Contents

Part 1

What Are We Doing Here?

01 Bad Medicine

Let me tell you a story about the time I ended up in a Cabo San Lucas emergency room where a doctor slowly and methodically dug around each of more than a hundred sea urchin needles and pulled them out of my feet like vertical splinters.

The localized anesthesia shots hurt just as much as his digging, so I figured I might as well skip the shots. My approach to pain management was staring intently at some Spanish version of the Hippocratic oath hanging in a rusty frame on the wall. I tried to translate it in my head. I thought about the life of Hippocrates. I felt happy to live in a time where we must know a heck of a lot more about medicine than he did.[a]

In the years since, I've learned that it's been a long and painful journey for modern medicine to get to this point.

Don't get me wrong; we need to give doctors their due. Anesthesia. Germ theory. X-rays. Antibiotics. Vaccines. DNA. Organ transplants. Chemotherapy. Magnetic imaging. The human genome. The list of medical advances that we now consider commonplace is *loooong*. Everyday medical treatments of today would have been considered a medical miracle not that long ago. Before the discovery of insulin in 1921, diabetes was a death sentence.

But for at least the first 1,000 years after Hippocrates, it wouldn't be hard to make a case that doctors killed more people than they saved. On his *Against the Rules* podcast, author Michael Lewis says, "For roughly 5,000 years, people called themselves doctors and pretended to know all sorts of things that they didn't know and were as likely to kill you as to cure you. These doctors existed because sick people desperately wanted to believe them."[1]

[a] I was also happy that it happened on the last day of spring break (instead of the first) and that I had learned how to surf—at least a little bit—before the sea urchin–covered rocks ended the fun. Why my friend's Cabo-based brother brought us to a surfing location where you can't safely walk from the waves to the shore (and didn't tell us) is beyond me. Also, two-plus hours of "surgery" cost me about $20 in cash.

Doctors in the early 1900s treated coughs and sore throats—in kids—with heroin.

During this time, doctors used X-rays to remove unwanted hair … and give people cancer.

Through the 1940s, doctors used the radioactive substance radium in an attempt to cure anything from asthma to blindness.[b]

Doctors continued to recommend smoking to relieve throat irritation well past the US surgeon general's report on smoking and health in 1964.

As late as 1967, Dr. Walter Freeman performed lobotomies (in his Lobotomobile) in an attempt to cure mental illness, hyperactivity in kids, and minor neck pain. Freeman's 14 percent fatality rate on more than 3,500 lobotomies doesn't do justice to those left in a permanent vegetative state.

Want a transportation-related example? Doctors treated everything with bed rest and scoffed at the benefits of exercise—unless "*taken in Olympian doses*"[2]—until the mid-1970s, when Laurence Morehouse and Leonard Gross's book, *Total Fitness in 30 Minutes a Week*, redefined "exercise" as "increased physical activity" where even walking counts.[3] It took until 1986 for the research[4] to catch up and show that increased physical activity helps with mortality.[c]

Even now, many doctors won't advise walking or biking for transportation as a health intervention. Why? Because they assume that the road safety and air pollution risks outweigh the physical activity benefits.[d] That isn't the case everywhere. But given that much of the transportation system was built by civil engineers, these doctors may have a point.

This is something we need to fix.

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[b] Right up through the 1940s, we put radium in toothpaste, lipstick, and even butter. Victims of radiation poisoning included the Radium Girls, whose job at the Radium Luminous Material Corporation in Newark, New Jersey, was to paint watch dials with radium-infused glow-in-the-dark paint. Doctors were adamant that the radium was harmless.

[c] In the 1897 paper "The Hidden Dangers of Cycling" published in the *National Review*, a doctor named Arthur Shadwell wrote that bicycling causes goiters, appendicitis, headaches, insomnia, nervous depression, dementia, and worst of all for women, "bicycle face."

[d] Multiple doctors told me this at an American Public Health Association conference.

Civil engineers have also been around for about 5,000 years. Like doctors, they've learned a lot in this time.

When people think about civil engineering, most think about structural engineering and public works projects such as roads, bridges, and dams. But civil engineering is a huge umbrella that encompasses most anything related to the design, construction, and maintenance of the built or natural environment. Civil engineers developed the first sewer systems, and modern sanitation alone apparently added 20 years of life expectancy.[5]

Traffic engineering falls under the umbrella of civil engineering, but traffic engineering has been around for less than 100 years.

A 1965 British report explains the origin story of traffic engineers: "In order to deal with traffic problems in a satisfactory way, it has been necessary to build up a scientific discipline" and, as a result, "a relatively new branch of engineering has therefore been evolved, that of traffic engineering."[6] I also found a 1959 paper published in *Traffic Quarterly*, the preeminent traffic-engineering journal at the time, stating that "only the last decade has witnessed the adulthood of traffic engineering" and that "there are few things today that are more important to the welfare of the modern community than good traffic engineering. It is right up there with medicine and education as a factor in the everyday life of every citizen."[7]

What do we mean by traffic engineering?[e] The British report simply describes it as "that part of engineering which deals with the traffic planning and design of roads, of frontage development and of parking facilities and with the control of traffic to provide safe, convenient and economic movement of vehicles and pedestrians."[8]

Safe is the key word there, but like doctors did for a thousand-plus years, traffic engineers spent the last hundred years killing as many people as they've saved.

At first, traffic engineers tried to rationalize road deaths, akin to doctors in an experimental field:

"It's a new discipline," they'd say.

"We're on a learning curve."

But errors by engineers suggest incompetence—even when due

[e] Transportation engineering and transportation planning are broader and more comprehensive than traffic engineering, but for the sake of this book, I'm going to use them somewhat interchangeably. When I want to differentiate, I'll make it clear.

to the newness of the science—and engineers don't want to portray anything other than extreme competence. So, it wasn't long before traffic engineers presented a nascent scientific field as if it was a finished product.

While the early traffic engineers knew what they didn't know, subsequent generations of traffic engineers started to believe that they knew more than they did. These traffic engineers then built out the transportation system without ever taking a good, hard look at the science (or lack thereof) behind it all. It's time to take that good, hard look.

