial reasons for becoming a first responder. Later, I decided to bring my academic experience directly to the EMS field and became a licensed EMT instructor. Therefore, my descriptions of data collection practices in public safety are from my own experience and observations of first responders and firefighters working in rural Michigan, and through previous research and observation I determined that my experiences are not unique to our area.

Being familiar with the problems of data collection and analysis in crash reporting and how improved reporting could improve traffic safety, I was eager to explore how documentation is generated and processed by first responders and firefighters and how I could use this knowledge in my traffic safety work. If anyone can figure out these systems, it should be me: I am researching data collection practices, teach technical and professional communication at a university, work as a TPC consultant, and have written many thousands of pages of text, yet even I still can’t manage to always generate good patient care reports quickly and effectively or easily use the fire and medical data collection and processing tools. Of course, given enough time and experience, most people can manage to enter sufficient data in these systems to keep the government overseers happy, but how good is the data?

Even though reporting systems used by law enforcement are sometimes cumbersome and complicated and the reporters may be busy and under stress, law enforcement offers are paid to do this work, trained regularly, and use the systems frequently enough to become adequately competent reporters. This is not the case for volunteer firefighters and first responders: The systems imposed on first responders and firefighters are, frankly, horrendous from a usability standpoint, and many of the reporters are volunteers with little to no training or feedback on their reporting practices. These users are also unlikely to contribute to overall system design or be asked for feedback, which is glaringly obvious when one attempts to use the reporting systems. Added to this, many fire agencies and first responder agencies create their own forms for data collection, so there is greater variation in form design, requested data points, and interface.

A typical rural fire agency may respond to one or two fire-related calls per month. The chiefs of these agencies are likely volunteers with other jobs that have nothing to do with ethnography, data analysis, or even firefighting, yet their interpretation of the national fire data collection system and the data they enter become the basis for national fire fighting and prevention policy and practice. Likewise, a typical rural or tribal medical first responder is a volunteer who may be working alone in a high-stress situation that requires all their attention focused on patient care. When a first responder is alone, as is often the case in rural areas, the data collection will wait for every other thing necessary to evaluate and treat a patient: CPR will always take precedence over data collection, and so does blood pressure checking, calming sick children, and helping an older person get back to their walker when they've fallen. Sometime after the call, often after returning to sleep and working the next day or more, the responder must remember what happened, how they treated the patient, and information about the patient's demographics. For the typical rural firefighter or first responder, good data collection will be accomplished through sheer luck rather than a systematic approach using sound practices.

The problem of adequate staffing to dedicate attention to data collection and entry may be intractable in volunteer and even most professional fire and medical first responder services; however, the usability of these systems and appropriate training on how and why to collect data can and should be addressed, even for large, professional fire and EMS agency staff. The forms and systems used by the smallest agencies are the same as those used by large ones, but agencies with large call volumes can at least benefit from the expertise gained through using these complicated systems more frequently. The form and system designers are clearly not focusing on usability for the rural responder who might enter a few forms per calendar quarter, and even with frequent use, the systems are no less difficult to use. Failing to address the audience is a basic failure of good communication practices and good instructional design. Other failures include lack of training, lack of explanation about why the data is collected, and lack of a design appropriate for the use case.

Reporting as a job function in public safety, healthcare, emergency management, and other areas of high stress, limited information, and limited resources requires reporters to balance seemingly opposite goals. The responder/reporter is being asked to make decisions quickly and take actions based on limited information to address unknown, rapidly changing, and potentially dangerous situations. Simultaneously with applying essential risk-mitigating skills to stabilize a situation, the reporter/responder is being asked to step back, think critically, collect data, and document the actions and circumstances to help those who will interact with this situation or patient right now, when the patient is passed to the next level of care, and during other similar situations in the further future. The responder should be thinking fast and acting decisively on the one hand, and the reporter should be deliberative, verbose, and even contemplative on the other.

This process of documentation is not the glamorous part of the job for any public safety worker. I have never met a police officer, firefighter, or first responder who said, "I chose this career because I wanted to write reports." Yet, this documentation and communication function is the part of the job that makes a tremendous difference to the lives of people in their communities from the first moment of a response. The quality of the very first verbal or written information sent by dispatchers to responders, and the subsequent communication between dispatch and responders directly determines what resources and capabilities will be available at every incident. The outcome for a single patient can be directly linked to the initial dispatch and every subsequent report, and in complex and large incidents, the need for expert and expedient communication increases exponentially. The response for some incidents may directly affect only one person's health and well-being, but the reporting of every incident goes on to impact the resources dedicated to underlying causes of illness, injury, property damage, and environmental catastrophe nationally and even globally.

Perhaps because the data collection process is not the exciting part of the job, neither the responders nor those who support them are likely to spend much of their time and resources on the data collection process. Another reason for a failure to create useful and simple reporting systems may be that those engaged in public safety are limited by their positionality as non-experts in documentation, communications, usability, and rhetoric. In the 480 page textbook *Emergency Medical Responder: Your First Response in Emergency Care*, the authors dedicate two paragraphs to reporting in the first chapter, and approximately one more page in the chapter called *Communications and Documentation* (Surgeons and Schottke 2016). The communications chapter does include very important information about the methods and tools for communicating, how to interact with the public and other stakeholders, and what is important to document, but the focus is much more about the process than about the implications of reporting. This textbook is designed for those who truly are the first responders on a scene, and those arriving first on scene are the ones who can shape the entire response, literally with life and death consequences. It would make sense to begin here with an emphasis on the importance of scene/patient assessment, data collection, and documentation, but the authors of this book and others like it are sharply focused on what Adam Banks describes as material access (2006, 41) and Stuart Selber as functional literacy (2004, 32) of reporting and communication systems.

The textbook is giving first responders basic information about why and how the data is being collected, and with this knowledge, they can perform this job function to some basic level. While this is certainly an essential skill for workers in public safety, this level of knowledge and skill may not provide those who rely on this data to proactively address risk with sufficient data to mitigate society-level risks. In other words, regulatory agencies are relying on the first responder to inform them about what is going wrong in our world, but they don't give these responders the critical risk literacy that they can use to understand this and then perform this function as well as they could.

I argue here that with relatively little effort, risk communicators could vastly improve the understanding of risk and proactively address risks to health, property, and the environment. Of course, instructors can teach first responders and everyone else responsible for gathering data to improve their data collection practices by simply spending more time on these topics, and agencies could give them better technological tools to make their jobs easier, both of which would likely have a positive effect on the quality and quantity of data available for analysis, but this might not address the real reasons for scarce data and a critical risk literacy. The reasons for inadequate data when making policy decisions and allocating resources to reduce risk certainly include limited functional access, but they also include the social constructs that deny the importance of certain data and devalue those who are performing these data collection functions. If EMS textbook authors do not recognize these front-line workers as important and competent data collection and analysis scientists, then they won't perform this function even when asked.

Denying their expertise could also limit access to the tools and knowledge that could develop their natural skills of qualitative reporting.

As mentioned in Chapter 2, in *Rhetoric of Risk*, Sauer explores how miners reported on risks and how these reports were interpreted (Sauer 2002). Miners were asked to collect accident data on forms with a small box for the narrative, and "[n]ot surprisingly, these narratives provided inadequate and incomplete data about event and conditions that precipitated the accident" (Sauer 2002, 89). Also not surprisingly, the small spaces for a narrative on EMS patient care reports (Figure 5: Patient Care Report for a rural EMS agency), and even more so, the limited time available to write this narrative, provide limited data for further patient care and public health research. The miners could easily identify risks within their work environment, but recognition of their expertise and authority depended on agency definitions that might not recognize local knowledge (Sauer 2002, 78–85). When a miner, first responder, or a citizen reports on an incident, and even more so on the potential for an incident occurring, the risk assessment specialists (usually engineers) from agencies such as the Mine Safety and Health Administration (MSHA) or Department of Transportation (DOT)[4] may not value these reports as highly as those

[4] Medical first responders and ambulances at all levels of pre-hospital care fall under the Department of Transportation in the United States. This is a legacy of the extraordinary loss of life on US roads in the 1950s-1970s and subsequent action by the US federal government to address these deaths and injuries as a transportation problem. This action and other measures successfully reduced the number and rate of traffic injuries and deaths in the US and throughout the world. The existence of this network of pre-hospital medical practitioners led to public use of this system as a broader urgent healthcare system and is now expanding further to provide community-based healthcare and social support in the US. This alignment of pre-hospital healthcare with the USDOT, an agency rightly not focused on healthcare, could itself contribute to less effective pre-hospital medical care due to the situated viewpoint of the USDOT as a *transportation* agency.

generated by data analysis experts using powerful quantitative data analysis tools. However, these first-person reports are what become the databases used by these experts. As Sauer reported (2002, 316), MSHA officials even discounted the first-person reports as potentially politically motivated, reducing their significance further as a basis for objective safety policy analysis. This devaluation of the front-line reporter and report content also implicitly places increased value on other reporters and data types. In Chapter 4 I'll examine this role of reporter and report type validity further in the case of pilots reporting on potentially unsafe aircraft.

