INTRODUCTION

> To understand the actual world as it is, not as we should wish it to be, is the beginning of wisdom.
>
> – Bertrand Russell, 1934, *Mortals and Others*, V. II

Sometimes designs are so bad, they hit you in the face.

In 1993, I was a 16-year-old Alabama driver with a new red Saturn. That Saturn gave me independence, and I loved that car from its pointy hood to its strange chopped-off rear. It was full of fancy new technology, including non-denting plastic doors and a motorized seat belt connected to a track along the door frame. I'm not sure why an automatic shoulder belt was a selling point, since you still had to buckle the lap belt, but it felt like the future.

In lower Alabama (or, as the locals call it, L.A.), if it's not dark clouds pouring torrential rain, it's a white-hot sun that turns a black steering wheel into a branding iron. I wielded the car's visor to battle the blinding sun: down in front, rotate left, rotate back, wherever the sun shone. It was a constant dance to make driving bearable.

When the Saturn attacked me, I had the visor down and rotated left, shielding the driver's side window. I parked, and when I opened the door to exit, *BAM!* Something slapped me in the face. I was dazed, and my first reaction was shock followed by raising my hands to protect myself. But no one was there. As my vision cleared I took stock of the damage.

My nose was scratched and I had a welt forming on my left cheek. I looked around for a tree branch or a baseball that could have hit me through the open door. It took some time but I identified the villain: the shoulder belt that was now nestled tidily into the right side of the driver's seat. It had disconnected from the door and slapped me across the face as it retracted. The heavy buckle hit me on the way down, giving me the black eye.

I mentally rebuilt the events. When I opened the door, the automatic seat belt tried to move forward on the track and encountered the sun visor. Because the release button was on the forward-facing side of the shoulder belt, when it hit the visor it disconnected, whipping down across my face. The visor wasn't huge, and it wasn't in the way of getting out of the car. I hadn't even thought about moving it before opening the door.

I wouldn't hear the words "human factors" for another four years, but in that moment I started thinking like a human factors psychologist. Why was the release button on the front of the shoulder belt? Who could possibly remember to move the sun visor to the front before opening the door? Why didn't the designers see this coming? Why was I so embarrassed that this happened to me?

I'd like to say that was the only time I didn't move the sun visor back before getting out of the car, but of course it wasn't. In the six years I drove it, I was smacked by the heavy plastic buckle about ten times. Each time I had that same reaction: "I can't believe I forgot *again*."

We Do It to Ourselves

I'm certainly all too human. We all are. We get fooled again and again, whether it's trying to push a door that says pull or to remember why we walked into the kitchen. The importance of the task is almost immaterial – it's as easy to forget to pick up milk as it is to forget a dog in the backseat of a hot car. Indeed, the penalty for forgetting to move the sun visor was high – ask my poor nose – but I couldn't remember to move the visor back from the side window before opening the car door. Our human brains aren't capable of remembering what we don't remember or constantly paying attention. Our constant (and predictable) failures are as central to our humanity as love, ambition, or any number of positive characteristics. But what can we do to help our all-too-human selves?

The first step in stopping mistakes is to acknowledge that making them is often beyond our control. Thanks to millions of years of evolution our minds react in predictable, if sometimes undesirable, ways to our surroundings. The second step is to understand consciousness and behavior at a level where we can predict how people will act. Third is to use this to create the world around us, working with our talents and acknowledging our failings. Once we understand how people see, hear, feel, and think we can make a world that protects us rather than "fools" us. The answer wasn't for me to remember to put the sun visor back, it was to change the situation so I didn't *need* to remember. But this kind of thinking, where we make the world around us easier, is more recent than most people realize.

As technology progressed during the second Industrial Revolution, machine development quickly outpaced our ability to adapt. Once our lives started to depend on these technologies, we needed a translator between the person and the machine: an interface. Before this, when someone could only move as fast as their feet could run, or only needed to dodge something as fast as it could be thrown, there was not much need to worry about how we used machines. For example, a gas pedal interprets the will of the driver regarding speed and the steering wheel interprets how they want the car to turn. A dial interprets which gas burner to ignite and how high. The phone dial pad or contact list interprets whom we wish to call. All of this began right at the turn of the twentieth century.

Thus, human-centered design began in the second Industrial Revolution, after years of machine-related deaths and crippled workers in factories. Some of the first people to recognize the disconnect between work demands and human capabilities were Frank and Lillian Gilbreth. Together, they founded a new field, one that took into account the person doing the work as well as the machine being worked with. The Gilbreths engaged with the same questions that confound modern designers. Today we worry about controlling autonomous cars. The Gilbreths had to understand how the public would react to *regular* cars, which moved a lot faster than a horse.