In this book, I'll show how traffic engineers designed and built a system that incites bad behaviors and invites crashes. The bad behaviors let traffic engineers off the hook, but most deaths and injuries are the predictable, systemic outcomes that traffic engineers inadvertently caused—thus, the title of this book—but that can be fixed.

Just knowing this fact isn't enough to fix the problem. Traffic engineers hold too much power, as well as the superpower to shut down most arguments. They do so by saying they are following the methods and standards. So if you want to win an argument with a traffic engineer, you need some ammunition. This book provides that by looking at what traffic engineers do wrong today and exposing the pseudoscience that led traffic engineering to create these methods and standards in the first place.

I felt the need to write this book when I realized that we aren't going to come close to fixing our road safety problems based on what I was taught in engineering school. I began digging into all the systemic things that traffic engineers do wrong. The more I considered the problems we face, the more I realized I needed to figure out ***why*** traffic engineers do what they do.

Traffic engineers don't want you to peek behind this curtain, because most traffic engineers have no idea what's behind it. But if we want to fix the carnage on our streets, we need to shine a spotlight on how little there is behind the ***why*** question. Following the science means first shattering the pseudoscience. Only then can we start making the world a safer place on a larger scale.

The sad reality is that we need a dramatic transformation of transportation, and we need the right kind of mind-set to make it happen. This goes for traffic engineers in particular because they are still the ones in charge of our streets. They won't change ***what they do***

without first changing ***how they think***. If your friendly, neighborhood traffic engineer reads this book, great. If not, this book will teach you how to effectively argue with your friendly, neighborhood traffic engineer.

When you finish reading this book, you're going to look at your city and streets much differently. Things that never bothered you before are going to drive you crazy.

You don't need to be a traffic engineer or transportation planner—or any kind of expert—to read this book or join the cause. That is one of the great things about the transportation discipline. Everyone has opinions (lots of them), and (almost) anyone can speak intelligently on their own experiences.

So if you want to learn the truth about traffic engineering and road safety,

If you want to fix our streets and communities,

If you want to make how we get around safer,

If you want to help start us on a path to saving millions of lives,

I'm happy to have you come down this rabbit hole with me.

If not, stop reading now and drive to work tomorrow.

02 Deal or No Deal

Guido Calabresi is a former federal judge and the former dean of the Yale Law School. For decades, he used to present his class with this offer from God:

God is going to give us a wondrous invention that will allow us to see new places, spend more time with family and friends, and do heretofore-unthinkable jobs.

In exchange for this invention, God is going to select 1,000 people at random each year, including kids, and strike them dead.

Would you take the deal?

Most of his students say no, of course not. That's a terrible deal.

Calabresi then says that cars and trucks kill around 40,000 Americans each year. Around the world, the number is closer to 1.35 million deaths annually. These numbers don't include all the serious and debilitating injuries, but still, we accept this deal without even thinking about it. Why? Well, that's the way it is and has been our whole lives. We can't imagine a world without cars.

This book isn't meant to imagine a world without them. I'm mostly looking for a world where a car isn't your only viable option.

I grew up just outside of Boston, in Watertown, Massachusetts. As a kid, my friends and I walked and biked all over town. We walked to school and biked to each other's houses. As teenagers, we hopped on the 57 bus from Watertown Square[a] to Fenway Park. If we wanted to get to Harvard Square, it was easy to walk to the 71 or 74 buses. Back then, Harvard Square was an experience in itself, but from there, we could take the MBTA subway Red Line to what felt like anywhere.

I spent my college years in Charlottesville, Virginia. While not as walkable or bikeable as the Boston area, it wasn't bad in and around the Grounds.[b] Other than the awesome sandwich shop at the Exxon

[a] For those who may be interested, Watertown Square is shaped more like a rounded pork chop than a square.

[b] At the University of Virginia, campus is referred to as the Grounds for whatever reason.

gas station or the Charlottesville Airport, I could get most everywhere I needed to go without a car.

For the next few years, I worked as a civil engineer at Sasaki Associates, a design firm located along the Charles River back in my hometown. As a young civil engineer, I was learning to design projects, applying whatever ***standards*** I found in the manuals without a second thought. Whoever wrote these 1,000-page books must know more than I did, I thought. The only time I ever felt a slight hesitation came toward the end of these projects. What I saw in person was never as good as the existing places I knew and loved.

I then took a civil engineering job at Clough, Harbour & Associates—more of a traditional engineering firm than Sasaki—and moved to Connecticut. It was the first time I lived in a place where I couldn't reasonably leave my street without being in a car. Sala's Corner Store was less than a half mile away, but as they say up in Maine, you can't get there from here. When I asked my friends and neighbors what they thought about this, they didn't have an opinion. It is what it is.

They had no idea what they were missing.

There is an episode of *The Simpsons* where the Simpson family visits Boston. Homer hates everything about Boston until he discovers candlepin bowling. Having grown up on candlepin,[c] I had the opposite experience when I first came across 10-pin bowling. I was in middle school when I went up to the second floor of the bowling alley and saw a whole new type of bowling. While not nearly as dramatic as Harry Potter seeing Diagon Alley for the first time, it was still a shock to not only find out that 10-pin bowling existed, but that 10-pin bowling was what most people considered bowling.

The same can be said of living on a street that I couldn't leave without a car. It was a bit of a shock to realize that such places existed but even more of one to find out that this was the norm for most people. What I experienced growing up around Boston, where a kid could independently get around town, was unquestionably atypical.

It started to drive me crazy.

Why were these streets like this? Why wasn't there a back road

[c] My mother won multiple candlepin bowling trophies when I was a toddler. She left me in what was apparently the bowling alley daycare.

that could get me there? Why was every building an island in a sea of parking?

I started digging a little deeper whenever I designed a project at work. I wanted to understand why, for example, the books told me that driving lanes should be so wide or that my project needed so much parking.

At the time, I had no idea how deep this rabbit hole was, but I only had to scratch the surface to see that there wasn't nearly as much science behind the numbers as the 1,000-page manuals make it seem.

