SZÉKELY ENGINEERING
EXPLANATIONS & EXAMPLES

Big Red and Lamentations Over the Image of Engineering, ***or***, The Rodney Dangerfield Profession – Really?

Big Red is one of the Colorado River's nicknames and the title of a fictionalized account by John Haase of the building of Hoover Dam featuring, as the protagonist, Frank Crowe, the dam's chief engineer, and while I recall my original copy of the 1982 paperback had blurbs on the cover saying it was 'soon to be a major motion picture', it never happened. The replacement paperback I bought on Amazon a year or two ago still, however, has the inside the cover painting of the major characters, where Crowe looks like he was to be played by the star of the TV White Shadow series.

Back in Volume 10, Number 1 of this publication, in discussing design-build, I referred to John Wayne's 1947 film, *Tycoon*, and, were *Big Red* to finally make it to the screen, it would probably look something like *Tycoon*.

These two examples belie what I've heard from my colleagues all my professional life, lamentations about the lack of respect engineering receives as a profession. This may have been true a century or two ago (though I of late have come to doubt such) but it's even harder to make that case today, what with STEM hype, personal computers, and self-driving cars. Furthermore, while we engineers could make a credible case that we're under compensated when compared physicians or attorneys, our sole Professional Society's occasional treatment of our supposed lack of recognition has led me to believe that many of my colleagues live in a world where they see society as unaware that engineering is the creator of the insular womb of safe comfort in which we live.

No, it's not that the general populace is *unaware*, but that the mover and shaker elites who mold popular culture have convinced John Q. Public that technological progress is intrinsically evil, or that the unintended negative consequences thereof outweigh its positive effects, and that without such "progress", we'd be, as Lancelot sung, in Camelot, 'in Eden still', witness films like *Avatar* and *The China Syndrome*.

I leave it to you to decide whether you believe such is merely the result of said elites' "innocent" ignorance or of virtue-signaling hypocrisy. My opinion is the latter, because I don't see them living like Thoreau at Walden Pond as I have, for short periods of time, and while it *is* sublime, I'd not trade it in as a lifestyle in place of the faux naturalist's likely characterization of today's "artificial" life as that of technological decadence.

A lemma of the anti-technology movement is that while socialism is nirvana and mom and pop commercial enterprises might be OK, corporations and assembly lines are bad.

Oh yeah? Then why not move to Venezuela or drive a Yugo or Lada instead of, say, a Chevy or Ford? Not to mention the fact I pointed out in an earlier newsletter, that one cannot fabricate [something as complex as] an automobile with one's own hands.

The same, however, cannot be said for something as "simple" as a clock, where a Greek astronomical calculator constructed over 2000 years ago had hand-cut gears, and while the ancient Greeks and Romans lived lives infinitely less environmentally stressful and incomparably more comfortable than those of Neanderthals, even they couldn't stock the fridge for a week with food from a supermarket.

So my point is, the technology developed through engineering is a good thing but we've had a guilt trip laid on us that has made us uncomfortable about it, and it's because of *that*, not ignorance of what engineering is, that it "don't get no respect."

Technological progress is not bad, but some people are bad. There always have been, and always will be, some bad people, but an obsession that Big Oil, Big Pharma, and others are engendering a Corporatocracy, will provide neither gasoline nor aspirin.

Of course, if Hare Krishna is your thing, you need neither – until you do.

Engineering for Dummies Redux, Part 4 - High Voltage, ***or***, Electricity Acts Funny on the Way to Your House.

In the mid to late 1970's when I worked for Crawford and Russell, a now absorbed Heavy Construction Engineering firm in Stamford Connecticut as an Electrical Designer, I broke in a Columbia University EE graduate engineer to the world of electrical light and power engineering while we were working on a chemical process plant being built in Louisiana. It seems there was, and remains, little or no attention given to the subject in his undergraduate curriculum, with him joking that anything over 50 volts was considered "high voltage".

The relationship between electricity and magnetism I discussed in *Of Shields and Signals* in Volume 1 Number 5, blossomed via Nikola Tesla's spooky genius into the electrical generation, transmission, and distribution system which delivers electricity to your lights and wall outlets.

Notwithstanding the plaque on a building at the corner of Fulton and Gold Streets in the Financial District, neither New York's nor any other place's "Electrical System" is based upon the system Thomas Edison originated in that location.

You see, like the friction in a water pipe causing a drop in delivered pressure directly proportional to distance, the resistance of a wire or cable to the flow of current in it, causes a like drop in voltage, also directly proportional to the distance. In both cases, these losses are *inversely* proportional to the diameter of the transmitting medium – the use of larger pipes and fatter wires allows the delivery of water and electricity with lesser losses. Digging trenches large enough for 30" diameter water mains is no big deal, but trying to deliver DC electricity to customers more than a mile or so away would call for cables too large and heavy to run overhead, or large, expensive motors driving generators at each end to step up and step down the voltage.

The same electricity-magnetism relationship which is the basis for the generation of electricity is what allows us to step up voltage via transformers, and it only works because of AC's magnetic field expanding and collapsing 60 times a second (50 almost everywhere except the U.S.). The higher the voltage, the more volts you can afford to lose and still have enough left to utilize to do work at the point of service, which brings us back to my friend's quip about high voltage.

In the industry in the US, everything under 600 volts is low-voltage (although in US Electrical Contracting it's anything below the utilization voltage of 120 volts), and from there to 35,000 volts (35 *Kilovolts*, or 35KV) is *medium voltage*, with *high voltage* classified as the range from 35KV to 230KV. Electricity is generated at medium voltage, transmitted at high voltage, and almost always utilized at low voltage (medium voltage motors are used in heavy industry).

Remembering that electric voltage is analogous to hydraulic pressure, the electric insulation is the wall of the electric "pipe" which keeps the electric "water" from spilling on to you and ruining your entire day, and has to get thicker and stronger as the voltage level increases, with 5KV and 35 KV being the common medium voltage cable insulation classes.

At medium and high voltage, plain insulation isn't enough – the pressure is so high, the cable has to be *shielded* to prevent stress point punch through of the insulation, and while high voltage insulated cable exists, it's less costly to run high voltage as exposed bare cable keeping energized lines, conductors, and *grounds* far enough away each other, to use the intervening air as the insulation, which is what you see run between huge electric transmission towers. The overhead power distribution you see between the "telephone poles" in suburban and rural areas is actually bare medium voltage, usually 5KV.

This propensity of high voltage electricity to overcome its insulation is but one of the ways it acts funny on the way to your house. Because of the additional losses caused by the *impedance* of AC electricity (which has led to the resurgence, thanks to modern rectifiers, of DC transmission for extremely high voltage among other applications), at high frequency, this impedance is magnified as *skin effect* which causes the current to travel more and more closely to the surface of a conductor rather the flowing evenly through it like water in a pipe.

At high enough frequency, the electricity leaves the conductor altogether, becoming the wireless of radio, TV, and cell phones. At high enough *voltage*, the oxygen in air is *ionized*, making air (and everything else) a conductor rather than an insulator (duh, lightning).

You need to stay away from uninsulated electricity – if you get too close, unlike the proverbial tree, it will *actually* jump out at you.