In addition to the failure to recognize certain data as valid, the emphasis on quantitative data imposes a process of data discovery that demands mastery of the processes that prefer this form of discovery, and by extension, prefers the knowledge and professions that use these processes, particularly engineering, physical sciences, and mathematics. When such a preference exists, there is a danger of excluding risk analyses that math-oriented professions are not comfortable with, and also a risk of excluding those skills and professions that are not based on quantitative discovery from risk management. I saw this in my work with engineers who either dismissed or denied the importance of first-person accounts of risk in traffic safety, as mentioned in Chapter 2, which resulted in a demand for quantitative data to substantiate what was blatantly obvious to someone who tried to turn left at a busy intersection with traffic approaching at 60 miles per hour.

The idea that some data and some expertise is more or less valuable is related to theories of positionality and situated viewpoints. Research by feminist theorists such as

Sandra Harding (Harding 1991; 2008) and Donna Haraway (1988) demonstrates that the cultural, social, and economic factors influence how knowledge is produced and valued. In risk assessments, the public and even workers engaged in managing risk are not situated in the same socio-economic, political, and educational realm as those who analyze risk data for policymakers, so input from those non-expert sources can be doubted or undervalued, even though the data reporters are expected to be the primary sources of that data. Data analysts may justify this contradiction by discriminating against data that is non-conforming to their ideals: Quantifiable data collected using the tools and conforming to the standards prescribed by the scientists should be more highly valued than other data types and sources even when the reporter of both quantifiable and qualifiable data is the same person. The quantifiable data are positioned within the analysts' culture and realms of expertise and other data are not. The impact of the researchers' situated viewpoints may be further exacerbated when the data is collected from racial and ethnic communities other than their own, for example crash data collected on an American Indian reservation, as described in Chapter 2.

The link to a quantitative imperative in risk assessment brings with it an intrinsic need for risk communicators to master the sciences, or for scientists to master communication. While both are possible and beneficial, I propose that the risk analysis process would benefit more from including those who master qualitative research, namely those with skills in the humanities and social sciences and especially those ad-hoc experts who experience and can describe the risk in their daily lives. Expanding the fields of expertise involved in risk analyses, communication, and mitigation also enculturates an expanded acknowledgement of alternative approaches to understanding risk and the possibility of better communicating risk to non-experts.

These ideas are in a way an inverse of the ideas about the use of technology in writing. Stuart Selber (2004), Cynthia Selfe and Richard Selfe (1994), Patricia Sullivan and James Porter (1997), and others recognized that the social and technical imperatives of computers and technology in the writing profession and classrooms impact writers and their prose. I propose that writers could impose their values on the methods used by engineers, statisticians, and policy makers for risk analysis, communication, and mitigation, which would lead (or return) to our understanding of risk as something that can be understood and managed from a humanistic perspective and not just a quantitative one. This approach to researching and communicating risk draws on ideas of intersectionality, positionality, and privilege, in particular what Sullivan and Porter (1997) call a rhetorical methodology of critical research that allows the researcher to perceive alternative approaches to research through an understanding of the cultural, political, and technical perspectives of those doing the research.

In addition to the ideas of rhetorical methodology, positionality, and critical research, these same scholars and Adam Banks (2006) understood that experts must develop a range and depth of literacies that allows them to undertake research and position it within a social, political, and technological context. Banks describes five types of access to technology: material access—the physical access to a technology; functional access—

the knowledge and skills to use the technology; experiential access—the ability to connect to and use a technology at will; critical access—the ability to understand the benefits and problems of a technology and be able to intentionally use that technology to effect change (2006, 138); and transformative access—the ability to use technology to transform society in a way that gives access and power to those who have been excluded in technological development in the past (2006, 2). Selber similarly describes a range of literacy: functional literacy—the basic ability to use computers as a tool (2004, 30); critical literacy—the ability to question the role of computers in society (2004, 74); and rhetorical literacy—users as critically aware producers of technology.

Both the understanding of literacy and of access apply to a range of risk management access and literacy and are reflected in the cases described this work. I believe that Selber's parameters (2004, 147) for a rhetorical approach to computer literacy are readily applied to risk analyses, communication, and mitigation, for a rhetorically literate risk analyst can certainly hope to be more effective if they are persuasive, deliberate, reflective, and prepared to engage in the social action that can mitigate risks of all types. Such a risk analyst is using a techne of risk management and can be expected to impact not only those directly at danger of the risks they study, but also to effect change in the culture of risk management more broadly.

Banks' levels of access (2006, 138) also certainly reflect the range of competencies and their respective impacts on risk management and society—a person who has material access to reporting tools can contribute information about risk, whereas the critical or transformative risk analyst will understand and use their assessments to effect social change. In Chapter 2 I discussed some of the social implications for rural and tribal communities that succeed or fail at critical risk literacy, and I will further explore risk literacy later in this chapter.

3.1 Usability

Another perspective for understanding why firefighting, EMS, and law enforcement data may be poor, incomplete, or invalid is that the data collection and reporting tools are just plain difficult to use. A system's usability will affect not just the quality and quantity of the data collected but will also affect a user's desire to participate as a data collector, and even though a user may be compelled to use a system, it should be as simple as possible. A poor user interface and system design show disrespect for users, alienating them from the research community that is asking for the data, and also limits the user to a material or functional access of a risk management system.

Rural volunteer first responders are called to fight fires and treat patients while also making substantial contributions to the data that local, state, tribal, and federal agencies use to make decisions about resource allocations, fire regulations, medical practices, automotive safety, and many other national and global health and safety practices and policies. Good EMS and fire data is just as necessary in rural and tribal areas as it is in urban areas, and perhaps more so. As with the disparity in traffic safety described in

Chapter 2, people in rural areas (which include most tribal areas) are 50% more likely to die of trauma (which includes MVCs) than in urban areas (King et al. 2018).

If the data collection systems are too difficult to use, then our primary sources of data will not report or report poorly. While the reasons for a poor or confusing user interface may be related to training of both the user and the designer, the concepts of differing viewpoints of those who make the systems and those that must use them are also intrinsically intertwined. I suspect that the primary reason for a poor system and user interface design is that the developers are simply not addressing one of the most basic elements of TPC: To determine whether something is usable, we should know what it is for and then we can evaluate whether it can be used for this purpose.

The systems used to collect and manage data about fires and emergency medical service (EMS) calls in Michigan are the National Fire Incident Reporting System (NFIRS) and the Michigan Emergency Medical Services Information System (MI-EMSIS). The goals and purposes of such systems are typically to collect data for research, help bureaucracies evaluate and manage publicly funded programs, and guide public and agency policy. The NFIRS database is operated by the Federal Emergency Management Agency (FEMA), which describes NFIRS as “a voluntary reporting standard that fire departments use to uniformly report on the full range of their activities, from fire to emergency medical services to severe weather and natural disasters"[5] and FEMA lists these benefits for end-users ("About NFIRS" 2022):

- *Fire departments can use NFIRS to track and manage apparatus, personnel and casualty information, document the full range of department activity, and justify budgets with summary and statistical data.*
- *Fire departments can use NFIRS data to focus on current community challenges, predict future issues, and measure program performance.*
- *The modular design of NFIRS makes the system easy to use because it captures only the data required to describe an incident.*

FEMA further describes the benefits of NFIRS for the U.S. Fire Administration (USFA), the policy-making and regulatory body related to firefighting in the United States. NFIRS should help USFA with the following users ("About NFIRS" 2022):

[5] Although the NFIRS is described as "voluntary," there are sanctions for failing to enter data into the system. For example, a department may not apply for federal grants unless NFIRS data is up-to-date, and in Michigan, data entry is required by law (*NFIRS*): "According to Public Act 207 of 1941, Section 29.1c (2c), the Bureau of Fire Services shall participate in the national fire incident reporting system (NFIRS). The national reporting system has been designed as a tool for fire departments (FD) to report and maintain computerized records of fires and other FD incidents in a uniformed manner. Section 29.4 and 29.5g of Public Act 207 of 1941requires the chief of each organized fire department, or the clerk of each city, village, or township that does not have an organized fire department, immediately after the occurrence of fire within the official's jurisdiction resulting in loss of life or property, shall make and file with the bureau a complete fire incident report of the fire. The report shall be made on and according to forms supplied by the bureau (BFS)."

