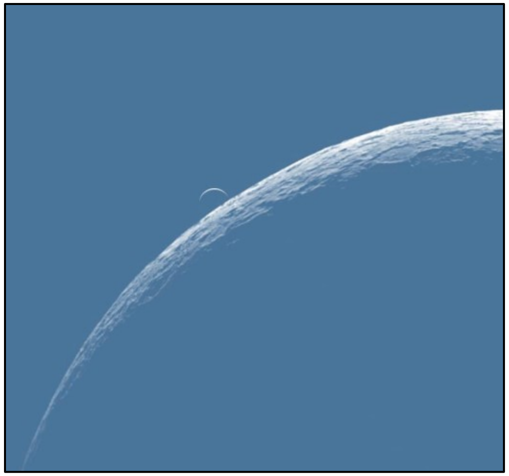


Science Camp #2020.11
Theme: Engines

20-24 July 2020 at Nelson Cabin
Cedar City, and surrounding area

Advisors
H. Roice Nelson, Jr., Andrea S. Nelson,
Paul & Kate Nelson, & Melanie Wright

Attendees
Taylor R. Wright, Ella D. Nelson, Halle N. Wright,
Dallin Spencer Nelson, Avalyn Ashby Wright,
Quinton M. Nelson, & Kendall Joyce Wright
Guest: Chloe Nelson

Past Science Camp Themes & Sites Visited

1. Nelson Cabin, Fishing, Condensation, Water Coloring, and Music
    1. Nelson Cabin
    2. Panquich Lake
    3. Swimming at Cedar City Aquatics Center
2. Mining Range, Frisco, Silver Reef, Iron Town, Astronomy at Frisco Peak, Archery
    1. Nelson Cabin, Kolob Reservoir, Silver Reef, Snow Canyon, Volcano
    2. Parowan Gap, Rack Range Mines, Frisco, Frisco UU Telescope
    3. Iron Mine, Iron Town
3. Geocaching, Mammoth Cave, Cascade Falls, and Cedar City Cemetery
    1. Nelson Farm, Fiddler's Canyon,
    2. Boys to Mammoth Cave, Cascade Falls and Girls to St. George and Pottery Making
    3. Cedar City Cemetery
4. Volcanoes, Classy Closets, Maps, Surveying, Sand Painting, and Genealogy
    1. Condo, Snow Canyon Volcanoes, Classy Closets, Fiddler's Canyon
    2. Nelson Farm to survey, Nelson Cabin
    3. Cedar City 24th of July Parade
5. Patterns, Horse Riding, Internet, Be-a-man-campout
    1. Dust Devil Ranch, InfoWest, Fiddler's Canyon
    2. Nelson Cabin
    3. Cedar City July 4th Parade
6. Music & Spoken Word, SilencerCo, Indian Tribes & Archaeology, Solar Astronomy
    1. Family Discovery Center, Sophie & Dallin's Baptism, SilencerCo, Music & Spoken Word, UU Science Museum
    2. Freemont Indian Museum, Boulder Anasazi Ruins, Escalante Petrified Forest, Bryce Canyon
    3. Parowan Gap, Solar Astronomy, Nelson Cabin, Uncle Des' & Aunt Sara's, Swimming
7. Rock Cutting, SUU Museum, Computer Hardware and Software, Cabin
    1. 1st Annual Fun Run / Walk, rock collection Bloody Ridge, rock cutting and polishing
    2. HTML at SUU, and Lego Robots at Nelson Cabin
    3. Astronomy at Nelson Cabin, Bottle Rockets, and having a good time
8. 8G: Geography, Genetics, Genealogy, Grandma, Grandpa, Geology, Geophysics, & Guitar
    1. Watered garden, 2nd Annual Fun Run / Walk, Iron Springs, Iron Town, Genetics, Cabin, Guitar
    2. Zion, Angels Landing & Emerald Pools, Geophysical Slides
    3. Bottle Rockets, swimming, and having a good time
9. Garden of the Gods, Drones, Intercontinental Divide, Teepee, Salida Hot Springs, University Mountains
    1. Bow & Arrows, Drone, Intercontinental Divide
    2. Guitar and Buena Vista 4th of July Parade
    3. Mount Antero, Hot Springs at Salida, Teepee
10. Eisenhower Park, Guadalupe River, i-Fly, Cave Without a Name, Alamo, San Antonio
    1. Hike to overlook San Antonio, i-Fly, swimming Guadalupe River State Park
    2. Cave without a Name, Singing, Rob Nelson on Sound and Music
    3. Alamo, Wax Museum, San Antonio Riverwalk

11th Annual Nelson Grandkids Summer Science Camp; Theme: Engines

<u>Itinerary</u>

Monday:
1. Fisco Kilns
2. Petroglyphs
3. Kiln Spring Kilns
4. Set Up Camp

Tuesday:
1. Nelson Cabin
2. Water Balloons / Races
3. Dutch Oven

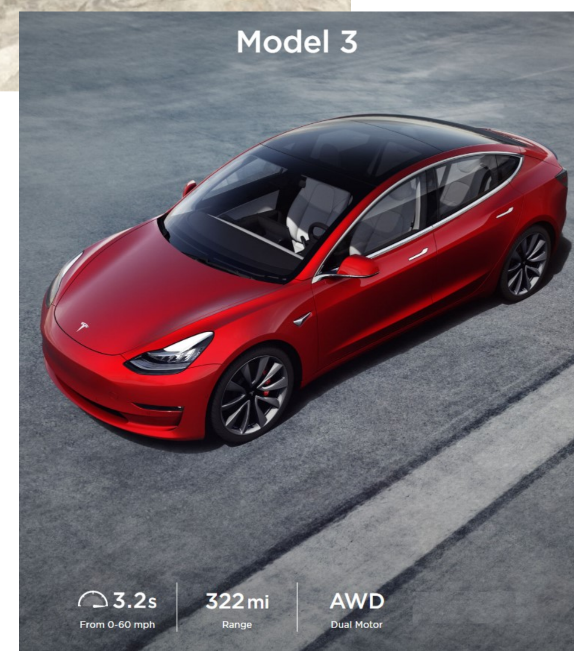
Wednesday:
1. Matheson Engines
2. Shooting Off Rockets
3. Experiencing a Tesla
4. Astronomy

Thursday:
1. Sleep In
2. Kolob Reservoir

Friday:
1. Clean the Cabin
2. Pack Up

Good Times!

Photos + slides will be posted at: http://www.walden3d.com/photos/Grandkids_Science_Camps/200720-24_Science_Camp



Schedule Saturday - Friday

- Saturday, 18 July 2020
  - ~2:00 AM Melanie arrives
  - Breakfast – German Pancakes
  - Aquatic Center
  - Dinner Pizza
- Sunday, 19 July 2020
  - Water Garden
  - Breakfast – Cold Cereal and Bagels
  - Sacrament at house
  - Come Follow Me
  - Lunch: Sausage Rice Casserole and Salad
  - Cedar Breaks and Alpine Lake
  - Dinner: Salads
- Monday, 20 July 2020
  - Water Garden
  - Breakfast – Beverly & Edwin Gurr pancakes & sausages & Orange Juice
  - 11:00 Meet Milford
  - Frisco Kilns
  - Lunch: Sandwiches (sprouted Wheat or Honey Wheat Bread, Turkey, Ham, Creamy & Crunchy Peanut Butter)
  - Petroglyphs
  - Kiln Springs Kilns
  - Cedar to pick up key and to pack food at house
  - Cabin set up tents
  - Dinner: hot dogs, brats, smores, chips, pork & beans, watermelon
- Tuesday, 21 July 2020:
  - Breakfast: Pancakes and Sausage
  - Lunch: Sandwiches
  - Surgical Tubing water balloons (Paul get tubing)
  - Water races
  - Exploring
  - Reading
  - Dinner: Dutch Oven Potatoes, Hamburgers, Cobbler
- Wednesday, 22 July 2020:
  - Breakfast Cold Cereal, Fruit, Bananas, Cantaloupe
  - 10:00 Al Matheson's Engines
  - Lunch: Sandwiches
  - 4-Wheelers
  - Rocket
  - Tesla
  - Dinner: Pizza
  - Cabin Root Beer Floats
- Thursday, 23 July 2020:
  - Breakfast: Scrambled Eggs and Bacon
  - Kolob Reservoir
  - Lunch: Sandwiches and Chips
  - Dinner: Tacos, Hamburgers, and whatever is left.
- Friday, 24 July 2020:
  - Breakfast: Cereal
  - Clean Cabin
  - Melanie leaves Cedar City by 11:30
  - Grandma & Grandma might go back to Cabin

Safety

- **Never go anyplace alone, preferably 3+**.
- Exception is if one of you is hurt, then:
  - One of you stay and help the person hurt.
  - The other one run and get help.
- If you get lost stay put, we will find you.
- If you hear a rattlesnake do not move quickly, just slowly move away from the sound.
- Do not run with a knife open. Use knife safety.
- If you cut yourself, apply pressure to the wound to stop bleeding, and send for help.
- Never point an arrow in a cocked bow or a gun at any person.
- Drink lots and lots and lots of water.
- Do not go swimming unless an adult is with you.
- Do not start branches on fire and swing them around where others can be hurt.
- Have fun, use common sense, and **think before you act**.

Everybody picks up their own dishes!

Everyone cheerfully does what the are asked to do by Grandpa, Grandma, Uncle Paul, Aunt Kate, Aunt Melanie, or other adults.