Most of my colleagues didn't have the time or patience for such nonsense. Their focus was on getting the project done and moving on to the next. The results were never as good as the empirical examples I grew up with, but fixing this problem would mean digging a lot deeper. So the next thing you know, I was applying to graduate school.

I had just gotten my Professional Engineering (PE) license—the profession's highest standard of competence—when I told our regional manager that I was quitting to go to graduate school. He asked me why and told me that a PE is all I would ever need and that a PhD isn't going to be useful at a company like his. I didn't say it out loud, but I remember thinking, "That's because I don't want to work here anymore." What I was really feeling was a disconnect between reaching a so-called pinnacle of professional competence with this licensure while at the same time only starting to realize just how much I didn't know.

03 Murder Incorporated

In the 1964 James Bond movie *Goldfinger*, James Bond (Sean Connery) tries to reason with Auric Goldfinger about his plan to release nerve gas into the atmosphere over Fort Knox:

> Bond: You'll kill 60,000 people uselessly.
> Goldfinger: Ha! American motorists kill that many people every two years!

Goldfinger underestimated the number … by a lot.

In 1964 alone, 45,645 people died on US roads. Combine that with 1965, and Goldfinger could've said that the number of people killed by American motorists was more than 90,000 people.[a]

The death toll on US streets continued to climb and climb, reaching 54,589 deaths in 1972 before it started to fall with the 1973 oil crisis.

The Vietnam War lasted from 1954 to 1975, and 58,209 Americans died in that conflict. I remember watching TV shows like *The Wonder Years* and thinking about how horrible that time period must've been. And it was, but over that same time span, drivers killed 974,567 people on US roads *by accident*.[b] These aren't accidents; these are results.

In truth, more Americans died on US roads than in all US conflicts combined, including the American Revolution.

There are countless other ways to try to put these numbers in perspective.

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[a] US motorists killed a total of 92,734 people in 1964 and 1965 combined.

[b] You may already know this, but *accident* isn't the right word. *Accident* implies bad luck and implies that nobody—including the traffic engineer—is to blame. It further implies that there isn't much we can do to keep it from happening again. Some want to use the word *collision*, but that also feels like it downplays the problem. Instead, I'll use the word *crash* whenever I'm not quoting somebody who used *accident* or *collision*.

In the United States alone, we see millions of injuries and tens of thousands of deaths every year. In most years, road safety saps more productive years of life than any other disease, including cancer and heart disease combined. A 1968 *Traffic Quarterly* paper, written by a lawyer who used to prosecute organized crime, says that "neither Al Capone nor all his contemporaries, their predecessors and successors, aided and abetted by Murder Incorporated[c] could account for the fifty thousand persons killed on the nation's highways in 1966, nor for the eight billion dollars out for the personal injury and property damage in that same year." He goes on to say that traffic safety "takes a far greater toll in our society in one year than organized crime could account for in one hundred years."[1]

Less than six months after the terrorist attacks of September 11, 2001, U2 played the halftime show at Superbowl XXXVI in New Orleans.[d] While Bono sang "Where the Streets Have No Name," the band paid tribute to the 2,977 victims of the terrorist attacks via a vertical scrim that scrolled through every name. With three names side by side, it took about 5 minutes. As we cross four million total traffic deaths in the United States alone since the advent of the automobile, we'd be looking at 110 hours of scrolling through names to pay tribute to our road safety victims today.

The Centers for Disease Control and Prevention (CDC) regularly points to traffic deaths[e] as the number one cause of unintentional injury death for all Americans aged 4 through 34.[2] This isn't new. I found a 2002 paper saying that "in the US, injury, both intentional and unintentional, is the leading cause of death from age 1 to age 45. Because it so disproportionately strikes the young, it is also the leading cause of lost years prior to age 75, more than either cancer or heart disease. Motor vehicle injury is the largest single component of these losses."[3] I also found a 1983 paper lamenting that "automobile crashes are the leading cause of death for all persons between the ages of six months and age 47."[4] And a 1965 paper warned us that "traffic accidents are the leading cause of death among all persons from age 5 to 31!"[5]

[c] Murder, Inc. was the unofficial name of the murder-for-hire group used by organized crime in the 1930s.

[d] The Patriots won.

[e] For kids 19 and younger, gun violence overtook car violence for the first time in 2020, according to the CDC database.

The World Health Organization (WHO) estimates that each traffic death equates to an average of 30 lost years of life expectancy.[6] With 1.35 million road deaths worldwide each year, more than 2 percent of *all* deaths from *all* causes, this adds up to 40 million years of life lost annually on our streets.[f] WHO also estimates that for every road death, there are at least 10 to 15 people hospitalized due to road crashes.[7] This means 13 million to 20 million hospitalizations and millions more that probably should've gone to the hospital.

But the United States must be doing better than our international counterparts, right?

Right?!?

The Organisation for Economic Co-operation and Development (OECD) ranks countries by road fatalities per 100,000 population. When I first looked at these numbers for 2004, no OECD country was worse that the United States.[8]

It's not much better now. The last time I checked, Argentina, Russia, and Georgia were the only OECD countries with a worse road safety fatality rate than the United States. It's also gotten relatively worse in the United States over time. Back in the 1970s, there were at least a dozen major countries with worse road safety records.

So what the hell have traffic engineers been doing for the last hundred years?

[f] Black, Brown, and Indigenous communities bear a disproportionate brunt of all this traffic violence. So do pedestrians and bicyclists.

04 Hand-Me-Downs

Just like infrastructure gets handed down from generation to generation, so have many of our traffic engineering standards and guidelines (along with an enduring traffic engineering mind-set). Current traffic engineers look at these books and assume that the people who came before us did enough research to know what works best. But when you dig in—even just a little—you begin to realize that most transportation engineering decisions and designs do not put safety first.

There is a fundamental disconnect between what we want our places to look and function like versus what engineers give us. To understand ***why*** traffic engineers, including me, did what we did, I went deep down dozens of rabbit holes.

