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2023-03-13 the door close button

This will probably be a short one, and I know I haven't written for a while, but it has always been the case that you get what you pay for and *Computers Are Bad* is nothing if not affordable. Still, this is a topic on which I am moderately passionate and so I can probably stretch it to an implausible length.

Elevator control panels have long featured two buttons labeled "door open" and "door close." One of these buttons does pretty much what it says on the label (although I understand that European elevators sometimes have a separate "door hold" button for the most common use of "door open"). The other usually doesn't seem to, and that has lead to a minor internet phenomenon. Here's the problem: *the internet is wrong,* and I am here to set it right. This works every time!

A huge number of articles confidently state that "80% of door close buttons do nothing." The origin of this 80% number seems to be a 2014 episode of *Radiolab* titled "Buttons Not Buttons," which I just listened through while doing laundry. Radiolab gets the statistic from the curator of an elevator history museum, who says that most of them "aren't even hooked up." This is reason to doubt our curator's accuracy. I don't think there is anything malicious going on here, but I do think there is an element of someone who has been out of the industry for a while who is at least misstating the details of the issue.

The problem is not unique to Radiolab, though. An Oct. 27, 2016 New York Times article, "Pushing That Crosswalk Button May Make You Feel Better, but...," covers the exact same material as the Radiolab article a couple of years later. And the article was widely repeated in other publications, not by syndication but by "According to the New York Times..." paraphrasing. This means that often the repetitions are more problematic than the original, but even the original says:

> But some buttons we regularly rely on to get results are mere artifices - placebos that promote an illusion of control but that in reality do not work.

Many versions of the article lean on this line even harder, asserting that door close buttons in elevators are installed entirely or at least primarily as placebos. But the NYTimes article provides brief mention of the deeper, and less conspiratorial, reality:

> Karen W. Penafiel, executive director of National Elevator Industry Inc., a trade group, said the close-door feature faded into obsolescence a few years after the enactment of the Americans With Disabilities Act in 1990.
>
> ...

> The buttons can be operated by firefighters and maintenance workers who have the proper keys or codes.

There are a few things to cover:

First, anyone who says that the "door close" buttons in elevators are routinely "not even hooked up" shouldn't be trusted. The world is full of many elevators and I'm sure some can be found with mechanically non-functional door close buttons, but the issue should be infrequent. The "door close" button is required to operate the elevator in fire service mode, which disables automatic closing of the doors entirely so that the elevator does not leave a firefighter stranded. Fire service mode must be tested as part of the regular inspection of the elevator (ASME A17.1-2019, but implemented through various state and local codes). Therefore, elevators with a "door close" button that isn't "hooked up" will fail their annual inspections. While no doubt some slip through the cracks (particularly in states with laxer inspection standards), something that wouldn't meet inspection standards can hardly be called normal practice and the affected elevators must be far fewer than 80%.

But perhaps I am being too pedantic. Elevator control systems are complex and highly configurable. Whether or not the door close button is "hooked up" or not is mostly irrelevant if the controller is configured to ignore the button, and it's possible that some of these articles are actually referring to a configuration issue. So what can we find about the way elevators are configured?

I did some desperate research in the hopes of finding openly available documentation on elevator controller programming, but elevator manufacturers hold their control systems very close to their chests. I was not lucky enough to find any reasonably modern programming documentation that I could access. Some years ago I did shoulder-surf an elevator technician for a while as he attempted to troubleshoot a reasonably new two-story ThyssenKrupp hydraulic that was repeatedly shutting off due to a trouble code. In the modern world this kind of troubleshooting consists mostly of sitting on the floor of the elevator with a laptop looking at various status reports available in the configuration software. The software, as I recall, came from the school of industrial software design where a major component of the interface was a large tree view of every option and discoverability came in the form of some items being in ALL CAPS.

The NYTimes article, though, puts us onto the important issue here: the ADA. Multiple articles repeat that door close buttons have been non-functional since 1990, although I think most of them (if not all) are just paraphrasings of this same NYTimes piece. The ADA is easy to find and section 4.10 addresses elevators. Specifically, 4.10.7 and 4.10.8 have been mentioned by some elevator technicians as the source of the "door close" trouble. With some less relevant material omitted:

> 4.10.7* Door and Signal Timing for Hall Calls
>
> The minimum acceptable time from notification that a car is answering a call until the doors of that car start to close shall be calculated from the following equation:
>
> T = D/(1.5 ft/s) or T = D/(445 mm/s)
>
> where T total time in seconds and D distance (in feet or millimeters) from a point in the lobby or corridor 60 in (1525 mm) directly in front of the farthest call button controlling that car to the centerline of its hoistway door (see Fig. 21).
>
> 4.10.8 Door Delay for Car Calls

> The minimum time for elevator doors to remain fully open in response to a car call shall be 3 seconds.