- *Analyze the severity and reach of the nation's fire problem.*
- *Use NFIRS information to develop national public education campaigns.*
- *Make recommendations for national codes and standards.*
- *Determine consumer product failures.*
- *Identify the focus for research efforts.*
- *Support federal legislation.*

The MI-EMSIS for medical responders does not provide such a clear and concise purpose statement, although the reader might infer that the goals are similar to NFIRS based on the type of data collected and the stated reporting requirements ("Michigan Emergency Medical Services Information System (MI-EMSIS)" n.d.)):

> *What You Need to Do - Life Support Agencies*
>
> *Michigan's EMS data repository is an all inclusive system. ImageTrend Elite has been selected as Michigan's statewide data repository (this is where all data will be uploaded). There are 430 demographic and EMS data elements in the National EMS Information System (NEMSIS) Gold XML data file. This represents all of the elements located in the NEMSIS Data Dictionary. Anyone submitting data to ImageTrend Elite should do so by importing or sending the NEMSIS XML file. This does not mean all 430*

elements must be collected for every call or even at all. It just means that any NEMSIS data elements collected shall be submitted to the repository.

I experience both systems as a volunteer firefighter and EMT. As a volunteer, accessing these systems is irregular and infrequent and is not a primary job function in my role as a volunteer responder and certainly not as part of my daily life outside emergency services. This is true for all the members of the three agencies that I volunteer for and is likely representative of most firefighters in the US: 70% of all US fire departments are listed as volunteer, and just 34% of all US firefighters identified as career (professional) firefighters ("National Fire Department Registry Quick Facts" n.d.). Volunteer medical first responders are more likely to be paid professionals, with 13% self-identifying as volunteers, but 74% of rural medical first responders are volunteers (Cash et al. 2021), so my experience is also likely representative of most rural medical first responders.

As an academic and professional TPC practitioner, I also cannot help myself from assessing these systems for their design and usability. These systems should be tested and validated by the expected users, which means that rural and urban, professional and volunteer, young and old, and every other user should be taught to use them and regularly provide feedback for improvements. While I cannot determine how or if these systems were tested, I can attest to the difficulty of using these systems on an irregular (from a first responder's perspective) basis. I can also interpret feedback from the many new users I introduce to these systems in my work as an EMS instructor and firefighter training officer.

I have never received positive feedback about these systems, nor do I find them intuitive or easily accessed. I continue to maintain, at best, material access to these systems, although this work is itself an example of using critical literacy of computer systems in general and of these types of databases in particular.

Setting aside the questions of how useful the data collected is to the requesting agencies, technical communicators can simply look at how systems that are difficult to use affect the users' ability and desire to complete required data collection and entry. Many studies examine the cognitive load on users who struggle with difficult user interfaces in computer systems, including healthcare data systems (Badenoch and Tomlin 2004; Roman et al. 2017). These difficulties not only unduly burden volunteers with competing life and work priorities, but they also burden them at times of fatigue and stress. The goal of these systems should be to simplify collection of essential data and not necessarily to gather as much information as possible, even if that data could be extremely useful.

Further complicating the use of these systems is the poor state of rural telecommunications infrastructure and information technology in rural and tribal areas ("2020 Broadband Deployment Report" 2020; "Report on Broadband Deployment in Indian Country" 2019), which are essential for functional access to these online reporting systems. My own experience with these systems reflects the documented difficulties in accessing these online databases, and I worked in telecommunications and IT for over 20 years, so I don't think the problem is user error. In my experience, rural and tribal first responder agencies have old computers, slow and unreliable internet connections, and limited or no workplace technical support, so their functional and material access is likely to be even more challenging than my own.

Parts of these systems rely on paper-based and paper-like (electronic tablets or laptops) data collection tools. Paper is not a bad medium for field-based data collection and is often the easiest to access and manage, particularly in rural and tribal areas. There will be inherent complications of transferring from one medium to another for final reporting, however collecting initial data on paper-based forms is the most broadly accessible format for people already under the significant stress of an emergency. Paper also provides a durable, transferable record that is easily shared with cooperating agencies that require immediate access to patient and incident information for continuation of care and documentation. Paper's greatest disadvantages for first responders are related to the need to limit data collection to one or two pages of pre-determined form fields that must capture information about a very broad range of unusual circumstances.

These usability challenges may be symptoms of the reduced value placed on the reporters that use them. Likewise, the data collection forms send negative messages to users about how valuable certain types of data are. In pre-hospital healthcare, patient data is collected on patient (or pre-hospital) care reports (PCR) (Figure 5: Patient Care Report for a rural EMS agency). These reports contain information on identity, demographics, vital signs, and the circumstances surrounding the patient contact. The vital signs and other quantifiable data are certainly important indicators of patient condition, but so is information about the patient and circumstances surrounding the reason for someone calling 911, which is information that would be entered as a narrative. The typical paper-based PCR includes a section for free-text entry of a narrative, and this is limited by the need to collect other information. In practice, it is difficult for a first responder to collect narrative information because it requires both the experiential access and functional literacy to generate this text, and the experiential access may be limited by time and situation rather than the physical presence of the form and a pen. Most responders do have the functional literacy to complete a reasonable patient narrative, which they would have needed to become licensed pre-hospital medical practitioners.

The PCR has two basic types of data, qualitative and quantitative, both of which can be what is known as "subjective" or "objective" information in medical terms (Podder, Lew, and Ghassemzadeh 2023). Subjective medical information is that which the patient or someone else tells medical personnel, for example how the person was hurt or their level of pain, whereas objective information is that which medical personnel see, measure, or feel. Some objective information is a combination of qualitative and quantitative, for example a heart rate of 90 beats per minute (quantitative) with a thready quality (qualitative). Subjective information could include quantitative data, such as a patient's report of blood pressure if the medical personnel did not observe it. The narrative can likewise combine qualitative and quantitative data, for example, a simulated cardiac emergency patient might have this narrative:

> *[objective:] Upon arrival PT [patient] was found supine on her living room sofa, anxious, pale, sweating, and complaining of [subjective:] chest pain*

radiating down an arm lasting one hour with severity 9/10. Husband states she fainted and fell to the floor and he moved her to the sofa. [objective:] No trauma observed or pain reported upon palpation of head, body, or extremities. [subjective:] PT reports numbness upon palpation of fingers. [objective:] BP 200/100, PR 140, PT given 4 x 81mg aspirin per cardiac protocol.

In my own experience, and paradoxically in terms of ensuring proper patient care, the more critical the patient, the less data might be recorded. When medical personnel are too busy treating life threats, they might collect zero information during treatment and must reconstruct the PCR based on memory with perhaps some very basic information literally written on the back of a hand. Such a situation is difficult to improve using any kind of training because it is simply a lack of sufficient resources, but critically evaluating the healthcare system and competently documenting the lack of resources in a grant application might lead to more resources in the future.