Job Chart

Monday	Tuesday	Wednesday	Thursday	Friday
Breakfast: - Gurr's - Everyone Help	Breakfast: - Pancakes & Sausage - Ella & Taylor Set-Up, Cook, & Clean-Up	Breakfast: - Cereal & Fruit - Taylor & Dallin Set-Up and Clean-Up	Breakfast: - Scrambled Eggs & Bacon - Grandma & Halle Set-Up, Cook, & Clean-Up	Breakfast: - Cereal & Fruit - Taylor & Ella Set-Up and Clean-Up
Lunch: - Sandwiches (make your own) - All Clean Up	Lunch: - Sandwiches (make your own) - Halle & Kendall Set-Up and Clean-Up	Lunch: - Sandwiches (make your own) - All Clean Up	Lunch: - Sandwiches (make your own) - All Clean Up	Lunch: - Sandwiches (make your own) - On the Road
Dinner: - Dallin set out hot dogs, brats, etc. - Avalyn Clean Up	Dinner: - Dutch Oven - Quinton & Grandpa Set-Up, Cook, & Clean-Up	Dinner: - Pizza - Root Beer Floats - Ella & Avalyn Set –Up and Clean-Up	Dinner: - Hamburgers & Tacos - Quinton & Kendall Set-Up, Cook, & Clean-Up	

Presentations
(Discussion of Science Activities over the last year)

- Taylor ______________________________________.
- Ella ______________________________________.
- Halle ______________________________________.
- Dallin ______________________________________.
- Avalyn ______________________________________.
- Quinton ______________________________________.
- Kendall ______________________________________.

Charcoal kilns near the ghost town of Frisco, Utah.

CHARCOAL

The West's Forgotten Industry

"EUREKA, NEVADA, August 11, 1879 — Two thousand persons, banded together, and with arms in their possession, defied the civil authorities and refused to have any of their number arrested. They now hold forcible possession of many coal pits in this county. By force they have prevented, and are now preventing, the owners of charcoal from hauling it to their furnaces, and they threaten to destroy other property and burn the town. Arrests have been resisted by the rioters, who are well armed, and organized under the command of desperate leaders."

When Governor Kinkead read this message from Sheriff Kyle and County Commission Chairman B. J. Turner of Eureka, he immediately called into active service a force of state militia and ordered them to the stricken city.

Between 1860 and 1880, when countless boomcamps were producing silver, there came into being in the West a gigantic industry without the aid of which the fabulous era of the silver moguls would never have been realized. Even then little heralded and now virtually unknown, charcoal production was a powerful, lusty business. Here is the story of that wasteful venture which literally swept the West like a blazing forest fire.

By NELL MURBARGER
Photographs by the author

The Fish Creek War was on—and all over the price of charcoal.

The supplying of fuel to the boom camp smelters was big business in the double decades between 1860 and 1880. It was an industry so profitable and powerful that in the space of comparatively few years it poured into the pockets of operators inestimable millions of dollars, and by its stranglehold on the smelter fires of the West, cast over the entire structure of Western mining a menacing pall and constant threat.

Reviled, greedy, troublesome, wasteful and corrupt—it still was the Grand Panjandrum industry of the West and when the smelter operators of Eureka united in slashing the price they would pay for a bushel of charcoal to 27½ cents instead of the 30 cents they had been paying, on the grounds that mining conditions no longer enabled them to pay the higher price, the trouble began.

The Charcoal Burners Association, numbering several thousand men in Eureka alone, rejected the reduction, refused to permit further deliveries of charcoal to the plants, and, on August 11, forcibly took possession of the town.

When the well-armed militia arrived a lull in the fighting ensued until August 18 when a posse of nine men, headed by Deputy Sheriff J. B. Simpson, attacked a coal pit on Fish Creek, 30 miles south of Eureka, and in a one-sided battle killed five of the coal burners, seriously wounded six others and took several prisoners. None of the law men suffered damage except to their reputations—the posse being criticized rather freely for the tactics employed. The battle, nevertheless, had the effect of ending the war.

Charcoal burning was not an exalted calling. Except for the men in charge of operations, it was work that demanded neither skill nor exceptional intelligence, and those so employed were looked upon as the dregs of the Western labor barrel. Receiving less than half the wage paid to common mine laborers, the charcoal camp employee lived in crude hovels or dugouts, under bad conditions of sanitation and health; and in the towns where he squandered his weekly $10 wage, he was scorned by every man from the gamblers and saloon keepers who greedily seized his purse, to the muckers and mill-men whose very livelihoods depended upon his continued labors.

Sweeping over the West like a pestilence, leaving behind it tens of thousands of acres stripped of timber, the charcoal industry also left in its wake a black record of bloodshed, racial strife and corruption, as well as whole Indian tribes rendered hostile and threatened by starvation through ruthless destruction of the nut-pine groves which, for untold centuries, had provided their mainstay of life.

In these days of the electric furnace, capable of volatilizing any known substance, it is impossible to appreciate the important industrial role played by charcoal in the last 5000 years.

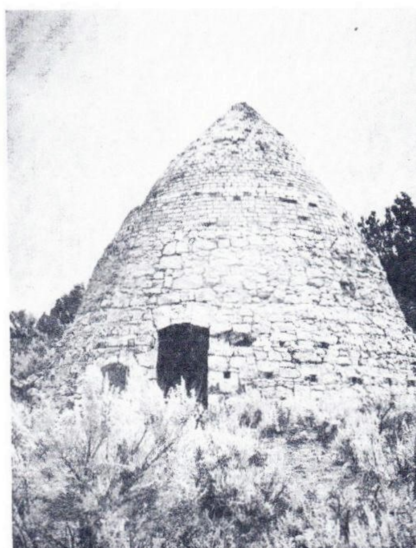
Following the custom established generations before in the Old World, the first charcoal produced commercially in the West was burned in pits—the beehive-type kilns being still undeveloped.

The pits were of various sizes. A large pit might hold as much as 100 cords of green wood, generally pinyon pine, juniper, mountain mahogany or quaking aspen. Ignited and allowed to burn to a certain degree before being smothered with earth, the cargo of such a pit would smolder flamelessly for 15 to 20 days before finally burning itself out. One firing in a pit of this size would produce from 2500 to 3500 bushels of charcoal—the black porous residue of wood from which all organic matter has been burned, leaving only pure, or nearly pure, carbon. Fed into the smelter furnaces in admixture with the ore and certain fluxing materials, and re-ignited under forced draught, this charcoal-carbon burned without smoke and produced an intense white heat—much hotter than could be realized from any type of wood in which organic matter still was present.

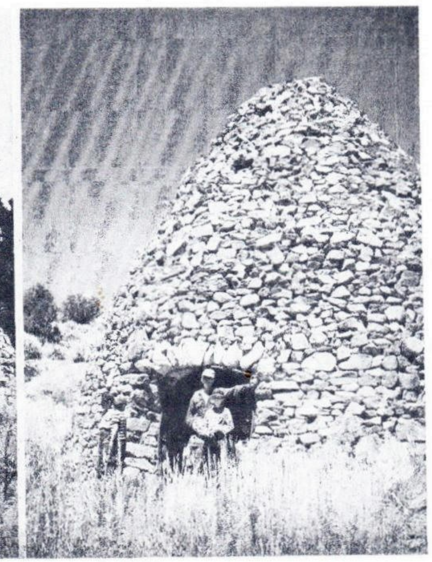
The practice of dealing in charcoal by the bushel unit prevailed throughout the West. A bushel of charcoal had a bulk of 1.59 cubic feet, and weighed from 16 to 20 pounds, depending on the species of wood used and quality of the finished product. One cord of green wood—four feet high, four feet wide and eight feet long—yielded by pit-burning, approximately 25 bushels of 'coal.

Price was contingent upon several factors—quality, hauling distance between pit and smelter, and that most

Charcoal from this stone and brick kiln was used in Iron City, Utah, iron smelters.



Native stone kiln that once supplied charcoal to Tybo and Hot Springs, Nye County, Nevada.



basic of all criterions—supply and demand.

Lowest quoted price for charcoal I have found in thousands of old mining reports and cost records, is the eight-cents-a-bushel rate paid by Oregon Iron Works, near Portland, in 1867—a price that would have yielded only two dollars for cutting an entire cord of wood, processing it into charcoal, and delivering it to the plant!

Lead smelters at Oreana, Nevada, at that same time, were paying an exorbitant 65 cents a bushel for their charcoal. As importation of charcoal from better wooded areas became feasible through arrival of the railroad in 1868, Oreana's profiteering charcoal contractors found it necessary to slash their demands to 25 cents a bushel—about the average price paid throughout the West.

Even at 25 cents, charcoal represented the smelter's largest single item of expense. That outlay varied widely from one mine to another, and from year to year—the quantity of charcoal required being contingent upon refractoriness of the ore, quality of the 'coal and skill of the operator.

Lead-silver smelters at Eureka, Nevada, for example, ordinarily required about 30 bushels of charcoal to reduce one ton of ore; but during the concluding six weeks of 1872, Ruby Consolidated Co., at Eureka, used 59 bushels to each ton. For a three-month period in 1872, Bristol & Daggett Smelter at Bingham Canyon, Utah, also used 59 bushels to the ton; and Winnamuck Furnaces, in Utah, used charcoal to a value of $24.45 for every ton of ore smelted—56 percent of the entire cost of their smelting operation.

During the balmier years of its operation the Eureka Consolidated Mining Company consumed charcoal at the average rate of 4600 bushels daily. Throughout the year the company maintained a stockpile of 120,000 bushels—only 30 days' supply—and the superintendent's report on September 30, 1872, lists the value of charcoal then on hand as $150,665.92. Richmond Consolidated, also of Eureka, had 215,000 bushels of charcoal on hand—enough to supply their operation for 46 days. By 1874 this company also was using 4600 bushels daily, and during the 22 month period from March, 1873, to January, 1875, expended for charcoal the staggering sum of $880,000. At their peak of production, the dozen furnaces at Eureka were purchasing $600,000 worth of charcoal monthly!

With this same situation, in greater or lesser degree, prevailing throughout the mining country, it may be imagined what was happening to the tree crop.