Based on posts from various elevator technicians, it's clear that these ADA requirements have at least been widely interpreted as stating hard minimums regardless of any user interaction. In other words, the ADA timing constitutes the *minimum door hold time* which cannot be shortened. Based on the 4.10.7 rule, we can see that that time will be as long as ten seconds in fairly normal elevator lobbies (16 feet, or about two elevators, from door centerpoint to furthest button). We can read the same in a compliance FAQ from Corada, an ADA compliance consulting firm:

> User activation of door close (or automatic operation) cannot reduce the initial opening time of doors (3 seconds minimum) or the minimum door signal timing (based on 1.5/ ft/s travel speed for the distance from the hall call button to car door centerline).

One point here can be kind of confusing. The minimum time for the door to be fully open is 3 seconds, but the door signal timing is based on the time from the indication of which elevator has arrived (usually a chime and illuminated lamp) to the time that the doors start closing. This will be at least a couple of seconds longer than the minimum door time due to the open and close time of the door, but since it starts at 5 seconds and goes up from there it will usually be the longer of the two requirements and thus set the actual minimum door time. Where this is likely to not be the case are single-elevator setups where the 5 second minimum timing will apply and the time from chime to door open eats up the first two seconds... in that case, the 3 second fully open time will become the limiting (or really maximizing) factor.

From some elevator manuals such as one for the Motion Control Engineering VFMC-1000, we can gather that that the "minimum door hold time" and "door hold time" are separately configurable. I have seen several mentions online that in most elevators the "door close" button functions totally normally during the *difference between the minimum door hold time and the door hold time.* In other words, there may be some period during which pushing the door close button causes the door to close, but it will be after the end of the ADA-required minimum door time.

Here is the obvious catch: since reducing the door hold time will make the elevator more responsive (less time on the way to a call spent waiting with the doors open), elevator installers are usually motivated to make the door hold time as short as possible. Since the ADA requirements impose a minimum, it's likely very common for the minimum door hold time and the "normal" door hold time to be the same... meaning that the window to use the "door close" button is zero seconds in duration.

We can confirm this behavior by finding an elevator with a very long configured door hold time. That seems pretty easy to do: visit a hospital. Most hospitals set the door hold time fairly high to accommodate people pushing hospital beds around, so the normal door open time is longer than the ADA requirement (the ADA rules are of course written assuming a person can cover 1.5 ft/s which isn't very fast but still seems hard to achieve when accelerating a heavy hospital bed in a tight space). Call an elevator, step inside, wait for around ten seconds from the chime for the minimum door hold to elapse, and then push the "door close" button. What happens? Well, in my experience the door promptly closes, although I admit that I've only tested this on two hospitals so far. Perhaps your experience will vary: I can see the possibility of a hospital setting the minimum door hold time high, but of course that would get pretty annoying and probably

produce pushback from the staff. In the hospitals where I've studiously observed the elevators the normal door hold time was close to 20 seconds, which feels like an eternity when you're waiting to get up one floor.

Another way we can inspect this issue is via door reopening rules. While older elevators used a rubber bumper on the door called a sensitive edge, most elevators you'll see today use a "light curtain" instead. This device, installed between the hall and car doors, monitors for the interruption of infrared light beams to tell if the door is clear. When the door is obstructed, ADA 4.10.6 requires the door to remain open for at least 20 seconds. After that point ADA just refers to the ASME A17.1 standard, which allows for a behavior called "nudging" in which the elevator controller encourages people to clear the door by closing it anyway (at slow speed). The light curtain can also be used to detect whether or not a person has entered the elevator, which can be used as an input to hold time. Some articles online say that you can "hack" an elevator waiting at an empty floor (because someone called the elevator and walked away, for example) by momentarily interrupting the light curtain so that the controller will believe that someone has entered.

Indeed this seems to work well on some elevators, but the ADA requirements do not allow an exception to minimum hold times based on light curtain detection. This means that the light curtain trick is basically equivalent to the door close button: we can expect it to, at most, shorten the door hold time to the ADA minimum. Nothing is allowed to decrease the time below the ADA minimum, except when the elevator is in a special mode such as fire or perhaps independent service.

So it seems that the reality of elevator "door close" buttons is rather less dramatic than Radiolab and the NYTimes imply: the "door close" button is perfectly functional, but details of the 1990 ADA mean that most of the time people are pressing it the elevator controller isn't permitted to close the door due to ADA rules. As far as I can tell, outside of the ADA minimum door time, door close buttons work just fine.

And yet tons of articles online still tell us that the button is installed as a placebo... something that is demonstrably untrue considering its significance in fire (and maintenance, independent, etc) modes, and shows a general lack of understanding of elevator codes and the ADA. Moreover, it seems like something you would find out is untrue with about five minutes of research. So why is it such "common knowledge" that it makes the rounds of major subreddits and minor local news websites to this day?