The Gilbreths (famously profiled with their many children in the book and film *Cheaper by the Dozen*) filmed people while working. They called these "time-motion studies." From these films they zeroed in on how to make motions smaller, more efficient, and with better flow. They proposed surgeons keep their tools on a tray, arranged according

to the most frequently used and the order in which they would likely be called for during surgery. Another was to build a raised stand for bricklayers, so that the worker didn't bend over to grab every single brick. They even enrolled the family in their research, as remembered by their son Frank, Jr., and daughter Ernestine:

> "Is it better to stack the dishes on the table, so that you can carry out a big pile?" Dad asked. "Or is it better to take a few of them at a time into the butler's pantry, where you can rinse them while you stack. After dinner we'll divide the table into two parts, and try one method on one part and the other method on the other. I'll time you."[1]

The Gilbreths were true empiricists. Optimizing motion may seem to have obvious benefits, but there was pushback from naysayers who claimed that lazy employees should simply work harder, and that the promise of increased production in shorter time *with easier work* was a dream. The Gilbreths were undeterred. Lillian Gilbreth even counted the "happiness minutes" of the worker as an important measure of work. She brought the radical idea that our world should be built to fit us, mentally and physically, rather than forcing the worker to adapt to whatever poorly engineered system was put in front of them – and all of this in a time when the announcement of her engagement noted that "Although a graduate of the University of California the bride is nonetheless an extremely attractive young woman."[2] That graduate deserves credit for being the first to consider the "human factor" in work, setting up the criteria that would be used by psychologists in the World War II.

Enter the Human Factor

Frank Gilbreth might have liked the controls used in the planes of World War II as they were clustered closely together, meaning smaller movements were needed to use them. But as aviators in World War II found out, this resulted in pilots accidentally retracting the landing gear when they meant to pull up the wing flaps. In a short time during World War II, dozens of planes crashed due mixing up the flaps and landing gear.[3] When your profession has a nickname for an error (in this case, the "Gear Up Club"), you might begin to suspect that there is a problem with the design of the controls. Most drivers have been in a similar club when renting an unfamiliar a car and turning on the wiper

instead of the lights, but with less egregious consequences. The thinking of the 1940s was that good pilots don't make errors. If a pilot forgot to put down the landing gear, it meant the wrong pilot had been chosen for the job. But the crashes couldn't be dismissed. The pilots knew how to fly. They weren't suicidal. The planes didn't malfunction. Why did they keep making the same mistake over and over again?

Psychologist Paul Fitts and Capt. Richard Jones decided to look at the problem from the pilot's perspective, asking over 500 World War II pilots to "Describe in detail an error in the operation of a cockpit control which was made by yourself or by another person whom you were watching at the time."[4] As someone who has sent out many surveys only to get a few returned, I wonder if Fitts anticipated the onslaught of comments he would get from pilots – all highly detailed and with many frightening close calls. My favorite was his description of a harrowing incident where the passengers were instructed to "jettison their baggage" to keep the plane aloft. But after saying goodbye to everyone's bags, the pilot realized the troubles came from him forgetting to switch power to an engine. This gave me a new perspective on losing my luggage.

By 1947, Fitts and Jones had finished their report. It was shocking. To get an idea of what pilots were facing, imagine renting a car with the brake and accelerator reversed or in entirely different locations. That's what switching between planes was like. Pilots moved between aircraft that positioned knobs differently for three critical controls: throttle, propeller, and air–fuel mixture. Three types of aircraft, three different locations for these controls. Pilots were expected to learn and adapt. Only often they couldn't, or slipped into a habit formed by flying another type of plane, meaning the more experienced pilots were the most likely to err. Almost all crashes blamed "pilot error," not the control configuration. Here, the pilots were ahead of the engineers – sometimes they glued cardboard triangles to the flaps control and a piece of tire to the landing gear, helping their hands realize when the wrong control was grabbed before they used it.[5]

Rebecca Cameron recounted an example of the entrenched thinking of the time in *Training to fly: Military flight training 1907–1945*. Due to the type of rubber tires on the planes, pilots tended to bounce when landing. Though not fatal, these bouncy landings were costly. When the damage was tallied, the colonel in charge demanded to know "What's the reason for all these broken landing gears? All these

broken wings?" When he was told it was "bad landings," he decreed, "Take a memorandum. There will be no more bad landings at this field."[6] You can imagine how well that worked. Such is the all-too-human history of believing that desire and effort can overcome design flaws.

I like to think of it as the difference between prescriptive and descriptive behavior. Prescriptive behavior is what one *should* do. Telling the pilots to land smoothly or use the "correct" controls is prescriptive. Descriptive behavior is what one *does* – pilots land poorly on solid rubber tires. Badly designed tires or confusing controls have predictable results. A good manager or designer recognizes that we have to work with humans as they are, not as we wish them to be. We have to describe how people act, understand them, predict them, and only then can we hope to come up with ways to encourage correct behavior or at least lessen the consequences for a mistake. Those who refuse to understand bad designs are doomed to repeat them.

A Prescription for Description

The gulf between the prescriptive and the descriptive describes many of our issues in living in a human-designed world. But to find solutions we have to understand a multitude of facts about the human mind and body. Researchers have amassed a great deal of this knowledge in cognitive psychology, social psychology, biological psychology, biology, neuroscience, and genetics, but it can be difficult to find an overview of how all those can be applied *right now* to the world around us. That's what I want to share in this book – the connections between these many areas of research with stories "ripped from the headlines." That's a lot of ground to cover, but by the last chapter you will understand enough about human capability and limitation to have unique insights into high-profile news stories and explanations for everyday frustrations and successes. Be warned – once you have an understanding of why we do what we do, you'll start to see the human factor everywhere. Hopefully it won't have to hit you in the face.