PATIENT CARE REPORT

INCIDENT NUMBER: (YYYYMMDD-##)

PATIENT:	DOB:
DL/M#	GENDER:
LOCATION:	EST. WEIGHT:
DISPATCHED COMPLAINT:	DATE:

TIME	BP	RESPIRATIONS	PULSE	SpO_2
	/	Rate: Quality:	Rate: Quality:	
	/	Rate: Quality:	Rate: Quality:	
	/	Rate: Quality:	Rate: Quality:	
	/	Rate: Quality:	Rate: Quality:	

TIME	TEMP

TIME	GLUCOSE

LUNG SOUNDS

L R
- ❑ ❑ Clear
- ❑ ❑ Rales
- ❑ ❑ Rhonchi
- ❑ ❑ Wheeze
- ❑ ❑ Absent

GLASGOW COMA SCALE

EYE OPENING
- ❑ 4 Spontaneous ❑ 2 To Pain
- ❑ 3 To Voice ❑ 1 None

VERBAL RESPONSE
- ❑ 5 Oriented ❑ 2 Incomprehensible
- ❑ 4 Confused ❑ 1 None
- ❑ 3 Inappropriate Words

MOTOR RESPONSE
- ❑ 6 Obeys Command ❑ 3 Flexion
- ❑ 5 Localizes Pain ❑ 2 Extension (pain)
- ❑ 4 Withdraws (pain) ❑ 1 None

Time:
GCS:

CHIEF COMPLAINT: ONSET/DURATION:

SIGNS & SYMPTOMS:

ALLERGIES:

MEDICATIONS:

PAST HISTORY:

LAST INTAKE:

EVENTS:

❑ OXYGEN via: Time: Flow Rate: | ❑ AIRWAY Type: Time: | ❑ C-COLLAR ❑ BACKBOARD Time: | ❑ CPR START END Time:

NARRATIVE:

DISPATCH: EN ROUTE: ON SCENE: AT PATIENT: TRANSFER CARE: CLEAR:

REPORTED BY:	E G M N V H	EMT:	E G M N V H	PPE
EMT:	E G M N V H	EMT:	E G M N V H	E - Eye G - Gown M - Mask
EMT:	E G M N V H	EMT:	E G M N V H	N - N95 V - Vest H - Helmet

PATIENT RELEASE: I refuse further treatment and/or transport by ambulance. Michigan Tech EMS has discussed with me the potential risks and complications by refusing treatment/transport and advised me that I can call 911 again at any time if I feel that emergent care is needed.

X_________________________ Witness _________________________

❑ EMS 10 ❑ LIGHTS & SIREN | TRANSPORTED TO HOSPITAL: ❑ YES ❑ NO BY: ❑ MTU POLICE ❑ MERCY ❑ OTHER:

Michigan Tech EMS | www.mtu.edu/ems WHITE – MTU YELLOW – MERCY PINK - DPSPS Revised 12/2020

Figure 5: Patient Care Report for a Rural EMS agency

It may be that the reduced value of a front-line reporter leads to the time constraints limiting material access, which is a problem fueled by limited human resources. Most first responders are working by themselves or with a single partner, which means that reporting will wait for the medical evaluation and treatment. I have also observed teams of three or more responders treating minor injuries or illnesses, and in these situations, the narratives are far richer and verbose, providing the reader with a full understanding of what happened and how the responders treated the patient. These teams also happen to be high-achieving university students interested in medical and allied health careers, and I would expect their language and critical thinking skills to be significantly further developed than the average population of first responders. These responders are likely applying rhetorical literacy (Selber 2004) and critical access (Banks 2006, 42): The responders will be using this experience to not only functionally report on this particular incident, but also use this experience to inform and develop their education and future work as doctors, medical scientists, and engineers.

3.2 Risk Literacy

A user's knowledge and expertise of these systems are factors determining quality of data, which are factors closely linked to usability, but there is a deeper knowledge and understanding that will help users not only access, but also participate in these systems to their greatest potential. System designers can make information functionally accessible and computer systems easy to use; however, users may lack essential skills and understanding that affect their ability to interact with even the best-designed and easily accessed systems.

While a typical first responder can be expected to have a high-school or higher level of reading and writing abilities to pass the state and national exams required to become an entry-level firefighter or medical first responder, they may not be fully familiar and comfortable with essential reading and writing, computer, and data analysis skills that would help them understand and optimally contribute to data collection systems.

As discussed earlier in this chapter, Selfe and Selfe (1994), Banks (2006), Sullivan and Porter (1997), and Selber (2004), consider literacies to be more than the functional skills of reading, writing, and speaking, but also social, political, and technical capabilities that allow a person to engage in and shape society. Without agency, individuals and whole groups may be sidelined and only marginally participate in the social structures which give opportunities for social worth and access to the resources which support healthy individuals and communities. In the realm of risk assessment, communication, and mitigation, critical literacy helps provide communities with the agency necessary to recognize and protect themselves from existential threats to their welfare, culture, values, and even basic threats to life.

As a means to improve risk data collection and risk mitigation, helping people gain the basic skills needed to collect, access, and enter data into data systems will certainly improve data, but helping them learn what this data is for and value themselves as an important part of improving emergency response and long-term risk reduction will stimulate a desire to fully participate and value their own input. These systems often treat their users as machines who should transmit data from a source to a destination with no opportunities for interpretation or participation. We fill out forms, pass them on to the data entry personnel or nebulous state system, and then we never hear another word about it unless we made a mistake. This places little value on the person who performs these essential functions, so they place little value on their actions.

When users are fully engaged and understand how and why they are performing a job function, they may go well beyond the minimum necessary compliance requirements. Ironically, public safety agencies ask first responders to address risky behaviors by asking them to explain to patients and citizens why a smoke detector is important and why they should use a car seat, but they don't give these same workers the benefit of the doubt and explain how their data collection is important.

As with the arguments to develop multiliteracies to improve students' writing and technology skills, risk communicators could develop multiple literacies to ensure that front-line data collection experts are fully engaged and familiar with the technical systems as well as the critical skills that allow them to fully assess and decide on what should be collected. Here is where critical or transformative literacy can lead to first responders assessing and identifying risks in their communities and making recommendations to mitigate these risks rather than relying on someone else who is physically and administratively far removed from the problem. This process can empower local experts to address local problems without waiting for the data to be evaluated several years later with some remote chance of local change coming many years after that.

An example of transformative literacy applied locally already happens when local practitioners interpret needs in their communities and apply for grants that meet those needs. This requires the firefighter or EMT to not only collect data, but also to interpret, understand, process, and present to grantors an argument for granting resources. As it happened in Chassell Township, one of the agencies where I work, our agency members didn't even need to collect additional data. The first responders determined a need to teach local citizens CPR based on intuition and backed up the need with nationally applicable statistics from public sources. We made the argument to a local philanthropy and received funding to establish a pool of CPR instructors with equipment to regularly tech CPR in our own community. Our agency now has enough AEDs for every responder and are teaching local citizens in CPR and first aid. This is transforming our township into one of the most prepared and well-staffed agencies in our area, all based on that first understanding and addressing the need for more citizens who could perform CPR and leveraging our literacy of the grant writing and submission process to meet this need.

Chassell Township Medical First Responders had the advantage of members with formal education and experience in grant writing and research at the local university and were able to apply these literacies beyond their day jobs. The literacies brought from a privileged workplace can be developed in first responders anywhere, and include computer, telecommunications, data collection, risk assessment & management, healthcare systems, environmental, funding and budgeting, grant writing and reporting, and teaching literacies. These are in addition to the firefighting and emergency medicine literacies that these workers already bring to the job and continue to develop through hands-on experience and continuing education. Although this list seems long and daunting, they each contribute to the workers' abilities to perform their primary functions and will help improve their social and economic standing outside their roles as first responders. And, as will all literacies, if instructors can teach first responders the basics and give them critical access to the processes, techniques, and technology, they can further develop skills on their own and transform their own agencies. Transferring these literacies and fostering their development would be applying critical literacy in these techniques.

3.3 Educating First Responders to Critically Report

As described in the previous sections, barriers to collecting, entering, and analyzing data include functional access, usability, multiliteracies, and tangible resources. I will return the focus to improving data collection and analysis, which brings with it competencies in other areas and provides first responders with skills and information that can garner additional resources.

People with limited functional and critical access to complex databases, computer systems, geospatial technologies, and healthcare research may feel that they do not have opportunities to participate in the complex technical and administrative systems that government agencies demand of them. While it is true that they may not have the same skills as the national experts that design and administer these systems, they do have the functional and critical skills that can identify and explain the problems that they encounter in their own communities. Each of us is empowered and capable of listening and telling stories, and these skills can supplement and can replace the quantifiable data that technologically driven systems demand.

My own experience informs this work as both a participant/practitioner and an educator in pre-hospital medicine, risk assessment, traffic safety, and firefighting. It is a privilege to not only participate but also inform future practitioners, and an even greater privilege to critically evaluate the systems I engage with. The pre-hospital and firefighting curriculum is full of important technical information to help these practitioners do their jobs better and more safely, and this content is developed by experts with far more experience and expertise than I could ever gather. However, as someone who studies rhetoric and technical communication, I do have the opportunity to inform my students about the how and why of good reporting. With this knowledge and experience I can provide students with many of the arguments I make in this body of work, and I have found that reporting can indeed become an exciting part of the job, even for those who have no interest in further study in medicine, engineering, or the humanities.

