This is my 33rd show, Science: Let's take a look. It's time to consider moving on. Some reasons to stay include the enjoyment of sharing so many ideas of science that have filled my life to the present day...the lively guests on the show who have covered topics ranging from plant ecophysiology to green city development to renewable energy to national lab research on energy to electric fish to human nutrition to the Las Cruces Space Festival and more. The show has also been one more way for our nonprofit private school, the Las Cruces Academy, to meet its mandate for outreach to the greater community.

On the other side of the ledger is the void in listener response. I still appreciate the second-hand comment through Nan Rubin of this station from Bernie Digman of the Milagro Coffee Y Espresso. Bernie appreciated that my colleague in Chicago, Hormoz BassiriRad, and I brought up the importance of plants' stomatal conductance in the globe's response to rising CO_2 levels. Alas, that is the only spontaneous response I've had in 33 shows. I've asked listeners to call in live, to text me, email me, post on my website, science-technology-society.com. To my regret, all those venues have been silent.

So, I face a choice this week and next, whether to continue the show or not. I can choose to spend the four hours a week in other outreach, with some groundwork to be done. I can choose to keep doing this show.

I know that we at KTAL are still building audiences for our shows. I know that it has taken time to get the word out on our website. Whether I stay or not, I hope for vigorous growth of KTAL. For my own decision, I'd like to ask my listeners a few more times, this week and next, to give me a spark – call me on the air, at 526-KTAL (526-5825), or text me at 575-571-2269, or send me an email at vince@lascrucesacademy.org, or leave a comment on the contact link on my website, science-technology-society.com. I'll soon have my answer for you. If you do call or text or post, make a comment, suggest a topic to cover, or just say hello.

Thanks.

Please note: I'll be posting this script on that same website.

For past audio recordings, you can also go to my YouTube channel, vince5305, where I made about two dozen segments into videos.

One response you might offer is an answer to a puzzle or a quiz. Here's one:

First, math...which is not science, since math need not agree with anything in the real world...but which is vital to science as a tool: Recall what prime numbers are – divisible evenly only by themselves and 1, so, 1, 2, 3, 5, 7, 11, 13, 17, 19, 23, ... How many consecutive *non*-prime numbers are there from 114 onward? Hint: 117 is non-prime, being 3x39.

Advanced, with algebra: How far is it worth traveling out of your way for cheaper gas? I have this on my website, at https://science-technology-society.com/fun-with-a-purpose/math/. Assume it's a round trip out of your way, and that: you fill up with *g* gallons at the cheaper place; that the gas is cheaper by an amount *d* or, if you like Greek letters, Δ, as we often do in science; that your usual gas has a price *p* per gallon, and that your fuel economy is *e* miles per gallon.

Opinion: How long do you think it will take for 50% of US primary energy (fuels for heating, transportation, industry...) to be derived from low- or no-carbon sources – wind, solar, hydro, geothermal, nuclear?

Today it's science stories from around the globe again, and a few stories I've put together myself. Next week, August 7th, Graciela Unguez comes back to talk some more about how electric fish, and we, develop our nerves and muscles...and, for the fish, their remarkable electric organs.

From the 13 July issue of Science, the international journal...with a ghostly (?) cover picture of a few of the 5000 optical sensors underneath the Antarctic ice in the IceCube Neutrino Observatory. Recently there, a massively energetic neutrino coming from far outside our galaxy was detected – quite an event, in that neutrinos interact so weakly with other matter that one may pass through several light-years' thickness of lead (trillions of miles) before having an even chance of reacting. It's amazing that neutrinos were ever detected, or the idea of them conceived (that goes back to Wolfgang Pauli trying to explain how some nuclear decays, beta decays, conserved energy and momentum). Pauli, by the way, made one of my favorite comments, this one about a scientific manuscript he received: "This isn't right; it isn't even wrong!" Such a comment is merited for some ideas, even more so the political ones than scientific ones.