In some cases, I would wonder why we did something one way and think to myself, "Man, were we dumb back then." Then I'd find an original source and realize, yup. For instance, Edward Fisher and Robert Reeder write in their 1974 book, *Vehicle Traffic Law*, "Most of the early pieces of legislation, studied from the vantage point of experience 50 years later, demonstrate utter lack of comprehension of the real problems."[1] In other cases, I'd come across a 100-year-old book and realize that we weren't dumb whatsoever. What we did was intentional. We knew exactly what we were doing.

It's fun to imagine an old-timey traffic engineer who looks like Dastardly Whiplash coming up with our so-called standards. On rare occasion, that wasn't far off. Instead, it felt more like we put a bunch of foxes in charge of the henhouse. In other words, some of early decision makers were more concerned with selling cars than with, for instance, accurately assessing safety.

William P. Eno (1858–1945) was not one of the foxes. Considered the father of the early traffic engineering movement, he lived through the emergence of the automobile age.[a]

[a] William Eno never learned to drive, but he was given an honorary driver's license by France in 1912.

In January 1900, Eno published his *Rules of the Road*, printing and distributing thousands of copies over the years. He proposed that drivers stay to the right and signal with their arms when turning or stopping. Eno recommended that we regulate the speed of cars, and in a follow-up piece, he suggested a 10 mile per hour maximum (and 3 mph maximum when turning or crossing a busy street).[2] He wrote New York City's first traffic regulations in 1909 as well as six books about traffic. Eno is credited with innovations such as the stop sign, pedestrian island, one-way street, and traffic circle.[b] In 1921, nine years before the Institute of Traffic Engineers[c] was founded, he created the Eno Foundation for Highway Traffic Control.[d]

One of the reasons I bring Eno up now is that, beginning in 1947, the Eno Foundation first published *Traffic Quarterly*, widely considered the preeminent, independent traffic engineering journal of the time.[e] For years, the Eno Foundation printed annual editions embossed with the name of the recipient on the cover. I have a few copies from the early 1970s, and each includes a handwritten note of appreciation from the editor.

Traffic Quarterly changed its name to *Transportation Quarterly* in 1982 and was published through 2003. As longtime editor Colonel Robert Goetz said in his initial 1947 editorial, *Traffic Quarterly* was made for the "many experts and professional men of long experience in the field of traffic" that "have sound and logical ideas and methods for the improvement of the present chaotic conditions in traffic."[3] The other big dogs on the traffic engineering journal block didn't come around until much later. *Transportation Research Record* (originally known as the *Highway Research Record*) kicked off in 1963, while the *Transportation Research* series started in 1967.[f] For

[b] Eno called them "rotary or gyratory traffic systems" and was able to get New York City to try the idea with Columbus Circle in 1905.

[c] Now known as the Institute of Transportation Engineers.

[d] Now known as the Eno Foundation for Transportation.

[e] For years, the journal's slogan was, "An Independent Journal for Better Traffic." It later became "An Independent Journal for Better Transportation."

[f] The *Transportation Research* journal series split into Parts A and B in 1979 but now has six parts (A through F). On a related note, the *Journal of the American Planning Association (JAPA)* (originally known as the *Journal of the American Institute of Planners*) dates to 1935. While not as useful for trying to get into the minds of traffic engineers, several *JAPA* papers helped my cause.

my purposes, *Traffic Quarterly*'s 2,427 papers and editorials provided a longitudinal record of what traffic engineers were thinking over the course of 57 critical years.

It was interesting that it took *Traffic Quarterly* six years to publish a paper written by a woman.[g] It was a bit wild to see a 1962 *Traffic Quarterly* paper blame the traffic congestion that men have to deal with on all the "housewives returning from shopping expeditions." This same paper goes on to argue ***against sprawl*** because it would harm the "young girls temporarily employed while seeking a tenure position in marriage."[4]

Sexist papers notwithstanding—and we'll see some racist ones as well—this collection of papers turned out to be a deep and useful rabbit hole. These papers, combined with hundreds of other books, papers, and reports from the last 100-plus years of traffic engineering, helped me wrap my head around ***why*** traffic engineers do what we do. What you are about to read, however, is not a history book. I'm using all these resources as a tool to tell the bigger story about why traffic engineering needs a tectonic shift.

After more than 50 years of publishing papers, *Transportation Quarterly* admitted in a 1999 paper that traffic engineers don't know as much as they think they do, noting that "most of the conventional responses to our contemporary transportation problems are doomed to be ineffective. We have a body of both theoretical and empirical research on transportation dating back more than 40 years that tells us so."[5]

[g] The first *Traffic Quarterly* paper authored by a woman was written by Dorothy Lee, the mayor of Portland, Oregon. She bragged about arresting pedestrians for all infractions. The second woman-authored paper came a year later when Clara Lagace, a planning commissioner from Gloucester, Massachusetts, wrote about building a seawall so as to add off-street parking along the waterfront.

05 Passing the Buck

Conference presentations about transportation safety often start with a statistic about how human error accounts for at least 90-something percent of traffic crashes or fatalities. The speaker eventually tells the audience that autonomous vehicles will eliminate ***all*** these human error crashes from the system.

Sounds pretty good, right?

This line of thinking is fundamentally flawed. It's also one of the most insidious impediments to building safer streets.

Why?

Because traffic engineers wholeheartedly believe that crashes and deaths are rarely, if ever, the fault of the traffic engineer. We did our job. The traveling public didn't do theirs. Back to business as usual.

Human error isn't blameless, but it's not the root cause of most safety problems. As is, human error makes it easy for traffic engineers to pass the buck. Instead, traffic engineers should consider human error a sign of deeper problems in our transportation system. Those deeper problems often directly relate to what the traffic engineer is responsible for: design.

Conventional traffic engineering methods have us designing major streets for traffic volumes 20 or 30 years down the line. Given all the human error, we want these streets to be forgiving, so traffic engineers design them to be wide and straight.

At the same time, we know that people tend to drive whatever speed they feel most comfortable driving. While speed limits play a role, street design plays a bigger one.