Silver and lead mines of the Southwest were situated in arid desert-type country having little or no merchantable timber and that was far more valuable for construction purposes and mine timbering than for charcoal.

The lash of the charcoal woodcutters, consequently, fell upon the small juniper and pinyon pine trees. Mature specimens may be no more than a dozen feet in height, with trunks a foot in diameter, and eight or 10 cords of wood to the acre is about the most they yield.

Thus, each filling of a single large charcoal pit required the total tree crop from 10 or 12 acres of land, and when such lands were set upon by the swinging axes of the woodcutters, their small brush-timber disappeared almost as fast as if swept by forest fire!

Evidence of the rapidity with which the Western desert hills were denuded is contained in two government reports.

In *Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains*, Rossiter W. Raymond proclaimed in 1872: "The wood for 10 miles around Eureka has been used up in a little over a year—thus the question of fuel becomes, at once a very important one."

Three years later, the *Appendix to Journals of Senate and Assembly, 7th Session*, stated: "The timber in the vicinity of Eureka is fast disappearing. The coal burners have stripped the hills and mountains within a radius of 25 miles, so that the supply of fuel for smelting purposes is a very important one in making an estimate on the future mining prosperity of this county. Charcoal . . . must be obtained from some other source very soon, or the furnaces must be stopped . . . Should the charcoal rates advance within the next month or two, a crisis is imminent . . ."

The situation in some sections of the desert became so drastic woodcutters were seizing upon almost any vegetation available. At White Hills, Arizona, even the spongy Joshua tree was pressed into service, and silver smelters at Candelaria and Tuscarora, Nevada, were fed with charcoal burned from sagebrush. So slow and tedious was this operation that at one time more men were working in Tuscarora's charcoal camps than in all the mines and mills of that silver-rich district.

This growing shortage of fuel materials was responsible, in large measure, for a transition that began creeping into the charcoal industry about 1870.

Where, previously, all charcoal was burned in earthen pits, the new trend was to beehive-type kilns, stoutly constructed of stone or brick. Offsetting the original cost of $500 to $1000 each, was the fact that such kilns could be used almost indefinitely, and by producing charcoal of a much higher quality and with less dross than was possible in pit-burning, the resultant saving in fuel material soon would repay the initial cost of construction.

I have encountered no authenticated record of beehive charcoal kilns being used in the West prior to 1872. In the summer of that year, according to Raymond's report published in 1873, Sultana Smelting Works, in American Fork Canyon, Utah, had in operation 12 kilns, with three more soon to be built.

"They have the shape of an old fashioned bee hive," wrote Raymond. "A diameter of 23 feet at the base, and a height of 20 feet. There is a charge door near the top in the back side, and a discharging door in front, level with the ground. A kiln holds 25 cords of wood, and the time for burning is 12 days; 38 to 48 bushels of good, solid charcoal are produced per cord of wood, or from 950 to 1200 bushels per day. Brands are returned to a subsequent fire. The above yield, it is seen, is far higher than can be obtained in a common charcoal pit."

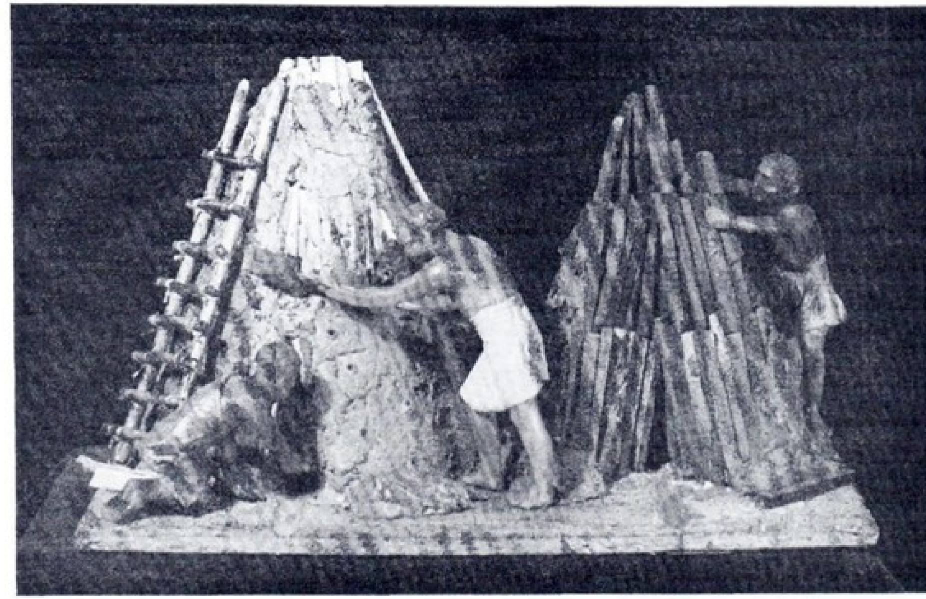
As effectiveness of the beehive kiln became apparent, they began sprouting in groups of three, five, 10; and everywhere built, they were at once a point of local interest. On September 2, 1877, the Eureka *Sentinel* reported:

"Henry Allen, the well-known contractor of Eureka, has just finished a work of considerable magnitude at Hot Creek. Last summer he was employed by Tybo Consolidated Co. to build 15 kilns in which the company proposed to burn the charcoal necessary to supply their furnaces at Tybo. He finished the work about a week ago, and some idea of its magnitude may be gathered from the fact that 600,000 bricks were used in building the kilns. They are oval in shape, having a diameter of 25 feet. Each one has a capacity of 1400 bushels, turning out that quantity of coal to each charge, the operation consuming five days. A great economy of time results from these kilns, instead of burning in the old-fashioned way, and as the company owns a vast quantity of wood in the immediate vicinity, they calculate on their fuel costing them about one-half the usual rates. A force of 20 men were employed about three months in building the kilns."

If the kilns were superior to the pit-method of burning, it was, indeed, a fortuitous circumstance, for the situation in many parts of the mining country was becoming drastic. A squeeze play had developed, with the mills and smelters in the middle. As surface ores were depleted and the mines deepened, production became more costly; and as exhaustion of timber resources forced upon the charcoal contractors an ever-lengthening haul, the price demanded for charcoal crept slowly but steadily upward. This situation lead directly to the Fish Creek war.

Another charcoal war, marked by less bloodshed and more humor, followed the importation of Chinese coolie woodcutters to a charcoal camp near Tybo, Nevada.

Because they would work more cheaply, Chinese laborers, in most mining camps of the Great Basin area, were about as welcome as the plague. Therefore, when charcoal burners with a contract to supply several million bushels of fuel to the Two-G Mining



Burning Charcoal, Early Industries Case, Knox Hall of Civilization, Buffalo Museum of Science. Primitive manufacturing arose largely from accidental discovery. Modern industry is based upon scientific knowledge. Photo by C. E. Simmons.

Dr. F. G. Tagert of Austin, Nevada, examines the excellently-wrought masonry of one of the six charcoal kilns at Ward.

Co., imported a large gang of coolies to perform the labor, white workmen united in protest.

Assembling on street corners and in saloons, small knots of muttering whites congregated in a roaring mob and stormed the sleeping charcoal camp. To the tune of cracking bull-whips, pistol shots and drunken curses they sent the Orientals fleeing for their lives. Morning found the charcoal contractors scouting the nearby hills for their scattered woodcutters. Driven back to the kilns, virtually at gunpoint, the still-jittery Celestials were ordered to resume work, and throughout that day discharged their duties under the combined threat and protection of loaded Winchesters.

Nightfall brought another conclave of miners bristling with guns and indignation. In deference to the armed guards, still vigilantly patrolling the charcoal camp and its environs, the original plan to "clean out the Chinks" lost some of its fire, and the contractors were given 24 hours in which to get rid of the Chinamen.

When end of this grace period found them still cutting wood under protection of the rifle-armed guards, another ultimatum was issued: Either the Chinese leave camp before another nightfall, or both they and their employers would be ridden out of town on rails.

White laborers, by this time, were so thoroughly aroused that wholesale bloodshed would have been inevitable had not the Chinese offered to leave peacibly in exchange for stage fare to Eureka, 100 miles distant, and passage money was supplied quickly by Tybo's Anti-Asiatic League.

Meanwhile the charcoal industry was eating itself out of the land. Smelters at Eureka, to cite only one mining center out of hundreds, were consuming 1,200,000 bushels of charcoal annually—the total tree crop from over 5000 acres of juniper-pinyon woodland—and the hills were completely denuded of wood in a 35-mile radius.

But whether the smelter operators liked it or not the handwriting was on the wall. The only answer was coke; and with retooling, experimentation and increased skill in both coking and smelting, the transition was gradually—but grudgingly—made.

As each smelter, in turn, discontinued the use of charcoal and converted to coke, erstwhile woodchoppers and charcoal burners drifted to other jobs, many of them to the coal fields of Utah and Wyoming. So the conversion, at last, was completed.

With the last charge of wood laid in the great stone ovens, and the last fire grown cold, the desert wind and brush moved in to erase the black scars of the charcoal camps, and Nature reclothed the land laid waste.

Many of the old beehive kilns are still standing. The best ovens I have seen are those near the old ghost town of Ward, Nevada, 18 miles south of Ely. Six in number, these kilns are larger than average—being 30 feet in height, with a floor diameter of 27 feet, and walls two feet in thickness at the base. Five of the 80-year-old ovens are preserved perfectly, the top of the sixth showing some deterioration. Built of random stone, square-faced to the exterior, with dressed stone forming the frames of the charge and discharge doors, the gracefully-arched stone roofs of these kilns—like those of most charcoal ovens—derive their sole support from the highly skillful manner in which their stones are fitted together.

I doubt if many stone masons of today possess the masterly technique necessary to erect such a structure, completely without mortar or structural steel reinforcing—yet these fine old kilns have been standing solidly since shortly after the Civil War, and for more than 60 years of that time have known virtually no maintenance or repair.