I teach Medial First Responders (MFRs) and Emergency Medical Technicians (EMTs) in our community. While reviewing the commercially prepared content for these classes, I recognized weaknesses and inadequate content regarding the purposes for and practices of reporting. In my lecture on reporting and documentation, I introduce students to many of the concepts contained within this dissertation: Why reporting is necessary, how the data is used, what happens if the data is inadequate, and how to improve report content. The information on how to collect the information seems to be less exciting to them than the information on why they should report this information. This tells me that the students can be interested in implications for reporting, which also tells me that they can learn to critically assess their responses when completing the forms.

The lecture emphasizes narrative inquiry and practices as described by Natasha Jones (2016b; 2020), Jeong-Hee Kim (2015), and Kristen Moore (2013) and antenarratives by Jones, Moore, and Rebecca Walton (2016). Narrative-based practices provide rich data that are not constrained by expertise or prescribed quantitative data collection forms. Narrative inquiry also provides opportunities for considering a broader context to the circumstances being described and allow those collecting data to critically reflect on their choices for report content. To accomplish this, I present information about how the data will be used in the national healthcare system and the consequences of underreporting or incorrectly reporting. The lecture explains the problem of data collection described in Chapter 2, specifically the failure of traffic safety engineers to identify locations for traffic safety improvements based on location and patient-specific reports. The result, as explained in Chapter 2, is that traffic safety engineers find it difficult to make safety improvements in areas where they know the most people are dying. Feedback from students has been overwhelmingly positive: They indicated that they had no idea that their reporting would form national public policy, nor did they know that the lack of accurate or complete reporting would perpetuate the disparity in fatalities and injuries faced by people in rural and tribal areas.

Such a lecture is an example of critical literacy described by Anne Gregory and Mary Ann Cahill (2009) or Stuart Selber's rhetorical literacy (2004): The instructor has deconstructed the process and given students the contextual circumstances that allow them to recognize the full implications of their reporting practices and then created content which effects systemic change. Following this lecture, the students would be expected to not only critically evaluate the specific reporting practices for this task, but also recognize that a broad context exists for any reporting that they may do in the future. The result should be improved data collection and, hopefully, improved analysis and mitigation by those who review and use this data in the future. The students should also feel empowered to make a direct impact on healthcare decisions and the survival of at-risk populations in their own communities as well as for affected populations globally.

This chapter focused on the user experience of field-based medical and fire reporting and how developing critical risk reporting literacies can improve the quality and quantity of essential field data collection and develop broadly applicable skills among first responders. Applying theories of usability and user-centered design from Robert Johnson (1998) are particularly useful for improving first responder data collection systems, and acknowledging the agency and authority of the report writers can lead to improved participation and attention to the reporting task as well as improved system design (Johnson 1997). Similarly, participatory design and critical literacy development could improve the overall reporting experience and competency, which, ultimately, would lead to improved health outcomes for patients and improved responder and public safety. For now, teaching innovations support improvements for the fourth E of traffic safety–emergency services.

4 Opportunities for Expanding Rhetorical Risk Assessment, Communication, and Mitigation Methods – The Boeing 737 MAX Case

In the previous chapters, I identified possibilities for helping groups with limited knowledge and financial resources to find, analyze, and communicate risk-related data where none supposedly existed. By empowering even a single person to recognize, collect, and interpret qualitative data, communities can take control of risk assessment and mitigation that will help address anthropogenic and natural risks in small communities. Even though I have focused on this approach as an effective strategy when resources and knowledge are limited, the approach can also be used when expertise and resources are abundant and rich quantitative datasets are available. The advantages to substituting or supplementing quantitative analyses with qualitative data are the same for both resource-rich and resource-limited situations: Qualitative data collection and interpretation improves the overall understanding of a problem, proactively manages risk, and accesses greater diversity of expertise and experience.

In this chapter, I look at several cases where a quantitative data analysis imperative may have led to catastrophic outcomes for some of the richest and most advanced corporations and government agencies. Commercial and governmental organizations such as Boeing, NASA, Raytheon, the Federal Aviation Administration (FAA), and any number of other large, well-funded agencies and companies would seem to have no financial or expertise constraints on collecting and processing any amount or type of data, yet they are still failing to interpret what's necessary to prevent catastrophic failures for similar reasons again and again. This may mean that the problem of understanding risk is not due to the number of resources available, but instead it may be based on how regulators and businesses do or do not value a human-based interpretation of a problem as well as how to communicate technical and risk information to each other.

My primary focus for this chapter, the crash of two Boeing 737 MAX passenger aircraft, occurred as I was researching and practicing risk assessment and communication focused on small, resource-poor communities, and it struck me that the conversations surrounding the crash investigations were very similar to those that I experienced in traffic safety assessments. In both local traffic safety assessments and aircraft safety assessments, risks are identified by collecting quantitative data from failures, which, in the case of aircraft, can often be catastrophic, involving hundreds of lives. In both of these transportation safety assessments, engineers and regulators rely on a significant amount of quantitative data to substantiate risk mitigation measures, sometimes even when qualitative data already point to a likely cause. The exact amount of data required may be pre-determined, as in a certain number of fatalities at an intersection that will automatically invoke a traffic safety audit, or it may be an unknown amount of data, as in when determining the exact point at which a plane is no longer allowed to fly due to near misses or actual crashes. Ironically, the point at which some activity becomes too risky is determined by intuition, and usually correlates to when politicians have decided that their constituents will blame them for catastrophes rather than blaming or ignoring the risk, as in the case of the recent train derailment in Ohio (Daly 2023) or forest fires throughout the western US (Haeffele 2016).

In Chapter 2, traffic safety agencies decided to reframe the idea of what an acceptable number of traffic fatalities is: instead of asking people how many deaths were reasonable nationwide, they asked them how many were acceptable in their own families. The response was predictable—most people accepted hundreds or even thousands of deaths nationally, but did not accept even a single death in their own family. Similarly, the public sees the risk of train derailments, forest fires, or other catastrophes as remote until they are personally affected or until the catastrophe is so large that it raises to a national conversation of what an acceptable risk is, as it did when Congress took on traffic safety in the 1960s ("Automobile Seat Belt Standards: Hearing, Eighty-Seventh Congress, Second Session, August 17, 1962" 1962). Somewhat unusually, the Ohio train derailment is a case that rose to a national level even though it did not directly cause any deaths. It may be that the insidious nature of toxic waste and the government and train operator's bungling of communication led to local and national outrage, or it may be that a combination of where and when it happened provided media and politicians with an opportunity to exploit the situation. An alternative outcome of reduced rage might have involved expert messaging or even information suppression, which raises a question of ethics for risk communicators: If you could design the messaging to reduce outrage about toxic waste, should you? The cases discussed in this chapter rose to national attention because they involved high-profile space operations and the always compelling plane crash narrative, but the reasons for outrage are familiar – failures in risk assessment leading to disaster with compounding failures of communication.

Unlike the previous cases, I did not participate in any part of the processes leading up to these disasters or their investigations. Instead, I reviewed news media reports, government and corporate media statements, and public documents related to investigations. In addition to the normal aircraft crash investigation processes that produce many reports and analyses, high-profile disasters such as these often lead to hearings and investigations by political bodies that look at more than engineering failures. It turns out that when the biggest disasters happen, governments, and by extension the public, are not satisfied with engineering analyses that rely on quantitative data and technical faults, and they turn to outrage to help them decide when enough is enough. All of the documents referenced in this chapter are in the public record, such as mass media publications, testimony, or evidence collected through voluntary and involuntary discovery as part of government agency or US Congressional investigations and reporting.

Official records from congressional hearings have a rich set of documents and other media collected by investigators and professional researchers. Although the summaries and statements most frequently published in mainstream media can be laden with emotional appeals for political purposes (yes, this is usually called political *rhetoric*), governmental investigations, especially those involved with technological catastrophes, have a tremendous amount of quantitative and qualitative data collected from the businesses and agencies involved in research, development, and deployment of the devices and systems at the heart of the catastrophe. The official reports also include images of original documents generated by workers involved and extensive bibliographic entries. These reports also contain a significant amount of quantitative data that is likely a logical appeal to the quantitative imperative that I experienced in my own work with government agencies.