Page 120, "Liquid sunshine." Chemist Doug MacFarlane at Monash U. in Melbourne, Australia, has created a fuel cell that absorbs solar energy to create ammonia, NH_3, ultimately from nitrogen gas and water. Water gets split into H_2 and O_2, with the hydrogen used reacted with nitrogen directly inside the solar cell, rather than in the classic Haber-Bosch process that uses high temperature and pressure. Ammonia is a topic dear to my heart; in my early/mid-career I researched the global nitrogen cycle, particularly ammonia synthesis by both microbes and industry. It's a hugely energy-intensive process, industrially accounting for 2% of all energy use in the world, mostly for making nitrogenous fertilizers. The Monash scientists have found a way to synthesize ammonia directly with solar energy. They propose to use it as a fuel (hmmm, a dangerous one – it's amazingly toxic as a concentrated liquid or gas, though it has been used in commercial refrigerators a long time). The group's solar cells have hit 70% energy efficiency, way above that of standard PV cells. The challenge is a slow rate, from the use of a viscous electrolyte in the cells; they're working on it.

The ammonia could be used directly as fertilizer, saving the energy cost of making such fertilizer. Another use is as a fuel in either fuel cells (highly efficient) in vehicles or stationary power plants or combustively in modified thermal power plants.

Other researchers in Australia are developing other ways of making ammonia, on land or in offshore rigs tapping ocean water. Let's see what happens!

Page 124, "When persistence doesn't pay." The sunk cost fallacy...Rational foraging for resources, be they food or gambling winnings, would posit abandoning routes of low potential return. Some "gambles" are huge – we might put the ITER nuclear fusion plant in this category, or a number of other big governmental and industrial projects. Alas, humans often persist, with our limited rationality sidestepped by cognitive biases. It turns out that rats and mice have the same problem. Brian Sweiss and colleagues in Minnesota studied humans, rats, and mice in very parallel experiments. Subjects had four reward options to explore, with a limited time. They could stay in one option or move on, opting

out at any time. They would get the reward only if they waited a predetermined time, which varied along with the level of the reward. Subjects who did not have the sunk cost bias gave up on lower rewards with long wait times. The majority showed the bias, however, waiting longer for a reward the longer they had already spent time in one option.

From the 20 July issue of Science...with a cover picture of Stanis Malom of Papua New Guinea, a victim of a neglected tropical disease, ,yaws. It's a bacterial disease that causes open sores and skeletal damage.

Page 208, "First smallpox drug approved." Wait, hasn't the smallpox virus been eradicated from the world, a great success story? Well, it still exists in labs, and terrorists may at some time release it, or a handling error in the labs may occur. The drug, TPOXX, has been tested in rabbits and monkeys in diseases similar to smallpox, but, for obvious ethical and safety reasons, not with smallpox itself. It was also tested for safety only in 359 human volunteers (no disease challenge – only administration of the drug itself).

Page 211, "Congo rapidly curtails Ebola." On 8 May an outbreak occurred in a remote region of the Democratic Republic of the Congo, threatening to spread to a populous city. No real wait this time! With a rapid deployment of lab equipment and personnel by WHO and Doctors without Borders, and with a vaccine developed during and after the last outbreak in 2014-16, the outbreak was quashed. Such vigilance is mandated continuously – the reservoir for Ebola is in nonhuman animals in the forest (fruit bats, I recall, perhaps erroneously).

Page 215, "Hackers easily fool artificial intelligences." Those self-driving vehicles have had their trials along with triumphs. They learn to track routes and avoid hazards (to themselves and to others) with artificial intelligence...and there lie big challenges. Recall the person walking a bicycle and killed earlier this year, with AI very slow to recognize the objects (and with emergency braking irresponsibly turned off!). Now, hackers are pushing to find the weak spots. They found that they could add a few stickers to a stop sign to have AI view it as a 45 mph speed limit sign in one case! In another case, not involving a vehicle, they found that they could alter gradients in color and texture to trick an AI device into viewing a turtle as a rifle! In another case, an image of Hello, Kitty was added to an image and all the cars in the image disappeared from the view of an AI machine. Lots of work to be done! AI researchers are pushing to meet the challenges, with techniques that even soften an image so that tricky gradients can't be exploited. Among the problems are that AI is implemented with "black boxes" that, once trained, are unintelligible to humans (a worry of the European Union for public safety and surveillance, for biases) and, as researcher Dawn Song notes, "There's no mathematical definition of what a pedestrian is."