Most charcoal kilns in the West were built of native stone, but occasionally brick or brick-and-stone kilns are encountered.

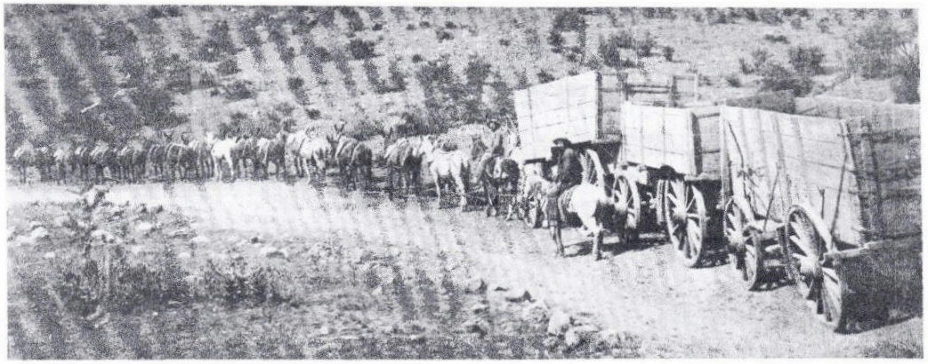
At the ghost town of Iron City, Utah, second point west of the Mississippi River where native iron ore was smelted, stands a perfectly preserved kiln and the remains of two others, all built of random stone for the lower two-thirds, and brick for the upper third. Thirteen badly deteriorated charcoal kilns at Tennessee Pass, Colorado, were constructed entirely of brick; and two groups of kilns I have visited—at Gold Hill, Utah, and Cottonwood Canyon, Inyo County, California—were built of adobe.

All the many kilns I have examined follow the same basic pattern—beehive in form, with an interior floor diameter of 20 to 30 feet. Near the top of each kiln is a charge door for receiving wood, and at ground level a discharge door for removing the charcoal—both openings fitted, originally with heavy iron doors which closed against an iron frame set into the stone doorway, thereby effecting a seal nearly airtight. All air necessary to control the burning process was supplied through a series of small vents built into the kiln wall.

The yards around most of the old kilns are still scattered with fragments of jet-black charcoal, which is recognized as one of the most imperishable of all man-processed materials. A few kilns are known to have been abandoned with their last charge still intact. In a remote section of the Stone Cabin range, northeast of Tonopah, Nevada, several kilns which supplied the smelters at Tybo, were left packed with their final charge—charcoal as excellent in quality as any that may be purchased today—and for more than 60 years, miners and ranchers in that vicinity have drawn upon this charcoal bank for fuel to fire the forges used in sharpening their tools and drill steel.

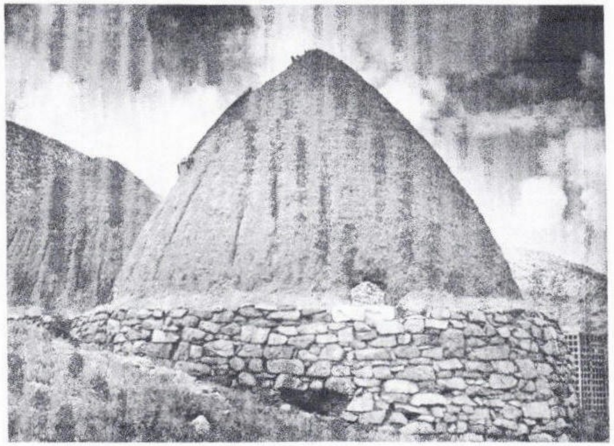
In other ways, as well, the kilns have been of use to man. All have been used as storm shelters by horses, cattle and sheep; and many have provided temporary havens for blizzard-threatened desert wayfarers.

But such uses, of course, are only transient and incidental. The real worth of the old charcoal ovens is their historical function in reminding present-day Americans of a now-vanished industry, without which the great silver and lead bonanzas of the early West could not have been harvested.



The use of coke by Southwest smelters ended the charcoal era. This Arizona Pioneers' Historical Society photograph shows a coke team between Bisbee and St. Davids in 1886.

Rock and adobe kiln built at Gold Hill, Utah, 65 years ago.



Desert Quiz:

One of the goals of *Desert Magazine* is to give its readers a better acquaintance with the history, geography, minerals, botany, Indian lore and the recreational opportunities in the desert country. And probably no part of each monthly issue contributes more to this end than the monthly quiz. You can always learn something new from this page. Ten correct answers is very good for a tenderfoot. Those who answer 15 correctly are eligible to become honorary members of the fraternity of Desert Rats. When you average 18 or more you become a Sand Dune Sage. The answers are on page 42.

1—If you were equipping your car for desert roads where there is likely to be heavy sand, the least important item in your kit would be—Water____. Jack____. Tire chains____. Shovel____.

2—After mining and processing, quicksilver is shipped in—Pigs____. Flasks____. Bags____. Kegs____.

3—Ruth, Nevada, is well known for its—Famous caves____. Prehistoric cliff dwellings____. Volcanic crater____. Open pit copper mining____.

4—Which one of the following words is not a synonym for the others—Arroyo____. Wash____. Escarpment____. Wadi____.

5—The Colorado River tributary which Major Wm. Powell named the Dirty Devil is now known as—Fremont River____. Virgin____. San Juan____. Escalante____.

6—The Inter-Tribal Indian Ceremonial is held annually in August at—Gallup____. Albuquerque____. Santa Fe____. Window Rock____.

7—According to legend, those who drink of the waters of the Hassayampa River will—Live to a ripe old age____. Always have good luck____. Become bald-headed____. Never again tell the truth____.

8—Cochise was a famous—Apache Indian____. Yuma____. Navajo____. Papago____.

9—Color of the Joshua Tree blossom is — Orange____. Creamy white____. Blue____. Lavender____.

10—On Highway 66 near Winslow, Arizona, the motorist crosses the—Bill Williams River____. Rio Grande____. Verde River____. Little Colorado River____.

11—Historically, the Jayhawkers are associated with—Trek across Death Valley____. Navigation of the Colorado River____. The Apache wars____. The Mormon migration to Utah____.

12—Charleston peak is located in—Arizona____. Nevada____. New Mexico____. Utah____.

13—Hardest of the following minerals is—Chalcedony____. Calcite____. Obsidian____. Topaz____.

14—To Reach Palm Canyon from Palm Springs, California, one travels—South____. West____. North____. East____.

15—The University of Arizona is located in—Phoenix____. Tempe____. Tucson____. Prescott____.

16—The historically famous Hole-in-the-Rock crossing on the Colorado River was used by—The Escalante Expedition____. Mormon settlers____. California '49er gold seekers____. Kearny's Army of the West____.

17—Galleta is the common name of a desert — Grass____. Tree____. Lizard____. Bird____.

18—Dr. H. H. Nininger is widely known in the scientific world as an authority on—Paleontology____. Cacti____. Meteorites____. Arid land farming____.

19—Rawhide is a ghost mining camp in—Nevada____. California____. Arizona____. New Mexico____.

20—Telescope Peak is in the—Funeral Mountains____. San Francisco Mountains____. Panamint Mountains____. White Mountains____.

Notes

What is an Engine?

- "An engine or motor is a machine designed to convert one form of energy into mechanical energy.
- Heat engines, like the internal combustion engine, burn a fuel to create heat which is then used to do work.
- Electric motors convert electrical energy into mechanical motion,
- pneumatic motors use compressed air, and
- clockwork motors in wind-up toys use elastic energy.
- In biological systems, molecular motors, like myosin in muscles, use chemical energy to create forces and ultimately motion."

Wikipedia

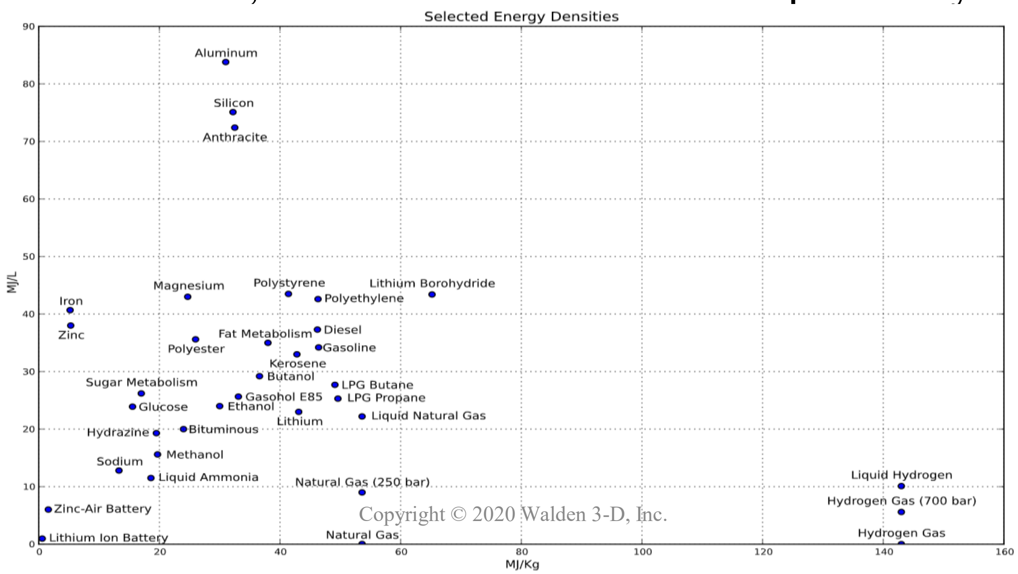
What is a Mechanical Engineer?

"Mechanical engineering is an engineering branch that combines engineering physics and mathematics principles with materials science to design, analyze, manufacture, and maintain mechanical systems. It is one of the oldest and broadest of the engineering branches."