We also know that higher speeds have a direct connection with more serious crash outcomes, particularly with pedestrians and bicyclists.

So when somebody speeds on this wide and straight street, crashes, and kills someone, it'll get chalked up as one of the 90-plus percent of human error crashes. The driver made the mistake of speeding.

Who cares if the engineer designed a street built for speed, just

begging you to go fast, as long as the guidebook was followed? The courts don't. Few others do.

The engineer will say that people need to behave better or that we need more enforcement. Case closed. Engineers don't learn anything about how to do their job better. There is no feedback loop.

This is a simple example, but as Sidney Dekker says in *The Field Guide to Understanding "Human Error,"* "Human error as explanation for accidents has become increasingly unsatisfying.… 'Human error' does not come out of the blue, and is not separate from the system in which it occurs. Error has its roots in the system surrounding it."[1]

What are the roots of error in traffic crashes? Street design is one, but it goes deeper. It includes the network around that street. And the viability of other modes. And how we design cars. And where we put land uses. And what those land uses are. And how we fund transportation. And how much the different options cost. Dekker goes on to say that "the deeper you dig, the more you will understand why people did what they did, based on the tools and tasks and environment that surrounded them. The further you push on into the territory where the errors came from, the more you will discover that the distinction between human and system failure does not hold up."[2]

Much of the human error rabbit hole that I fell into stems from the work of British psychologist James Reason, whose first book on this topic came out in 1990. In that book, Reason alludes to the overconfidence of traffic engineers: "Problem solvers and planners are likely to be overconfident in evaluating the correctness of their knowledge.… They will justify their chosen course of action by focusing on evidence that favours it and by disregarding contradictory signs."[3]

In a research project I led,[a] we surveyed 18,000 people and found that every single road user admitted to some form of law breaking.[4] If everyone is breaking the law, it's easy to place blame on everyone … except the traffic engineer.

We'll talk more about human error later in the book. For now, suffice it to say that our current approach lets engineers off the hook in almost every situation.

[a] Called the scofflaw survey.

06 Won't Someone Please Think of the Children?

We now kill well over 7,000 pedestrians each year in the United States.[a] This number would hit 8,000 per year in the late 1970s and early 1980s. It dropped into the low 4,000s in the early 2010s following the Great Recession.[1] Traffic engineers like to point out that these fluctuations are beyond our control. A 2020 pedestrian fatality report states that "many factors outside the control of traffic safety officials contribute to annual changes in the number of pedestrian fatalities, including economic conditions, demographics, weather, fuel prices, vehicle miles traveled, and the amount of time people spend walking."[2]

If walking were actually safe, most of these contributing factors wouldn't matter much. Fuel prices might not help, but fuel prices don't kill pedestrians.

Let's look at child pedestrians. One recent study says that "a safe pedestrian must manage to perceive, attend to, and process multiple sources of stimuli within a very short time period. Young children struggle to do so safely."[3]

So we know that kids have difficulties assessing things like the speed and distance to a moving car, which in turn leads to difficulties in figuring out when a gap in traffic is enough. Kids also have limited peripheral vision and trouble locating sounds. Yet traffic engineers don't design to help kids out. We'll design everything as we normally do and then put up some signs that try to limit speeds around schools at certain times of the day and certain times of the year. That's it.

Kids under age 18 represent nearly a fourth of the US population, but other than signage, traffic engineers make little effort to design for them. Denver won't even lower the school zone speed limit to under 35 mph if it considers the adjacent street important for cars. Denver isn't alone.

Parents ask for a crosswalk and pedestrian signal. Traffic engineers say there aren't enough pedestrians crossing the street to warrant them.[b]

[a] We climbed to 7,508 pedestrian deaths in 2022.

Let's say we do put in a pedestrian signal. Traffic engineers will time it for a healthy, determined adult rather than an inattentive, meandering kid.

Whatever the case, let's say a kid gets hurt crossing the street. Who's at fault? It might be the driver. It could be the kid. In the court of public opinion, it could be the parents for letting their kid walk on a dangerous street or the school for letting the parents let their kid walk on a dangerous street. It could even be an act of God, like an icy street.

It's never the traffic engineer.

It's easy for traffic engineers to make sure we don't get blamed. We've been doing it forever. In 1960, *Traffic Quarterly* published an editorial by its longtime editor, Colonel Robert Goetz, about road safety. What is the biggest road safety problem? Obviously, it's the "deliberately hazardous driving."[4] In his editorial the next year, the Colonel reminds us that traffic engineers have done everything they possibly can: "Obviously no effort has been spared to build safety into our highways."[5] So, why is our nation's safety record so bad? The Colonel says that maybe you should look in the mirror, American people: "The highway engineer cannot build causation or safety into the minds of unqualified drivers or willful speeders…. Some improvement in the national character of our driving is urgently needed."[6] That same year, *Sports Illustrated* put out an issue dedicated to ***Safe Driving: An Important New Series***, with a typical highway filled with cars as the cover model.[c]

A special effects artist who goes by Xiaojie created a video showing two kids about to cross the street. As the kids enter the crosswalk, a dozen spiked bollards, or posts, come flying out of the ground to keep drivers from entering the crosswalk. At the same moment, a giant medieval morning star swings back and forth in front of the waiting cars.[d]

This medieval-protected crosswalk scenario is fiction—and

[b] Did we count how many people swam to San Francisco before building the Golden Gate Bridge in the 1930s? Of course not.

[c] Yes, *Sports Illustrated*.

[d] A "morning star" is a spiked ball on a shaft that you might see in a *Mortal Kombat* video game or wielded like a club in *Game of Thrones*. For those who care, one of Joffrey's Kingsguards in *Game of Thrones* uses a morning star in the Battle of the Blackwater.

maybe a bit extreme—but there is no real reason traffic engineers can't build a system that better protects people, particularly kids who are walking or biking.

We choose not to. We have priorities other than safety.

Plus, it's not like it's our fault if somebody gets hurt.[e]

[e] As you can probably tell, I will sometimes refer to all the traffic engineers out there—and those that came before—by using "we" or "our."