I analyze these documents using rhetorical practices learned doing primary research in graduate school and practiced as an academic and professional technical communicator, focusing on first-person accounts from those directly involved in the product development and testing and subsequent analyses by investigators. I was not looking for conclusions by the investigators or the people involved; instead, I looked for specific words and phrases that indicated increased or decreased value for certain data types, examples of how and why certain communications between workers took place, what might have been said but not necessarily represented by quantitative data, and how those communications could be linked to the decisions made leading to the events. This is similar to my research of the motor vehicle reports discussed in Chapter 2 and the methods used by Sauer to research coal mine safety (2002): by reading, watching, and listening to the first-person accounts of the workers involved, many inferences can be made about how the workers understood problems and why workers' personal experiences may or may not have been valued or acted upon. My experience as a researcher involved in government-funded projects and practitioner of technical and professional communication certainly helped me navigate the technical data and highly specialized language from engineering and law, but I found that many of the documents were written for political and policy purposes and so were not beyond most readers with a college or technical education in any topic. The documents also included presentations, statements, and other media intended specifically for a general, non-technical public audience.

A triangulation method that started with me first hearing about these events in mass media helped me connect many sources and media types to a risk analysis event. As an event unfolds, many higher ranking corporate and agency representatives give interviews laden with clues about what might have led to the disaster and are frequently followed by apologetic, accusatory, or defensive statements by others involved. In the case of the 737 MAX crashes, FAA leadership made statements about their data analyses that hinted at a preference for certain types of data that would allow them to make a decision about grounding the aircraft ("FAA Acting Head Dan Elwell On Boeing Decision : NPR" 2019):

> *[Dan Elwell, acting administrator of the Federal Aviation Administration]: "And when you have a common thread between two accidents, then the argument for grounding becomes necessary. Grounding becomes necessary, and so that's what we did. We didn't have that link until yesterday morning, yesterday afternoon about midday.*
>
> *[NPR's David Greene]: But isn't this something that analysts and experts have been saying for days now, that these two crashes appeared similar?*

> *[FAA's Dan Elwell]: Yeah. Many were saying it, but nobody had data to act on it. It was all conjecture. And in aviation, the FAA in the U.S. has always acted on data. We're a data-driven organization. We have the safety record we have today based on science, risk analysis and data.*

A close reading of this interview revealed the kind of words that I looked for in documents and media that indicated a preference for certain types of data: the FAA representative labeled evidence of a problem with these aircraft as "conjecture" ("FAA Acting Head Dan Elwell On Boeing Decision : NPR" 2019, para. 7). This led me to begin collecting media and official reports about this crash so that I could explore the content for clues about the processes and methods used to analyze the risks involved in this disaster and make connections between the actors and events.

4.1 737 MAX Disasters

In 2018 and 2019, two new passenger jets of the same type crashed, killing all 346 passengers and crew (Fallows). This aircraft, the 737 MAX, implemented many advanced safety systems, including systems that automatically adjusted flight control surfaces to prevent the aircraft from becoming uncontrollable and restoring stable and safe flight. Such systems are not new; however, the level of automation is increasingly independent of pilot input, even overriding pilot input in an attempt to overcome accidental or intentional pilot control. These types of automated systems rely on vast amounts of data and high-speed processing and, by their nature, emphasize automated data collection and processing over human decision-making. Such a technological imperative reduces the value of human decision-making, and for seemingly good reason, because most aircraft crashes are due to human error ("Accident Statistics" n.d.; Billings and Reynard 1984). However, the impact of such an emphasis on computational data processing may be reducing the value of human decision-making throughout an organization, industry, and even the social structures designed to manage this technology.

In the case of the 737 MAX design and eventual safety assessments, data collected and presented by humans were ignored, disregarded, or undervalued, leading to unsafe designs and, ultimately, to aircraft crashing (Fallows 2019; Newburger 2019). The reasons for valuing automated systems over human decision-making can be attributed to a mistrust in human judgment, but other factors such as greed and fear also have roles. Ironically, humans may rely on automation to reduce the impact of emotionally influenced decision making, yet emotion is what could save lives in cases such as these.

Pilots had complained about the new software and systems that overrode pilot input, leading to dangerous flight conditions (Fallows 2019; Newburger 2019). Remarkably, the FAA and Boeing did not ground these aircraft based on these complaints, even after losing two aircraft. In fact, the FAA continued to argue that there were insufficient data to ground these aircraft and decided only after accumulating and processing additional flight and satellite data to ground the aircraft ("FAA Acting Head Dan Elwell On Boeing Decision : NPR" 2019). Had the FAA and Boeing listened to the pilots' and engineers' fears, not to mention glaring evidence of the first aircraft loss with all crew and passengers killed, the second crash may have been averted.

This case has many similarities with other disasters where the value of quantitative data has been differently valued than even extremely rational and expert opinions presented by humans. The Challenger and Columbia space shuttles were both lost due to decision-making which pitted engineering and technical data against human intuition and knowledge. Investigations into the Challenger crash heard accusations of a lack of quantitative risk assessment being blamed (Bell and Esch 1989), while others linked failures to communicate intuitive concerns by engineering staff to NASA leadership (Beardsley and Palca 1986; "Rogers Commission Report" 1986). Just over 17 years later, the Columbia shuttle crash again showed weaknesses in how humans understand and control the risks posed by flying these extremely complex machines. Investigators linked the failure of humans to accept conclusions based on computer simulation and other quantitative data (Wilson 2003) to the Columbia's destruction on re-entry from space. In one shuttle crash, the humans were accused of failing to gather quantitative data, and in the other humans were blamed for failing to believe it. In the cases of the shuttle and 737 MAX crashes, the difficulty was not in generating enough data, but instead in how humans interpret and value data from different sources.

In the Challenger space shuttle crash, engineers knew about the risks of the joint seals used in the shuttles' booster rockets after field-testing the joints, yet these concerns did not lead to a redesign of the joint:

> *"Morton Thiokol, Inc., the contractor, did not accept the implication of tests early in the program that the design had a serious and unanticipated flaw. NASA did not accept the judgment of its engineers that the design was unacceptable, and as the joint problems grew in number and severity NASA minimized them in management briefings and reports. Thiokol's stated position was that 'the condition is not desirable but is acceptable.'" ("Rogers Commission Report" 1986, 121)*

The data, visual evidence of potential joint failures, was inadequate, improperly understood, or insufficiently compelling to lead to a redesign. Similarly, damage to the heat shielding on many flights leading up to Columbia's destruction had been documented (Wilson 2003), yet this data, again visual evidence, did not lead to a change in design or flight protocols. Hearings were convened, reports published, and recommendations made to overhaul NASA's safety culture, potentially leading to a structure where safety information would receive priority consideration. Fifteen years later, the same problems plagued another large and well-funded government agency.

FAA Acting Administrator Daniel Elwell gave similar reasons for waiting to ground the 737 MAX after nearly every other country had already grounded this aircraft following two crashes in six months:

> *"We have been working tirelessly since that accident to find evidence that could help support a reason behind it, and the new information that we got*

> *just today [three days after the second aircraft crashed] verified for us that the incident flight, the Ethiopian airlines flight, the track of that airplane was close enough to the track of the Lion Air flight that went down in the ocean four or five months ago, close enough to that flight to warrant the ground of the airplanes…We said all along, we weren't going to ground until we had actionable data, and that's what FAA looks for…As I said, we are a data-driven, action-oriented agency and we don't make decisions about grounding aircraft or regulating or even shutdown decisions for airports or aircraft without actionable data. And in this case, the actionable data didn't arrive until today…" (Wang 2019)*

Again, there was visual evidence and even complaints by pilots that this aircraft might have problems, yet the FAA insisted that there was insufficient data or good enough data to ground the 737 MAX (Newburger 2019; Fallows 2019). What more actionable data does one need besides two aircraft crashing in five months?

These cases show that the culture within these large, technoscientific organizations does not trust certain kinds of data. They are willing to allow catastrophes to repeat until there is overwhelming public opinion or simply no more resources left to lose. The same techniques recommended for educating and empowering individuals to collect, interpret, and report findings in small communities could also help large, rich organizations recognize and mitigate risk. The engineers, administrators, and managers in these organizations can benefit from learning the techniques used by groups with limited resources and those who practice qualitative data collection. As with reading, writing, computer software, and other skills, the knowledge of how and when to use qualitative data and critical thinking for risk assessments is a form of technical literacy that can be developed through education and experience. As with other literacies, there is also a range of risk communication literacy, from a functional application of the techniques through a full understanding of the implications for using or not using qualitative risk data and on to a full integration of thinking about risk in all activities by individuals and organizations. Once risk communication becomes an integral part of work and thought processes, the risk communication-literate person described in Chapter 3 would recognize, evaluate, and act on risks they see rather than simply recognizing and reporting. Such an enculturation of critical risk literacy could open new ways to see problems or place higher value on alternatives to the status quo.