Page 224, "Regulate to reduce chemical mixture risk." Not a surprise to me, but a number of chemical mixtures are far more hazardous together than estimated from adding their individual hazards. I can think of ways it can happen, such as having two chemical hit both alternative metabolic pathways in our bodies. A number of agencies are working on this, including WHO and the European Inland Fisheries and Aquaculture Advisory Commission; reassuringly, the US regulatory agencies such as EPA have a history of considering mixture hazards, though only for human health, not wildlife or ecosystem function.

Page 243, "Meat consumption, health, and the environment." Meat is undoubtedly a good source of nutrients – calories per se, protein, iron, zinc, vitamin B_{12} – that are less readily available in other foods such as grains. (A reason that hunter gatherers all pursued hunting, of course.) Meat consumption is

rising in all continents and subcontinents (e.g., India, though consumption there is tiny). China now tops the list, with an annual consumption of over 8M tonnes in the graph, twice that of North America (I think the scale is wrong; that makes only 8 kg per capita in China per year!). The health consequences are mixed – better overall health, though modest extra cancer risk from high meat consumption, particularly colorectal cancer with processed meats (hold the pepperoni!). The environmental consequences are larger, with land use, water use, and methane emissions rising, along with water pollution by nitrogen and phosphorus wastes (can't avoid it with current practices; check the feedlots along I-10!).

Page 285, a full research article, "Domain-focused CRISPS screen identifies HRI as a fetal hemoglobin regulator in human erythroid cells." OK, what does that mean? It means that almost all of us humans begin life in the womb and to about 6 months of age have a special form of hemoglobin, fetal hemoglobin, then switching to a different protein, the adult hemoglobin. The article explores how it happens, tracing a regulatory protein that we make unless we have a variant that causes a few of us to stay with fetal hemoglobin. For people with sickle-cell disease or related thalassemia, that can be a plus, as it helps prevent red-cell sickling and its nasty effects. My interest in the article and the phenomena is in the pros and cons of the switch. Fetal Hb hangs onto oxygen more tightly. That helps a developing fetus to grab oxygen from the mother's blood – else, it could only share a part of the oxygen in the blood reaching the placenta. What's the effect in adults who have fetal Hb only? The article says it's not much of a handicap. I note that fetal Hb only gives up its oxygen to needy cells (in muscles, brain, etc.) at lower average oxygen partial pressures (19 mm vs. 27 mm Hg, in the ancient units used by doctors and medical researchers – about 1/8 to 1/6 of free-air oxygen levels). We rarely ever need to deplete oxygen in our lungs to such low levels, so why do humans make the switch? What evolutionary selection pressure exists for this? Aha – if the mother kept fetal Hb, it would be a problem for the infant again!

From the 19 July issue of *Nature,* the other premier international journal of science:

Page 304, "The lost dogs of the Americas." Genetic analysis of modern dogs and of the remains of Paleo-Indian dogs show that they came from different lineages. With the arrival of European colonists in the Americas, the original dogs died off. Those original dogs were not domesticated from N. American wolves but were related to Siberian huskies (those beautiful dogs! We had a small American huskie).

Page 305, "Where the wild whales went." Bone fragments found in Roman archaeological sites turned out to have the protein and DNA signatures of right whales and grey whales, no longer found in the Mediterranean. It appears that Roman whalers extinguished both species in the Mediterranean.

Page 306, "Sterile mosquitoes." If you've been to tropical northern Queensland, Australia, you encountered mosquitoes. Can we be rid of them? (Lou Ellen and I have been to many tropical nations, including Viet Nam, where the absence of mosquitoes betokens some drastic measures. Hmm.) Insecticides pose real problems. One way to get rid of them is by making sterile males, made sterile by infection with a natural bacterium of the genus Wohlbachia, long known to have this interesting effect (no time to get into the genetics here). Trials ran in 3 Qld. towns, sponsored by a Google spinoff and Australia's CSIRO labs, achieving more than 80% reduction in the mosquito populations.

Page 306, "Herbicide lawsuits." A US federal judge is allowing lawsuits against Monsanto to proceed, with plaintiffs alleging that a groundskeeper developed non-Hodgkins lymphoma from exposure to

glyphosate (RoundUp). That will be very interesting, using one cancer case among many not related to glyphosate in a test. I have my bets on this. What are your bets?

Page 307, "Fossil-fuel vote." Ireland is close to divesting itself of all investment in fossil-fuel companies, the first nation to do so. Legislation passed the lower house and is expected to pass the upper house and become law.