No doubt a large portion of the problem is laziness. The "placebo" theory has a lot of sizzle to it. Even though the NYTimes is somewhat noncommittal and only *implies* that it is the true purpose of the button, most of the online pieces about door close buttons I can find appear to be based solely on the 2016 NYTimes article and actually repeat the claim about the placebo affect more strongly than the NYTimes originally makes it. In other words, the "fact" that the door close button is a placebo seems to mostly just be a product of lazy journalists rewriting an NYTimes piece enough to not feel like plagiarists.

There is also a matter of aesthetic appeal: the placebo theory sounds great. It has the universal appeal of mundane reality but also hints at some kind of conspiracy to deceive in the elevator industry. And, of course, it makes everyone feel better about the high failure rate of mashing the "door close" button without the complexity of an accurate explanation of the 1990 ADA rules. The NYTimes piece basically makes it sound like the ADA banned door close buttons, and it's easy to read the ADA and see that that's not true... but it takes some real attention and thought to figure out how the ADA really did change elevator controls.

This type of phenomenon, a sort of "internet urban pseudo-legend," is not at all unique to elevator buttons. In fact the very same 2016 NYTimes article that started that year's round of elevator button "fun facts" is also to blame for another widespread belief in placebo buttons: crosswalk request buttons. The NYTimes article says that most crosswalk buttons do nothing, explaining that the buttons were made non-functional after an upgrade to computer light controls. What the article does say, but many readers seem to miss, is that this is a fact about crosswalk buttons in *New York City*.

Many traffic lights operate in "actuated mode," where they base their cycling on knowledge of who is waiting where. Older traffic lights mostly used buried inductive loops under the lanes to detect lane occupancy (that a vehicle is present), but a lot of newer traffic lights use either video cameras or compact radar sets. Since they don't require cutting into the pavement and then resealing it, these are cheaper and faster to install. Newer video and radar systems are also better at detecting cyclists than pavement loops---although earlier video systems performed very poorly on this issue and gave video lane presence detection a bad reputation in some cities.

New York City, though, was a very early adopter of large-area computer control of traffic lights. One of the main advantages of central computer control of traffic lights is the ability to set up complex schedules and dynamically adjust timing. Not only can centrally-controlled traffic lights operate in sequence timing matched to the speed limit of the street, they can also have the durations in different directions and sequence speed adjusted based on real-time traffic conditions.

The problem is that combining central timing control with actuated operation is, well, tricky. In practice, most traffic lights that operate under sequence timing or remote timing control don't operate in actuated mode, or at least not at the same time. What some traffic lights do today is switch: sequence timing during rush hour, and actuated mode during lower traffic. Even with today's developments combining scheduled timing with actuation inputs is tricky, and New York City adopted centralized control in the '70s!

So New York's adoption of central control was also, for the most part, an abandonment of actuated operation. The crosswalk buttons are actuation inputs, so they became non-functional as part of this shift. The 2016 NYTimes article explained that the city had estimated the cost of removing the now non-functional buttons at over a million dollars and so decided to skip the effort... but they are removing the buttons as other work is performed.

For the second time, this runs directly counter to the "mechanical placebo" argument the article is based on. The buttons weren't originally installed as placebo at all; when they were put in they were fully functional. A different decision, to switch to centralized timing control, resulted in their current state, and even then, they *are* being removed over time.

Moreover, the same does not apply to other cities. The NYTimes makes a very lazy effort at addressing this by by referring to a now-unavailable 2010 ABC News piece reporting that they "...found only one functioning crosswalk button in a survey of signals in Austin, Tex.; Gainesville, Fla.; and Syracuse." It is unclear what the extent of that survey is, and I lack the familiarity with traffic signaling in those cities to comment on it. But in a great many cities, most of them in my experience, actuated traffic signals remain the norm outside of very high-traffic areas, and so the crosswalk buttons serve a real purpose. Depending on the light configuration, you may never get a "walk" signal if you don't press the button, or the duration of the "walk" signal (prior to the flashing red hand clearing time) may be shorter.

Actually one might wonder why those crosswalk buttons have so much staying power, given the technical progress in lane presence detection. Video and radar options for waiting pedestrian detection do exist. I have occasionally even seen PIR sensors installed for this purpose in suburban areas. The problem, I think, is that detecting a pedestrian waiting to cross involves more nuance than a vehicle. Sidewalks don't have lane lines to clearly delineate different queues for each movement. A video or radar-based system can detect a pedestrian waiting on the corner, but not whether that person is waiting to cross one direction, or the other, or for an Uber, or just chose that spot to catch up on Tik Tok. Video-based waiting pedestrian detection may be too prone to false positives, and in any case the button is a robust and low-cost option that can also be used to meet ADA objectives through audible and tactile announcements.

So there's a story about buttons: the conspiracy about them being placebos is itself a conspiracy to get you to read articles in publications like "Science Alert." Or maybe that's just an old tale, and the reality of content-farmed news websites falls out of some implications of the ADA. It's a strange world out there.