If the FAA and Boeing would have simply asked pilots what they thought about how these planes fly with the intention of using this information to inform their decision-making process, it seems certain that the second plane crash could have been avoided. This is no different than recognizing a rural tribal community's concerns about high speeds on the state highway that runs through their town. Until enough people are killed, authorities will not be compelled to make changes to the system that led to those deaths: The typical transportation safety guidance requires safety improvements when a significant number of crashes has already occurred ("Highway Safety Improvement Program | Mass.Gov" 2020;

"MDOT Data Driven Safety Analysis (DDSA) Guidance" 2022). This is the opposite of risk mitigation; it is risk continuation until the worst possible and inevitable outcome. This is what I will call a risk-friendly system of risk assessments.

4.2 What Makes a Risk-Friendly System?

Our educational, scientific, governmental, and economic structures seek to remove subjectivity from decision making in a quest for fairness and rationality, which may instill mistrust of subjective assessment and evaluation. The risk assessment and mitigation culture that demands overwhelming quantitative data to make rational decisions is likely fostered by this cultural focus on objectivity and an emphasis on the scientific method for all scientific and engineering processes, even though this method does not exclude a scientist's observations as a valid form of data. I believe that the emphasis on quantitative data does lead to repeatable and consistent results in engineering and science while minimizing subjectivity, but at the expense of not providing future scientists with the intellectual tools necessary to consider alternatives. Removing subjectivity from the scientific process also removes opportunities for critically assessing the process, data, and results. This rational, objective process results in a risk-friendly system of scientific and engineering processes because it encourages people to continue risky behavior until there is an overwhelming quantifiable data that proves a risk exists. The opposite of a risk-friendly system is one where all people can anticipate risk using individual or cumulative knowledge of what makes things risky, allowing proactive risk mitigation without demanding a catastrophic outcome first. This would be a risk-averse system, and it would rely on those interpreting and communicating risk to use intuition in addition to other risk assessment tools to minimize risk. To be fair, anyone involved in risk assessment and communication is likely trying to avoid catastrophes, except perhaps those who may be avoiding the risk of a loss of profits when people avoid their products.

In engineering, risk is something to be expected, quantified, and accommodated at a <u>reasonable cost</u>. Unfortunately, this cost is often paid in human lives: The Massachusetts DOT's Highway Safety Improvement Program's (HSIP) defines this cost with a threshold: "[An] eligible cluster is one in which the total number of 'equivalent property damage only' crashes [one fatal or injury crash equals 21 property damage only crashes] is within the top 5% in the region" ("Highway Safety Improvement Program | Mass.Gov" 2020) which is similar to Michigan's guidance which calls for improvements when a location is in the top 5% of the state's "high crash list" ("MDOT Data Driven Safety Analysis (DDSA) Guidance" 2022). Fortunately, guidance from the Massachusetts DOT, Michigan DOT and similar agencies also calls for proactive safety assessments for new projects and systemic mitigation measures which apply improvements to a roadway system, but proactive measures still focus on historical crash data that prove the efficacy of mitigation measures. This quantitative imperative may be the reason why risk managers seemingly accept loss of life, environment, and security instead of trusting judgment to do what's right.

A 1989 article titled "The Space Shuttle: A Case of Subjective Engineering" in the influential *IEEE Spectrum* journal (Bell and Esch 1989) criticized a failure to quantify the risk of flying the space shuttles, which the authors suggested made the risk simply too unknown for the engineers to be taken seriously. Following this line of thought, a risk that can't be quantified isn't a risk worth taking, but I don't think that's what the authors intended to say. They probably meant that engineers should not trust judgment and intuition, instead placing ever greater emphasis on quantitative risk assessment and doubling down on a shift away from intuitive deduction as an acceptable form of scientific and technical development. This distrust of intuition becomes more obvious in the apparent criticism of Will Willoughby, the head of safety and reliability of the Apollo moon program, for saying, "statistics don't count for anything" and, "they have no place in engineering anywhere" (Bell and Esch 1989, 42). This clearly calls for removing subjectivity from the engineering process, but read through today's lens, I can understand the opposite: Perhaps the reason that the Apollo missions accomplished the seemingly impossible over 50 years ago was exactly because the head of reliability and safety trusted his intuition and judgment instead of waiting for every possible piece of quantitative data to substantiate his decisions.

The "Subjective Engineering" article further posits that the lack of taking quantitative data seriously led to a culture of failing to properly assess risk, and ultimately may be what led to the Challenger's eventual demise. Perhaps the problem was that this time period in US scientific discovery was a transitional phase when scientists and engineers were abandoning instinct, intuition, and judgment, but had not yet mastered, or created the machines to master, the vast amounts of quantitative data required to make accurate risk assessments for extremely complex machines. In the 1950s and 1960s, engineers created spacecraft and aircraft with extremely limited computational capacity by modern standards, instead relying on theoretical concepts of physics, creativity, and an iterative process of trial and error. Even the Apollo program, which had phenomenal resources dedicated to it, relied on the creativity and ingenuity of engineers in the most critical times, such as when the Apollo 13 mission was saved with a series of ingeniously modified systems and workarounds (Uri 2020). In spite of such a spectacular history of success, by the time the Challenger exploded, NASA may not have had the *science* of risk management mastered but had already lost the *art* of risk management.

After 737 MAX crashes occurred, we might have expected an article from *IEEE Spectrum* called "737 MAX: A Failure of Objective Engineering," for we have come so far from the gut-level engineering of the 1950s and 1960s that we can't even imagine that a human could understand what's wrong with the machine under their (ever decreasing) control. Indeed, the *Final Committee Report on the Design, Development, and Certification of the Boeing 737 MAX* recommends that Boeing "needs to restore its reputation as a company focused squarely on safety and quality" and "can and must take significant steps to create and maintain an effective, fulsome, and forthright safety culture" ("Final Committee Report on the Design, Development, and Certification of the Boeing 737 MAX" 2020, 229). To accomplish this, the report states that Boeing is undertaking a series of changes, including: "(7) Expanding our Safety Promotion Center for employees to learn and reflect on our safety culture and renew personal commitments to safety;" and "(8) Expanding our anonymous safety reporting system to strengthen safety management systems within Boeing and our supply chain" ("Final Committee Report on the Design, Development, and Certification of the Boeing 737 MAX" 2020, 230). These steps must be interpreted as a move away from purely quantitative safety management and toward a system where qualitative input from individual employees and aircraft users is valued and used to ensure the safest aircraft possible.

With a risk-averse approach to the 737 MAX crashes, the FAA and Boeing may have used the information supplied by pilots (Fallows 2019) or engineers (*BBC News* 2020) during aircraft development to change the plane's design or reprogram the flight computers. A risk-averse system would not require specific faults to be identified, or could reduce the number of faults (crashes) that would initiate a grounding while anticipated problems were examined. This would require large companies and government agencies to empower more people to question design decisions and give authority and responsibility for safety to a broader range of expertise and knowledge, something that was called for as a way to improve safety culture at Boeing ("Final Committee Report on the Design, Development, and Certification of the Boeing 737 MAX" 2020).

The abandonment of qualitative risk assessment has led us to a scientific and technical culture that not only accepts risk but demands the consequences to prove that these risks exist. A quantitative risk assessment can only be retroactive, because without evidence that the risk leads to unacceptable losses, then it does not exist. This is how we arrived at the situation where two aircraft must crash before we can say "Aha! Now we can prove that something is wrong!" and an intersection in a rural tribe will only be risky when police have collected enough crash reports with severe injuries and fatalities to make a hot spot on a GIS map. Without qualitative risk assessment as an acceptable measure, we will never listen to the children who must cross that intersection and say that they don't feel safe, and we'll never prevent those deaths from happening in the first place. This is a perfect opportunity for engineers, regulatory agencies, risk managers, and the public to apply risk techne, or the art of risk assessments. By evaluating risks using learned knowledge and experience as well as quantitative data, risk assessments will be richer, more inclusive, and empowering and may lead to risk-averse systems of risk management rather than the risk-friendly system of a quantitative imperative.