Wikipedia

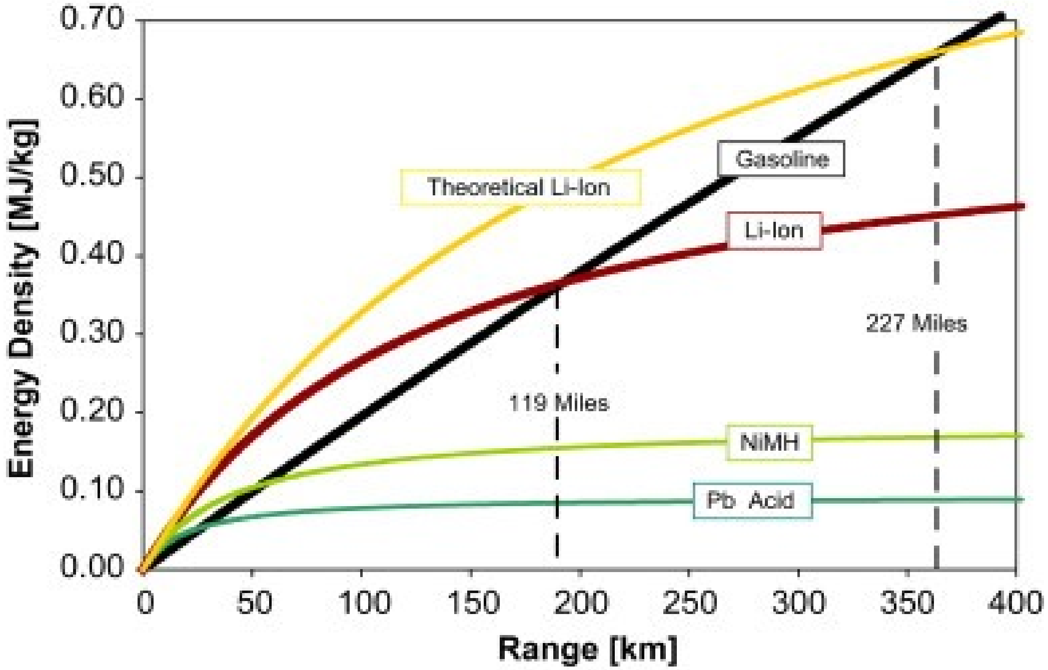
Engine Basics:

- Typical engine power output measurements:
  - What is power? In the most basic form, power is work performed over a specific amount of time.
  - In an electric motor, the mechanical power is defined as the speed times the torque.
  - Torque is a rotating force produced by an engine's crankshaft. The more torque an engine produces, the greater its ability to perform work. The measurement is the same as work, but slightly different. Since torque is a vector (acting in a certain direction), it's quantified by the units pound-feet and newton-meters.
  - Mechanical power is typically defined as kilowatts (kW) or horsepower (hp) with one watt equaling one joule per second or one Newton-Meter per second.
  - Horsepower is the work done per unit of time. One hp equals 33,000 pound feet per minute. Converting hp to watts is achieved using this relationship: 1 hp = 745.69987 W. However, the conversion is often simplified by using 746 W per hp.



Energy Density

- Energy Density - Energy density is the amount of energy stored in a given system or region of space per unit volume.



- Pressure/compression relates to energy density. The higher the pressure the more energy potential you can pack in the same space. You can compress or cool to fit more fuel. We compress our water bottle rockets, but we haven't tried launching with liquid nitrogen yet. (but that would likely freeze and crack the plastic bottle).

Types of Engines

1. Horse Power
2. Steam (external combustion)
3. Physical Engine – Pneumatic, clockwork, hydraulic
4. Internal combustion engine
5. Jet Engine (reactive engine)
6. Rocket Motor (reactive engine)
7. Electric Engine
8. Ion Engine

1. Horse Power - how many horse power does the rig below have?

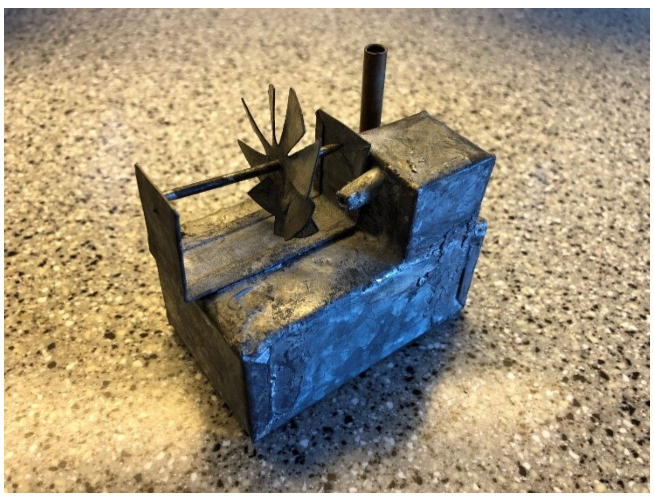
When the steam engine began to do the work of horses in the mines during the early 1800s, the mine owners began to ask how many horses an engine would replace. James Watt, who invented steam engines, figured out a mathematical way to equate horses to engine power. Thus the term horsepower was invented.

2. Steam (external combustion)

a. The original steam engines were not mechanical engines but pumps. In this manner, a fire engine in its original form was merely a water pump, with the engine being transported to the fire by horses.

b. A steam engine is an external combustion engine because it keeps the fuel and exhaust products separately — they burn fuel in one chamber and heat the working fluid inside the engine through a heat exchanger or the engine's wall.

c. Grandpa Nelson's homemade steam engine from when he was a kid:



a. The 1^{st} Industrial Revolution was largely due to steam power; Uncle Paul's job is very focused on the 4^{th} Industrial Revolution (Cyber Physical systems, but each revolution builds off the prior ones).

How Engines Changed Industry & Lives

Andrew Anderson 1754-1803

|

Nels Anderson 1802-1857

|

Bengt Nelson 1834-1919

|

Bengt Nelson, Jr. 1860-1926

|

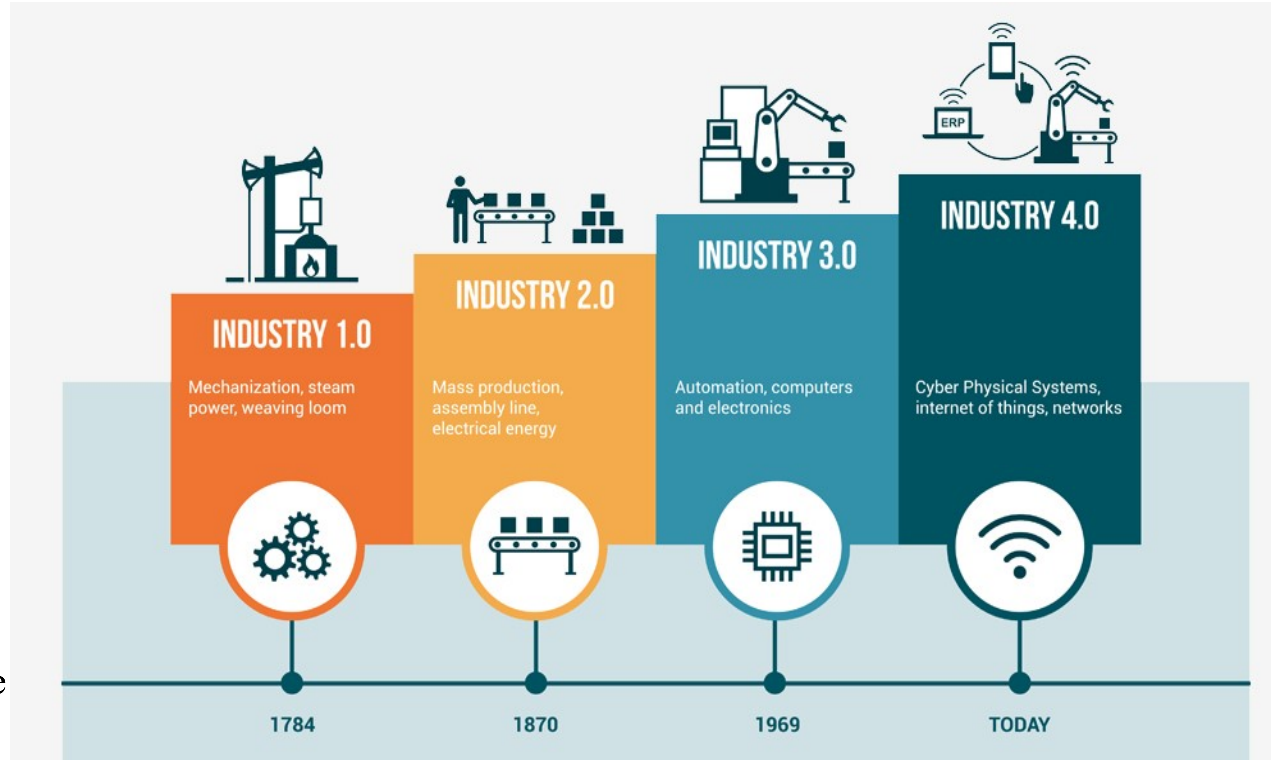
Roice Bengt Nelson 1891-1947

|

Howard Roice Nelson 1916-1996

|

Grandpa Nelson 1st year of college 1969



3. Physical Engine – Pneumatic, clockwork, hydraulic

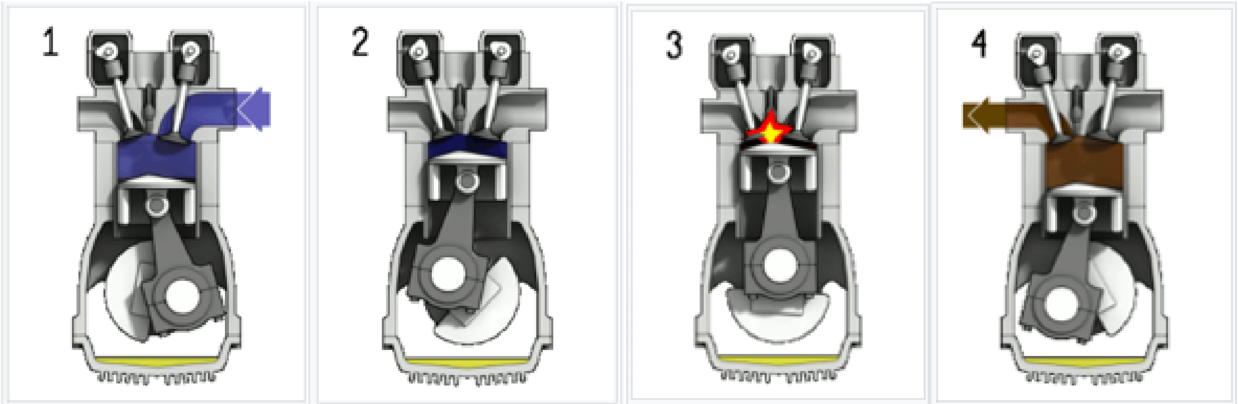
These engines rely on stored mechanical energy to function. Clockwork engines, pneumatic, and hydraulic engines are all physical drives. Physical drives were probably the first ever used. Catapults, trebuchets, or battering rams all rely on this type of engines.