07 Little Lies

In a 1971 *Traffic Quarterly* paper titled "The First Consideration," FBI director J. Edgar Hoover says too many drivers "tend to make speed, not safety, their first consideration."[1] But for engineers, Hoover assures us that it's safety first: "The safety of the public is to be the first consideration of the staff."

In other words, Safety Is Our #1 Priority!

This slogan is embraced by generations of traffic engineers.[a]

But let me put it to you straight: safety first is a lie. Safety has never been the top priority.

Transportation exists for a reason, and that reason isn't safety. We want to move people and goods from here to there and quickly back again. People make (and spend) a lot of money on this.

In one of the older road safety books I was able to track down, *Seven Roads to Safety* (1939), Paul Hoffman states, "First, a qualification. Safety is not necessarily the most important thing on earth. 'Safety first' is a misnomer. Sometimes we want other things first. But all will agree, I believe, that if we can have safety along with other things, the result is more pleasant."[2]

We'll talk a lot more about Paul Hoffman later.

Jack Leisch is another guy who had a long and influential career in traffic engineering. In response to a paper lauding roundabouts, Leisch put our priorities in order for us: "Let us first consider the course that the United States pursued in its highway development and what goals were to be achieved in traffic operations: increase in capacity; increase in speed, followed by improvement in safety."[3] And Leisch is a guy who was inducted into the exclusive Institute of Transportation Engineers (ITE) Honorary Member club. At last count, only 96 people have been inducted since

[a] I recently made a presentation at the Colorado Department of Transportation and learned that their Wi-Fi password was S@fetyF1rst. If they need to change it now, sorry about that.

1933.[b] Leisch's ITE profile says that one of his most significant contributions "was his belief that the design of a roadway must be viewed from the standpoint of the motorist—the real user of the facility."[4]

When testifying before Congress in 1973, Highway Safety Foundation executive director and traffic engineer William Sacks said that "we are dealing with accidents which are byproducts of the system whose purpose is really not safety, it is mobility."[5] He then suggests that the main problem with road crashes is that they reduce system productivity.

So, why do we want to reduce crashes? We do so because crashes increase traffic congestion and reduce mobility. We also do so because crashes cost us money. Misidentified priorities lead right into how we mismeasure transportation, which we'll talk about later. At best, we can say that we have ***conflicting objectives*** in transportation. Sure, traffic engineers want to improve safety, but before doing so, we want to minimize congestion, maximize mobility, minimize costs, and so on.

Safety is never first on the list.

Otto, the defunct autonomous vehicle company bought by Uber,[c] was a bit more direct. It used the motto ***Safety Third*** when talking about its work. Engineers pasted "Safety Third" stickers all over Otto's San Francisco headquarters because they knew their founder would love them.[6]

Soon after being acquired by Uber—and prior to getting approval to test Otto's self-driving cars in San Francisco—a driver's dashcam video caught one of Uber's test cars blowing through a red light and straight through an enormous crosswalk in front of the Museum of Modern Art.[7]

Uber used the incident to try to drum up support for autonomous cars. It said that at the time of the incident, the driver, not the software, was in control of the car. Human error is the obvious culprit, which is "why we believe so much in making the roads safer by building self-driving Ubers," said a company spokesperson.[8]

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[b] The ITE Honorary Member club inductions date back to 1933, and as far as I could tell, the first woman inducted (Willa Wilcox) wasn't until 1992. The first—and seemingly only at the time of this writing—Black engineer in this ITE Honorary Member club (Garrett A. Morgan) died in 1963 but wasn't inducted until 1998.

[c] Otto was founded in January 2016. Uber bought it for $680 million in August of that same year.

It turned out that wasn't the case. According to a *New York Times* article, "The self-driving car was, in fact, driving itself when it barreled through the red light, according to two Uber employees, who spoke on the condition of anonymity." The autonomous test car went through six red lights that day.[9]

While traffic engineers may not be near Uber on the deceit spectrum, the reality is that traffic engineers never start the design process with safety. Truth be told, traffic engineers rarely ever think about safety because we assume that the system will be safe if we follow our guidebooks.

I've heard folks like Chris Argyris, a former Harvard Business School professor, call this the difference between espoused theory versus theory-in-use. Traffic engineers say that safety is our first priority, but such organizations, as Sidney Dekker suggests, "lack a conherent strategy on continous improvement … [and] if you recommend design or organizational changes, you are likely to invite more opposition. This will cost money, after all, or suggest that some people higher up were not doing their jobs."[10]

Even though Dekker wasn't talking about traffic engineering in this quote, anybody who has ever proposed a potential solution to a traffic engineer in a public meeting can attest that it hits close to the mark.

Personally, I have a hard time watching public meetings about road safety unfold. My main irritant has to do with what I call ***engineer speak***.

That's what engineers use when they want the public to sit down and shut up. It's the overly technical language meant to appease or confuse the audience. It's the catchphrases meant to deflect blame. It's the sneaky terms said to make things sound better or worse than they are. When we like something, we describe it as an improvement or investment in a public good. When we don't, we use words like *degrade* or say it requires a public subsidy.

Here are some of my favorite least favorite examples of engineer speak.

"Safety is a shared responsibility."

When the public tells the engineer that they don't feel safe crossing the street here or bicycling there, traffic engineers will remind everyone that ***safety is a shared responsibility*** or that ***personal responsibility*** needs to play a bigger role. In other words, they don't

plan to fix the problems with design changes; they just want everyone to follow the rules we've laid out for them. I've found versions of this almost as far back as the traffic engineering literature goes. A 1955 paper tells us that "safety is everybody's problem" and that "if each accepts his individual share of the responsibility, the task [of improving road safety] will be easy."[11] Some of today's more progressive traffic safety movements use this phrase as well. They want "safety is a shared responsibility" to mean that engineers and policy makers need to share in this responsibility of creating a safe transportation system. Unfortunately, traffic engineers and policy makers continue to co-opt it in a way that shifts blame onto road users.

"We need to take a balanced approach."