5 Conclusion: What Risk Literacy Can Do

As I conclude this dissertation, another case of a tension between qualitative and quantitative evidence in transportation safety is developing: a train derailed in East Palestine, Ohio and burned, releasing hazardous materials. The citizens of East Palestine have been posting videos to social media showing chemicals in water near their homes (Washington Post 2023) while the Environmental Protection Agency and the Ohio Governor's office simultaneously declare that the water and air are safe ("East Palestine Water Quality Update | Governor Mike DeWine" 2023). It is still too early to determine whether the public or the regulators are correct, but the public is hearing information that they do not trust because they can see with their own eyes that something is wrong. The citizens trust their eyes, and the regulators trust their sampling. The surface water may indeed be contaminated, *and* the drinking water may indeed be safe, but both sides are having difficulty using their respective data to make sense of the situation.

This emerging case could immediately apply the critical risk literacy, participatory design, and user-centered approaches to risk management I introduce in Chapter 1 and develop throughout this dissertation. Chapter 1 also describes how I came to study risk communication and what let me to understand why quantitative risk analysis is failing to understand risks and prevent disaster. The introductory chapter considers how technical and professional communication (TPC) and rhetorical practices are relevant to risk management and proposes how TPC can be applied to risk assessment. I also consider how quantitative risk analyses may be alienating those that risk managers are trying to protect and perpetuating social, economic, and cultural divisions.

Chapter 2 looks at how a quantitative imperative is failing to identify local traffic safety problems in tribal and rural areas and the repercussions for these communities. This chapter also takes a closer look at the political, social, and human cost of failing to conduct more inclusive and equitable risk assessments and suggests solutions found in participatory design.

In Chapter 3 I use my personal experience to describe the risk data collection process in public safety and highlight problems of usability and risk literacy among first responders. This chapter develops the idea that TPC concepts of literacy can be learned with relatively little effort and describes how that can lead to wide-ranging improvements in data quality, quantity, and the overall development of agency among those working in the field.

The final cases presented in Chapter 4 show how the problems I discovered in local risk management activities are also prevalent in large, resource-rich organizations involved in space exploration and commercial aircraft production. I propose the same types of risk literacy development and user-centered design in these organizations to avoid the pitfalls of a quantitative imperative that contributed to the airline disasters described in that chapter.

Finally, I arrived at a conclusion that a quantitative imperative to risk management is risk-friendly; that is, when decisions are made based on data that accumulates as a result of a risk, we must continue facing the risk until enough quantitative data proves the risk exists. To avoid the quantitative imperative of a risk-friendly system, I propose a risk-averse approach that seeks risks using a combination of common sense, intuition, inclusion, and enough quantitative data to support our intuition, which is a proactive approach that does not demand a certain number of fatalities before we mitigate a risk. This is an application of Robert Johnson's descriptions of techne (1998, 24, 51–53), the art of knowledge, or in the case of this work, the rhetorical art of risk assessment. If we only focus on the outcomes to validate a risk, then we will always be waiting for the worst possible thing to happen before we make decisions, and we blind ourselves to an otherwise obviously dangerous curve in the road, poorly practiced medical procedure, or improperly programmed flight control computer.

We need data to make decisions, but that data can be so much more than discrete quantities of dead and injured people, contaminated water, or failed home mortgages. The art of risk assessment includes data from stories, pictures, listening, reading, conversations, and even intuition. Most of us successfully use these data points every day just to make it out the door, and it helps us avoid paralysis through analysis, which is what the FAA seemed to be facing as they considered grounding the 737 MAX. I believe that we have had the ability to use qualitative methods for successful risk analysis in the past, and we still trust qualitative research in many fields, but the emphasis on objectivity through quantitative, machine-friendly data has gone too far.

Subjectivity not only provides us with valuable data where quantitative data is unavailable or insufficient, but also supports a holistic view of problems from multiple standpoints. Including the observations from a diverse group of experts, including those experts without formal technical training in risk management, engineering, science, and mathematics, can only improve the overall understanding of risk, allow for a broader range of viable risk management options, and enable proactive risk mitigation. Excluding or discounting "non-experts" from the risk assessment process contributes to what cultural theorists describe as a fatalist culture (Wildavsky and Dake 1990; Dake 1992), leading members of this group to resign themselves to risk. Increased participation by all stakeholders, particularly those who are often excluded from decision making processes, establishes agency among those whom we are trying to protect, and encourages personal responsibility and authority for mitigating risks as well as encouraging a broader trust in the social institutions that regulate risk.

5.1 Future Study

This dissertation advocates using personal experiences and observations as valid and valuable data, which offers additional opportunities to research rhetorical practices in risk management using rhetoric, ethnography, and even quantitative studies. This is not a totally new approach to risk analysis and is a recommended process in traffic safety ("3.0 Overview of Road Safety Audit Process | FHWA" n.d.) and well demonstrated by Kathryn

Quick, Adam Larsen, and Guillermo Narváez's national survey of safety issues in Indian Country (2019), even if the format may not be practiced as often as it could. The difference between the typical qualitative study conducted by a department of transportation or other government agency and the recommendations in this work are in the people, data, authority, and outcomes. Whereas a typical qualitative study might use surveys to gather opinions using forms and short responses to identify discrete problems within a range of objectives set by external authorities, the rhetorically motivated qualitative study would engage all parties to explore what risks are perceived, why the risks exist, and have a goal of systemic improvements through collaborative mitigation planning. Authority for setting priorities could be vested in those affected by risks instead of meeting the goals of an external authority. The form of participation is also subject to critical review, because, as described in Chapter 2 and 3, a policy or system can exclude participation through poor design, poor policy, or lack of functional or material access. Taken together, the differences between traditional qualitative studies and those proposed here are in the goals, objectives, process.

The lecture described in section 3.4 can be structured as a usability study, behavior analysis, or narrative inquiry to document the impact of rhetorical training on a group of first responders. Additional studies could address the usability and user interface/user experience (UI/UX) of data collection and reporting tools used in public safety or any other safety-oriented system. Instructional content can be tested to determine how effectively it improves risk literacy among expert and non-expert groups and how it affects risk mitigation outcomes. These studies can all include both quantitative tests, for example by measuring report entry speed and accuracy following interventions, and by the qualitative methods proposed throughout this dissertation.

These suggested studies as well as the data collection systems and procedures for public safety and any other processes used in risk management should be critically evaluated to ensure that they are easy to use, correctly collect information that serves broader goals of health and safety programs, and do not discriminate or alienate users or beneficiaries of risk management. Critical evaluation would involve participatory design like that described by Natasha Jones (2020; 2016; 2016b; 2016a) and Kristen Moore (2016; 2016; 2013), which goes beyond obligatory public listening sessions and truly engages the public to identify *and address* their concerns. Because the risk assessment processes are themselves systems and involve technological tools, these critical evaluations would also be from a user-centered perspective, to avoid what Robert Johnson described as "colonized knowledge ruled by the technology and the 'experts' who have developed the technologies" (1998, 5).

5.2 Risk Literacy in Daily Life

There is certainly a danger to trusting intuition and non-expert advice: The COVID-19 pandemic made that abundantly clear through public resistance to proven infection control measures, such as refusal to wear masks, and ineffective and even dangerous remedies popularized through social media, such as the inappropriate use of antiseptics and ultraviolet light as a treatment for viral infections (Popat 2020). This is why risk literacy is so important, for if more people understand how to critically evaluate risks, then politicians may avoid making statements that harm their reputation and risk public skepticism of authority, experts might be able to better inform policy makers and the public, the public might be better at differentiating between helpful and harmful practices, and those at risk will not ignore guidance that can help them be safe and healthy.

Risk literacy is also an essential skill to help individual resilience, even when there is no obvious danger to prepare for. In late 2019 my daughter experienced an illness that suddenly paralyzed her. This happened not because of risky behavior, an accident, an insidious disease, or anything else that was predictable or preventable. However, having a level of risk literacy allowed me to critically assess the situation and trust the phenomenal experts who informed, treated, and guided our family through the crisis. Some people say that a child's severe illness is something that no parent should have to experience, but I think that life-changing challenges, and yes, even tragedies involving a child teach us so much more about ourselves and those who care about us than a life of safety and comfort ever could. My own risk literacy helped our whole family recognize her illness and subsequent disability not as a tragedy, but as an opportunity to discover resilience, tenacity, and a seemingly endless supply of caring people who create opportunities for people with disabilities.

Although this dissertation is about minimizing risk and tragedy, I believe that risk and uncertainty can be good for us if we face it with knowledge and experience, and especially if we use that expertise to help others. We cannot avoid risk, but knowing how to recognize, evaluate, and face risk allows us to persevere in the face of seemingly insurmountable odds. The outcome can be so much more than risk awareness because what we learn through our own resilience, and even more so through the resilience of the ones we care about, will help us face any challenge.

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