4. Internal Combustion Engines

a. Gasoline - What is a Spark Plug and why is it needed?

   i. The biggest IC engine can generate 109,000 HP

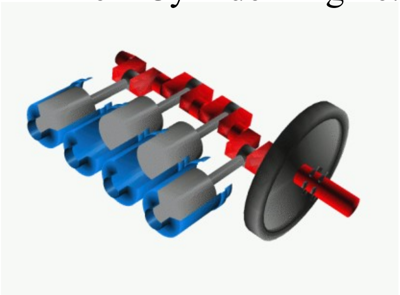
   ii. IC engines derive energy from fuel burned inside a specialized area of the system called a combustion chamber. The process of combustion generates reaction products (exhaust) with a much greater total volume than that of the reactants combined (fuel and oxidizer). This expansion is the actual bread and butter of IC engines — this is what actually provides the motion.



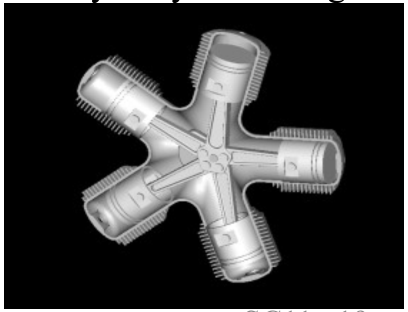
The four stages of the four-stroke gasoline combustion engine cycle:

1. Induction *(Fuel enters)*
2. Compression
3. Ignition *(Fuel is burnt)*
4. Emission *(Exhaust out)*

Inline 4 Cylinder Engine:



Rotary 5 Cylinder Engine:



4. Internal Combustion Engines continued

b. Diesel

i. Self-igniting to due heat generated during compression (i.e. no spark plugs).

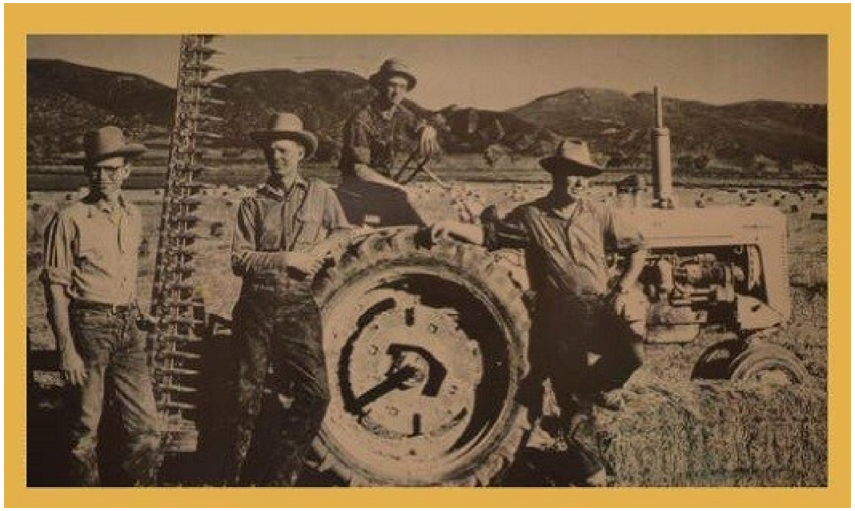
ii. Most diesel engines can burn bio diesel (meaning you could take the grease/oil you cooked with and put it in your car engine.

iii. Lots of types of Diesel Engines (Tractors, Trains, Large Trucks, Rotary Aircraft, Jets (but they are unique in their compression cycle which will be covered next)

iv. High-speed diesel engines are often used as emergency and backup generators to provide power during grid outages. The ability of a diesel engine to start rapidly, often in less than 10 s, makes them particularly attractive in this respect.

Examples of Diesel Engines

Uncle Dick, Uncle Bud, Uncle Ted, & Howard



Young Nelson Cousin

Cousin Lynn, Cousin Carl, & Cousin Paul

Brother Hamblin,
Enoch 4th of July Parade

Jones Cousins in Sheep Parade

More Examples of Diesel Engines

Left Top: Promontory Pass

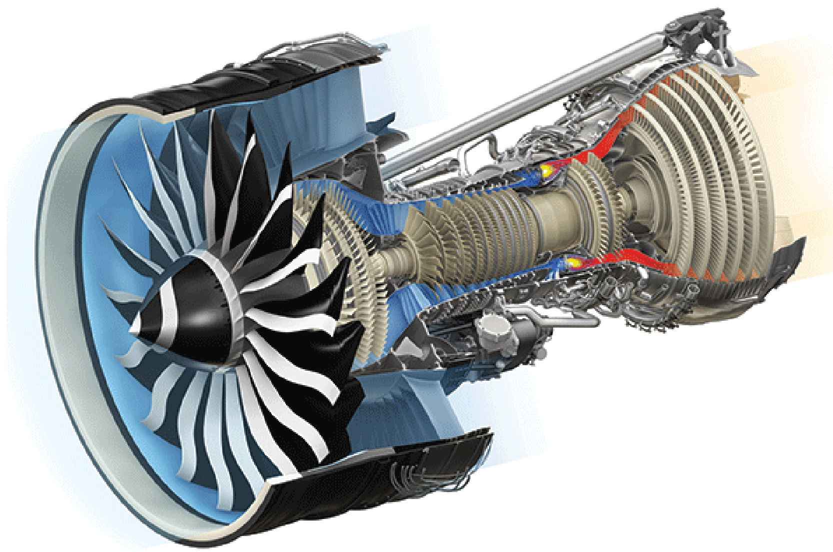
Below Right: Big Boy

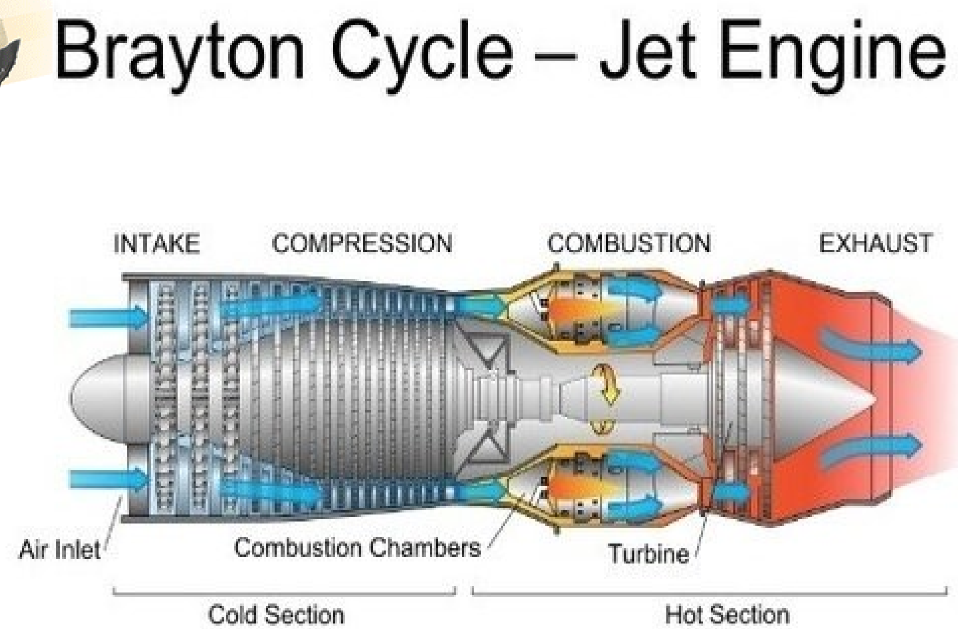
More Examples of Diesel Engines

5. Jet Engine

Jet engines use a series of fan blades (with complex directionally grain grown high end materials) to compress air to increase the efficiency of power output making modern flight possible.

a. Reaction engines, colloquially known as jet engines, generate thrust by expelling reactionary mass. The basic principle behind a reactionary engine is Newton's Third Law — basically, if you blow something with enough force through the back end of the engine, it will push the front end forward.