In many cases, the public wants more space for pedestrians and bicyclists. Or they want the engineer to help slow cars to make streets safer for other modes. The engineer reminds the audience that ***we need to balance everyone's needs***, which in theory means that we need to find an ***appropriate balance*** between things like design consistency, safety, aesthetics, environmental issues, and community goals (espoused theory). What it really means is that driving and cars are still more important (theory-in-use). This can flip when a vocal minority is complaining about giving up space or priority to pedestrians or bicyclists at what seems like the expense of cars. The engineer might remind those folks that we need to take a balanced approach to the transportation system and shut them up as well.

"Efficiency."

When a traffic engineer talks about prioritizing ***efficiency***, this means increasing traffic flow. And when traffic engineers talk about an efficient traffic flow, this means more cars moving faster. The better traffic engineers now focus on moving people instead of cars. This gives more weight to high-occupancy vehicles or transit (and sometimes even pedestrians and bicyclists).[d] What's always left unsaid is that focusing on efficiency means limiting necessities like the amount of time we give to pedestrians trying to cross the street. In other words, *efficiency* means that we've got to give priority to vehicle speeds and vehicle movements.

[d] Although when engineers measure people flow, no engineers account for car lanes being wider than bike lanes.

"Improvement."

Traffic engineers will refer to pretty much everything they do as an ***improvement***.[e] But what's left unsaid is that *improvement* usually means an improvement for those in cars. In other words, anything we do to improve vehicular traffic flow gets classified under the umbrella of an improvement. Does that improvement make things worse for pedestrians, bicyclists, or transit users? Or how about the people who live or work along this "improved" street? The answer to these questions is beside the point.

"Not my job."

More often than not, the phrase "Not my job" gets used when traffic engineers try to defend themselves for things not turning out as people imagined they would. For example, traffic engineers from the heyday of the interstate era liked to point out—after the fact—that they were told to build highways but to do so as inexpensively as possible. So when they tore up the poorest neighborhoods to build these new highways, they remind us how they fulfilled the task they were given and what a bang-up job they did. Worrying about the people who live where these highways end up is ***not my job***. We'll later see how untrue this is—because many of the old traffic engineering books highlight slum clearance as a bonus of highway building—but it's a convenient retcon.[f]

"We need to study the problem further."

Traffic engineers offer ***to study the problem further*** simply to blunt and divert public attention by kicking the can down the road. In the old days, we'd appoint a blue-ribbon commission. Whatever the term, this approach lets traffic engineers avoid dealing with complaints until a later unspecified date. Whether the traffic engineer plans to actually study the problem further is irrelevant, but it shuts the discussion down and buys some time. How much time does it buy? Once the furor dies down, few come knocking on your door

[e] Traffic engineers sometimes use the words *upgrade* or *enhancement* instead.

[f] A retcon—or *ret*roactive *con*tinuity—is a plot device used to change a previously established narrative. One of the early examples, well before the term existed, happened when Sir Arthur Conan Doyle brought Sherlock Holmes back from the dead. Bored with writing Sherlock stories, Doyle killed him off. Doyle faced a lot of backlash. In the next book, it turned out that Sherlock faked his own death by secretly climbing onto a ledge and hiding until he could escape. Convenient.

to ask for that study. If they do, then the study perpetually remains almost done. "We need to study the problem further" is often a nice way to put the problem off indefinitely.

"The standards say ...."

This is a big one. Traffic engineers like to tell the public that whatever the public is proposing won't work because ***the standards say*** this or ***the standards say*** that. The truth is that they are referring to guidelines, not standards. Other than the *Manual on Uniform Traffic Control Devices* (MUTCD) and the ADA Standards for Accessible Design, none of the guidance encased in our massive national manuals should be considered "standards." Even the MUTCD—often used to tell the public that a crosswalk or pedestrian signal isn't warranted—gives the engineer discretion to overrule the infamous warrants with ***engineering judgment***.[g] If you want to give traffic engineers the benefit of the doubt, you could argue that it's just a slip of the tongue and that *guidelines* and *standards* are synonymous anyway. If you want to know the truth, many traffic engineers know exactly what they are doing.[h] The use of the word *standard* is intentional. First, it shuts people up because it's hard for people to argue with a standard. Second, it keeps us from getting our hands dirty. It keeps us above the fray. As a 1973 *Traffic Quarterly* paper says, traffic engineers "frequently cloak themselves in the mantle of neutrality."[12] In other words, traffic engineers don't take sides; we only do what our traffic engineering books tell us to do. Casually referring to something as a *standard* helps us do that.

"Public participation."

One common misconception is that traffic engineers go to public meetings because they want to hear what the public has to say and adjust their designs accordingly. In most cases, this couldn't be further from the truth. By the time most traffic engineers step in front of the public, they've already decided what they want to do. Their job that night is to announce what they've decided and defend it by showing some carefully selected, inferior alternatives. The DAD acronym (decide, announce, defend) was something my old boss joked about prior to my first public meeting when I was a young engineer.

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[g] *Engineering judgment* is another loaded term, which we'll talk about later.

[h] On the other hand, some traffic engineers probably do believe them all to be standards.

My job was to use all the above strategies to get the meeting over as quickly and painlessly as possible. Any changes to our design would be the opposite of quick and painless. Historically, as the same 1973 *Traffic Quarterly* paper points out, "most of these hearings receive little notice, and are attended primarily by" people "who congratulate each other on the high degree of consensus reflected at the hearing."[13] These days, ***public participation*** is a required part of most projects, but traffic engineers still think about this obligation merely as a box that needs to be checked off. The amount of opposition a traffic engineer sees at a public meeting is quite inconsequential.[i] We write them off as squeaky wheels and the usual vocal minority that always come out to complain. As a 1959 paper in *Traffic Quarterly* says, "The 'squeaking wheel' minority cannot be the only determining factor. Certainly, the economic well-being of our great city is closely tied in with its traffic circulation."[14] Plus, we all know that people would never bother coming to public meetings to say you're doing a good job. It's going to be the squeaky wheels no matter what we do.