Page 336, "Newfound differences between great apes." How did we become so different from other great apes, with so few changes in our DNA? Now that new high-quality genomes are available for a chimp and an orangutan, comparisons brought to light structural differences – whole sections deleted or duplicated in us relative to our most recent common ancestor. Many of the changes disrupted gene function in us, and that appears to have been a good thing (for us, not for the rest of the biosphere!).

Page 350, a full research article, "Insights into clonal haematopoesis from 8,342 mosaic chromosomal alterations." Well, our DNA mutates in our bodies as we live, with a bit in our germ line (eggs and sperm) but more in our body cells, or somatic cells. Most of the mutations lead to death of the mutated cells (no big deal) or have no notable effect on function, but some do. UK researchers using data from the UK Biobank found some genetic markers that strongly affect the probabality that the carrier will have lots of somatic mutations and a consequence higher probability of blood cancers. What can a carrier do? Not much, I'd guess, but it's of interest in medicine.

Page 382, a full research article, "Synchronous tropical and polar temperature evolution in the Eocene." Earth has been cooling substantially over the last 58 My, from an apparent mean sea-surface temperature of 29o (really uncomfortable to us, had we been there!) to our current 15oC. The temperatures are inferred from biological markers (lipids) in sediments. The point of the article is that both low and high latitudes changed temperature at the same time. Concurrent estimates of CO_2 concentrations show that the sensitivity of temperature to CO_2 levels is high, at the level of our high end in climate models. Be worried. Recall that life survived higher T....but not with the global life-support system of agriculture, water supplies, etc. delicately balanced on current T.

From *Carnegie Science*, the newsletter of the Carnegie Institution of Science. Lou Ellen and I spent six months at their Stanford, CA facility, working alongside the great Joe Berry, XXX, and others, on XXX.

Page 7, "Surprising Land Preference for Borneo's Elephants." Greg Asner, whom I first met at least 15 years ago, has an amazing remote-sensing methodology linked with ground studies of all kinds (plant identification, animal tracking). Central is the Carnegie Airborne Observatory, flown on a Cessna, the most sophisticated remote sensing system in the world. Greg and his team, led this time by Luke Evans, found that Borneo's elephants preferred degraded, more-open forests. The team's call is for these forests not to be converted to agriculture.

Page 16, "Habitability of Proxima b Now in Question." You may have read about the planet Promxima Centauri b, or heard my show about it on January 30th (made into a YouTube video). Exobiologists, scientists looking (very optimistically!) for life on other planets, touted it as having an appropriate environment for temperature and "solar" (stellar) radiation. I pointed out a large number of problems with that view. Well, game over. Meredith MacGregor and her team found that the planet's host star flared up massively, becoming 1000x brighter in 10 seconds, with the event lasting 2 minutes. Any life there would be toast. I invite you to look at my video for more context in the search for life outside of Earth.

Page 19, “The Case of the Missing Xenon.” Xenon is one of the noble gases, a chemical element with a filled “shell” of electrons, making chemical combination with other elements nearly impossible. Xenon has been made to combine with highly reactive fluorine. The question in this article is, Why does our atmosphere have so little xenon, while carbonaceous meteorites left from the formation of the Solar System have much more? The clue in research by Alexander Goncharov and Hanyu Liu is that xenon can react under high pressure in the Earth’s interior to form compounds with nickel and iron....so that it didn’t escape into the atmosphere. My caveat is that the compounds formed only at very high pressures, those found most of the way to the Earth’s core. I would expect that the bulk of the xenon at lesser depths would still be able to migrate to the atmosphere.

From the New York Times opinion page of 24 July (my birthday), “Why Progressives Should Embrace the Genetics of Education,” by Kathryn Paige Harden. In a paper published in the scientific journal, *Nature Genetics*, a team looked at data (suitably anonymized) from 300,000 customers of 23 and Me. They found that a combination of some thousands of normal genetic variants could be formed into a score, which they called a polygenic score. In Americans of European ancestry, a score in the top 10% correlates with a 55 percent rate of completing college. A score in the lowest 10% correlates with a 9% rate of completing college! The NY Times commentators say that we have to address the genetic bad luck of the low scorers and to reduce the meritocracy that gives achievers rewards. I have no idea how this could be done.