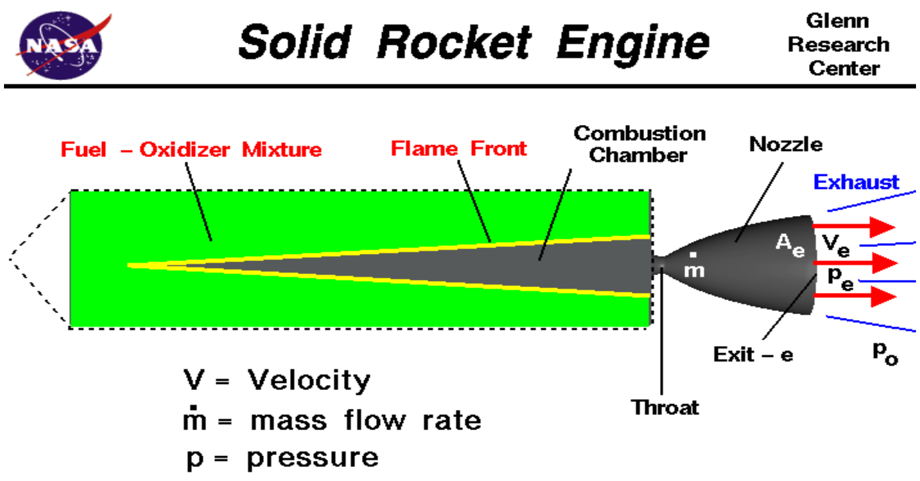




6. Rocket Motor

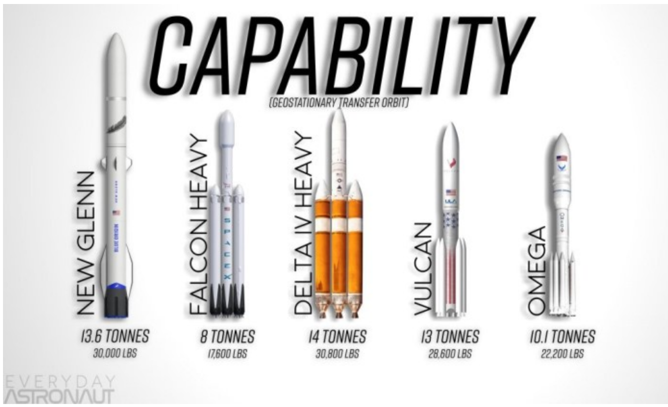
a. Solid Rocket Motor – another type of reaction engine.

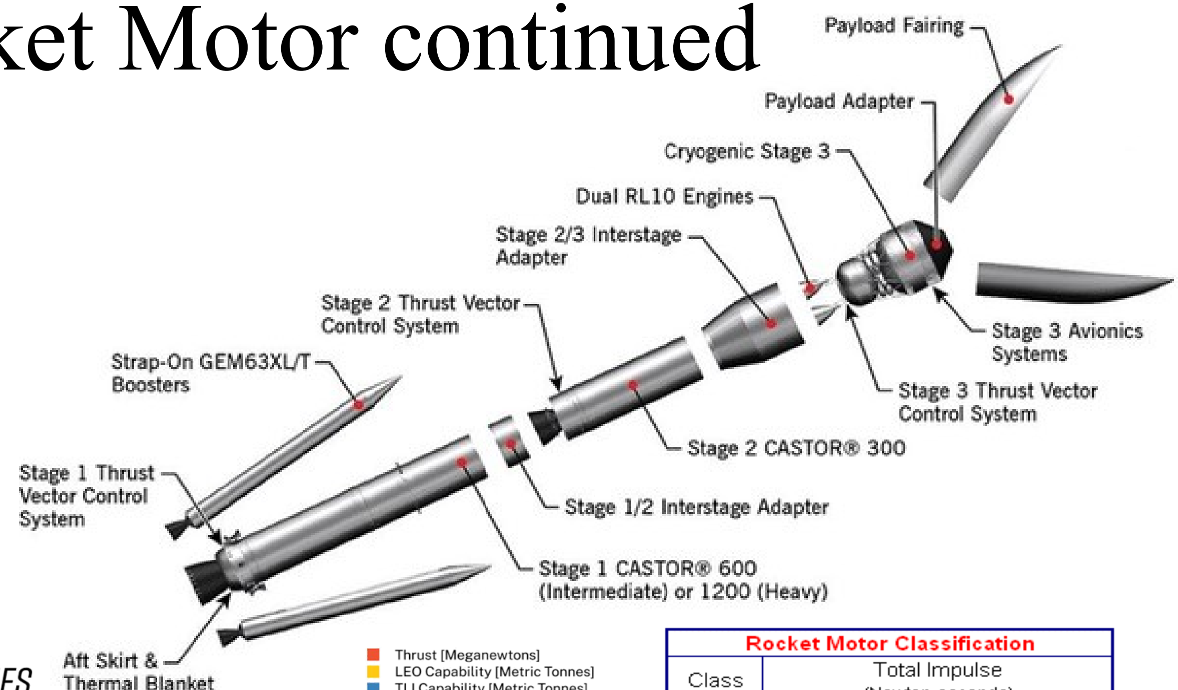
b. On this slide, we show a schematic of a solid rocket engine. Solid rocket engines are used on air-to-air and air-to-ground missiles, on model rockets, and as boosters for satellite launchers. In a solid rocket, the fuel and oxidizer are mixed together into a solid propellant which is packed into a solid cylinder. A hole through the cylinder serves as a combustion chamber. When the mixture is ignited, combustion takes place on the surface of the propellant. A flame front is generated which burns into the mixture. The combustion produces great amounts of exhaust gas at high temperature and pressure. The amount of exhaust gas that is produced depends on the area of the flame front and engine designers use a variety of hole shapes to control the change in thrust for a particular engine. The hot exhaust gas is passed through a nozzle which accelerates

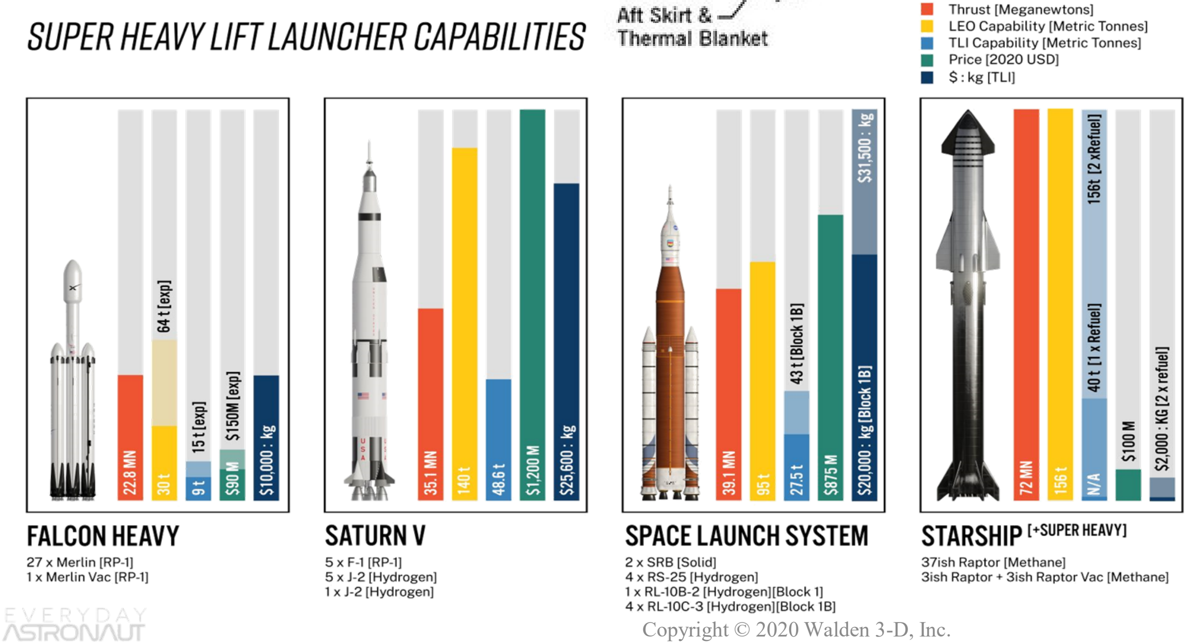


Thrust = $F = \dot{m}\, V_e + (p_e - p_0)\, A_e$

6. Rocket Motor continued







Rocket Motor Classification

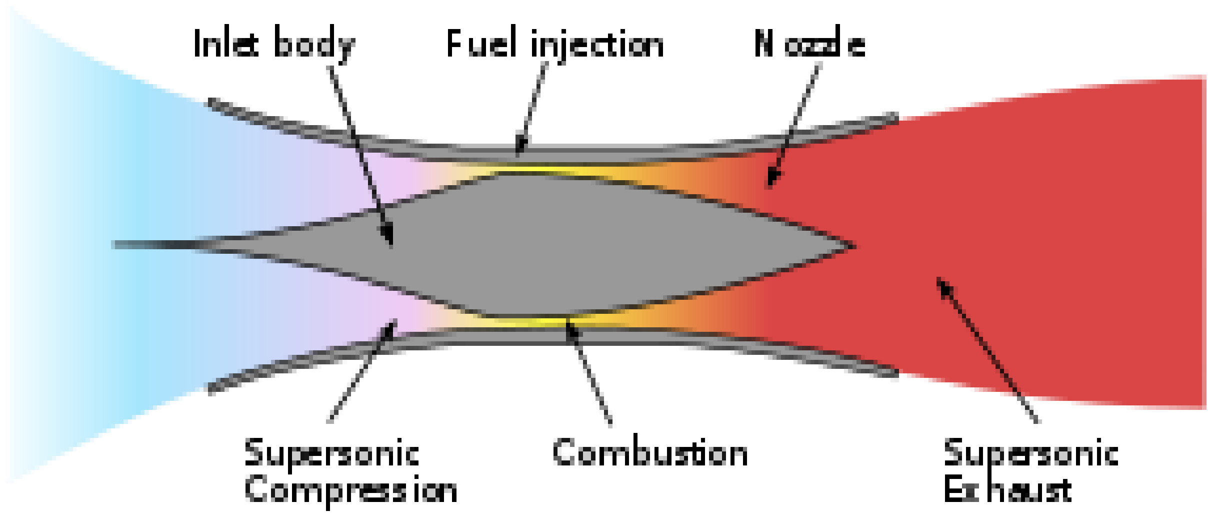
Class	Total Impulse (Newton-seconds) Equal or greater than		Less than
A	1.26	>	2.5
B	2.5	>	5
C	5	>	10
D	10	>	20
E	20	>	40
F	40	>	80
G	80	>	160
H	160	>	320
I	320	>	640
J	640	>	1280
K	1280	>	2560
L	2560	>	5120
M	5120	>	10240
N	10240	>	20480
O	20480	>	40960
P	40960	>	81920
Q	81920	>	163840
R	163840	>	327680
S	327680	>	655360
T	655360	>	1310720

6. Rocket Motor continued

c. Scram Jet / Hypersonics

   i. A scramjet (supersonic combustion ramjet) is a variant of a ramjet airbreathing jet engine in which combustion takes place in supersonic airflow. As in ramjets, a scramjet relies on high vehicle speed to compress the incoming air forcefully before combustion (hence ramjet), but whereas a ramjet decelerates the air to subsonic velocities before combustion, the airflow in a scramjet is supersonic throughout the entire engine. That allows the scramjet to operate efficiently at extremely high speeds.

   ii.