Traffic engineers also like to argue that public participation processes will lead to worse outcomes. A 1977 *Traffic Quarterly* paper lays out this thinking. Because of public participation, "transportation facilities may cost more, be less safe, and have a longer trip time." Why? Well, all these pesky people and their opinions mean that we can no longer focus on "classic engineering." Moreover, "participants may not be representative of the entire community," so why should we listen to them? If we do, "the results of participatory planning will not be as optimal in the classical sense as traditional planning."[15]

Yup.

[i] I wouldn't hate hearing this sentence said by Dr. Evil.

08 Science versus Faith

One of the best things about science is that when it's done right, it's self-correcting. Science is in a constant state of acquiring knowledge, and if new knowledge contradicts old knowledge, we try to figure things out and change courses if necessary.

The discipline of traffic engineering often acts more on faith than science. Dan Brown's book *Origin*, from the Robert Langdon series, discusses the difference. Faith, by "its very definition, requires placing your trust in something that is unseeable and indefinable, accepting as fact something for which there exists no empirical evidence."[1]

As for science, Dan Brown suggests that "science is the antithesis of faith…. Science, by definition, is the attempt to find physical proof for that which is unknown but not yet defined, and to reject superstition and misperception in favor of observable facts.[a] When science offers an answer, that answer is universal. Humans do not go to war over it; they rally around it."[2]

Traffic engineering always wanted to be a science. We came up with theories, put them into practice, and waited to see what happened. We made adjustments, sometimes to improve safety, but usually to improve traffic flow. Still, we learned from our mistakes. We had a feedback loop based, at least in part, on the scientific method.

But much of what traffic engineers do today isn't that different than what traffic engineers did generations ago. That isn't a problem in itself. The problem is that we continue to do so despite evidence to the contrary. Take roundabouts, for example. Why did they fall out of favor in the 1940s and 1950s? The reason, according to one 1988 paper, is that "in those days, the loudest voice and best oratory generally prevailed in establishing highway standards when supporting data were lacking."[3]

[a] Given the antiscience trends we've seen recently, Amy Poehler and Seth Meyers might say "Really!?!" to this definition.

And data was indeed lacking. A 1968 *Traffic Quarterly* paper tells us that "the quality of the available data is so poor that it is impossible to establish benchmarks for any kind of measurement: we are today largely unable to determine whether the accident rate is increasing or decreasing or to evaluate the efficacy of any specific countermeasure." As a result, "accident research in general is not characterized by a high degree of sophistication, and mere awareness of the problem does not provide a solution."[4]

Heck, we traffic engineers back then readily admitted that we didn't know that much. The author of a 1971 *Traffic Quarterly* paper[b] specifically about road safety says that "usually the approaches were based more on hope and logic than on practical facts."[5]

Congress also knew this to be a problem. In 1965, a House of Representatives report on road safety bluntly states that "much of what has been done has never been tested, evaluated, or applied."[6] But a Senate report from later that year implores us to take action "without waiting completion of long-term research projects."[7]

The next year, Congress created a new federal agency on traffic safety, and President Lyndon Johnson appointed William Haddon, a doctor by training, to head that up.[c] Not long into the job, Haddon pointed out that crash research is still in what could be considered its prescientific stage. Haddon said that "increasing attention is being paid in accident research to the evaluation of the efficacy of preventative measures. But this is a substantially new trend. Relatively few accident countermeasures—some in use for decades—have yet be subjected to adequate scientific scrutiny."[8]

Traffic engineers didn't even invent the striped zebra crosswalk until London first tried it in 1948. In this case, they treated it like a science experiment by testing the design at 1,000 sites across the United Kingdom. After a statistically significant drop in pedestrian

[b] The author of this 1971 paper also warns us that most of the money we get for road safety research comes from "the major insurance, oil, and automobile companies."

[c] In 1966, William Haddon, who is widely considered the father of modern-day injury epidemiology, was an administrator in two newly created agencies: the National Traffic Safety Agency and the National Highway Safety Agency. These agencies were consolidated into the National Highway Safety Bureau (NHSB) in 1967, which, in 1970, became what it is known as today, the National Highway Traffic Safety Administration (NHTSA). NHTSA is pronounced "NITZ-ah" in case you want to talk the talk.

fatalities as compared to the control group was seen, this painted crosswalk design became the official crosswalk treatment in 1951.[d]

Seat belts date back to an 1885 patent by Edward J. Claghorn of New York. It took 99 years for New York to be the first state to require their use. Even in the early 1960s, "it was widely accepted as a 'fact' that in an automobile accident occupants who were thrown from the car were safer than those who remained inside. Indeed, the connotation of 'thrown clear' was that the ejectee would otherwise have been killed."[9] This "widely accepted … fact" contradicted reports from a decade earlier telling us that being thrown clear usually led to death, not safety.[10] It took us longer than it should have to listen.

We later figured out that seat belts reduce the risk of fatality by 45 percent and injury by 50 percent. This should've been a good lesson for us when airbags were invented in the early 1950s. But it took more than four decades before the federal government required those in new vehicles.

In her last book, *Dark Age Ahead*, Jane Jacobs calls traffic engineering "a 'perfect' example of antiscience masquerading as the science it betrayed."[11] Years earlier, in *The Death and Life of Great American Cities*, she warns us that the traffic planning profession is a "pseudoscience" that "seems almost neurotic in its determination to imitate empiric failure and ignore empiric success."[12]

William Haddon doesn't disagree. In his 1965 *Traffic Quarterly* paper, he makes it clear that traffic engineers base "programs on unsupported presumptions … often with dogmatic public assurance as to their efficacy."[13]

Traffic engineers still do so today. We have faith in those who came before us. We trust that those who came before us knew what they were doing. Those who came before us, however, didn't know much. How do I know they didn't know much? They said so … time and time again.

This undeserved faith has stifled the science. In 1993, the prominent road safety researcher Leonard Evans wrote about how little we've accomplished: "It has been more than 50 years since driving behavior and traffic safety were first analyzed in a technical way….

[d] The Abbey Road crosswalk wasn't installed until the late 1950s, only a decade before the Beatles crossed.

(continued...)