6. Rocket Motor continued

d. Liquid Rocket Motor

   i. Like compression in an internal combustion engine, liquid rocket motors also use compressed fuels to power the engine/motor. Some liquid rocket engines super cool their fuels to increase the density which pack more energy for the same volume space (e.g. how SpaceX can launch and have enough left over fuel to land the rocket booster for reuse).

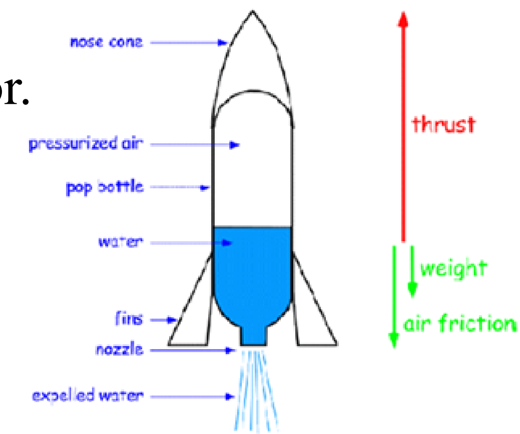
6. Rocket Motor continued

e. Water Bottle Rockets

ii. Water Bottle Rockets are a similar rocket motor.

2-Liter Water Bottle Rockets Overview

Great detailed website: http://www.et.byu.edu/~wheeler/benchtop/flight.php



The equation for thrust, caused by water exiting the nozzle, is:

$$T = (P_{in} - P_{out}) \cdot A_n$$

where P_{in}-P_{out} is the difference between pressure within the rocket and atmospheric pressure, and A_n is the cross-sectional area of the nozzle opening. Thrust is dependent on pressure, nozzle diameter. The amount of water dictates how long the thrust force will be applied, and therefore contribute to the rocket's total kinetic energy.

The following values are the optimal values for maximum height at 90 psi:

- Air/Water ratio = 0.5 liters
- Dry Weight = 220 grams
- Stabilizer Length = 3.5 inches
- Maximum Height = 350 ft (impact pressure = 120 mph baseball pitch)

Water Bottles with thicker plastic (cord strength) can be pressurized greater; many European bottles have much stronger cord strengths than U.S. plastic bottles.

The following mathematical expression yields ~apogee height for a given total flight time:

$$h_{ap} = (g/8)(t_{end})2 - 3.5 \text{ meters}$$

Water rockets, requiring a largish capacity for air and water, are usually large in diameter, this causing a large amount of drag and limiting the height achieved. However, the impulse rating for even a 2 liter water rocket is normally E - four times the impulse of a pyro motor that can be bought over the counter in a high street toy shop.

Motor Impulse Classes

Impulse /Ns	Class
I <= 0.625	¼A
0.625 < I <= 1.25	½A
1.25 < I <= 2.5	A
2.5 < I <= 5	B
5 < I <= 10	C
10 < I <= 20	D
20 < I <= 40	E
40 < I <= 80	F
80 < I <= 160	G
160 < I <= 320	H
320 < I <= 640	I
640 < I <= 1280	J
1280 < I <= 2560	K
2560 < I <= 5120	L
5120 < I	>L

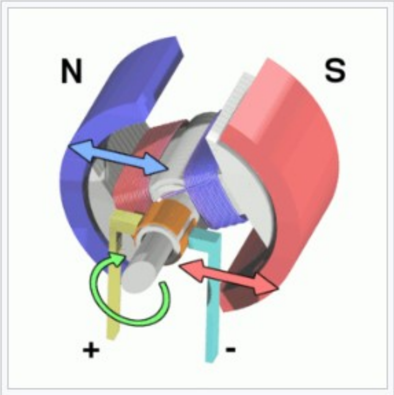
7.a. Electric Engine

There are three types of classical electrical engines: magnetic, piezoelectric, and electrostatic.

a. The magnetic one is the most commonly used of the three. It relies on the interaction between a magnetic field and electrical flow to generate work.

b. Piezoelectric drives are types of engines that harness some materials' property of generating ultrasonic vibrations when subjected to a flow of electricity in order to create work. Since they use expensive materials and require comparatively high voltages to run, they're not as common as magnetic drives.

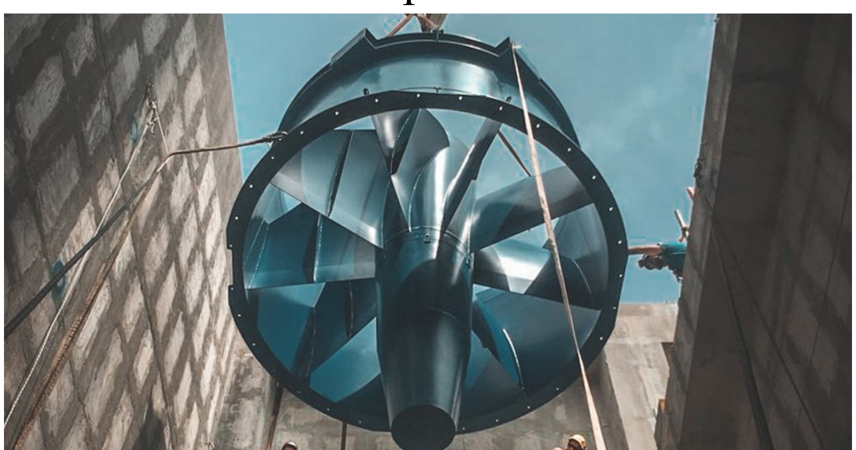
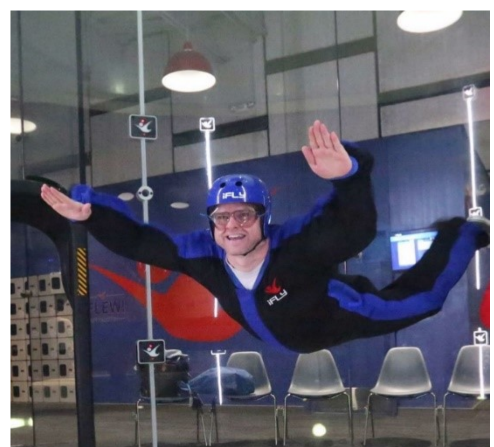
c. the energy density of batteries is two orders of magnitude below that of liquid fuels. However, electric motors have a higher energy conversion efficiency and lower mass than combustion engines they can provide a higher deliverable mechanical energy density. With a gasoline engine only 12-30% of the energy from the fuel you put in is used to move it down the road depending on the drive cycle.



7.b. Electric Motor

e. Indoor Skydiving is made possible by a large elector motor driving a large fan.

   i. You need a fan that's at least 20 feet in diameter, any smaller and you can't get a steady column of air big enough to lift a person. That fan needs to spin fast enough to move air at up to 150 miles per hour, so the motor you will need will use an incredible amount of power, it's not something you can run on household mains. You'll probably need some kind of three-phase VFD (A variable frequency drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage of its power supply.) motor since it will need to be variable speed. Although you'll need a properly certified engineer to calculate the motor specifications but probably several hundred horsepower at around 1000 rpm. You can combine four 250 horsepower fans to achieve the same affect.


7.b. Electric Motor continued

f. Nuclear - The NASA Mars rovers use nuclear power plants called Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) to provide 125W of electricity to operate the drive motors and power the onboard systems as well as provide heat to keep the electronics warm during the sub-arctic Martian nights.

8. Ion Engine

Ion Engine - An ion thruster or ion drive is a form of electric propulsion used for spacecraft propulsion. It creates thrust by accelerating ions using electricity. An ion thruster ionizes a neutral gas by extracting some electrons out of atoms, creating a cloud of positive ions.

a. Ion drives are kind of a mix between a jet engine and an electrostatic electric engine. This class of drives accelerates ions (plasma) using an electrical charge to generate propulsion. They don’t function if there are ions already around the craft, so they’re useless outside of the vacuum of space.
b. Uncle Paul’s company made the Dawn spacecraft (launched Sept. 2007).
c. Dawn was become the first probe ever to orbit a dwarf planet, as well as the first to circle two celestial bodies beyond the Earth-moon system.
d. The Ion Drive engine takes four days to go from 0 to 60 mph.
e. This same type of Ion Drive is now being used on MEV (Mission Extension Vehicles) Northrop Grumman makes to service dying satellites in orbit.
f. This illustration depicts NASA's Dawn spacecraft arriving at the dwarf planet Ceres

Notes

2020 Science Camp

- What was best about 2020 Science Camp?
  - ______________________________
  - ______________________________
  - ______________________________
- What would be your ideal 2020 Science Camp Theme?
  - ______________________________
  - ______________________________
  - ______________________________