Engineering:

From your mind!
through your heart(?)

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Outline

- Provide some insight into what "engineering" is as a profession and as an academic major
- Raise some issues that you may want to consider as you are deciding what to do in your future
  - Will you find personal fulfillment as an engineer?
- Some discussion of different engineering disciplines

WHY ALL OF THIS IS IMPORTANT!

Volkswagen to Pay Up to $14.7 Billion to Settle Diesel-Emissions Claims

The settlement comprises vehicle buybacks or fixes

Volkswagen has settled emissions claims with regulators and owners of about a half million diesel-powered vehicles. The settlement terms were announced Tuesday by environmental regulators. The WSJ's Lee Hawkins explains.

What is Engineering?

- Ok, so it is claimed that engineers can make the world better....
- HOW... do they do it?

Definitions of engineering

en·gi·neer [en-*juh*-**neer**] Show IPA *Dictionary.com Unabridged*

noun

1. a person trained and skilled in the design, construction, and use of engines or machines, or in any of various branches of engineering: *a mechanical engineer; a civil engineer.*

engineering Use **Engineering** in a sentence Like

en·gi·neer·ing [en-*juh*-**neer**-ing] Show IPA

noun

1. the art or science of making practical application of the knowledge of pure sciences, as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants.
2. the action, work, or profession of an engineer.
3. skillful or artful contrivance; maneuvering.

Origin:
1710–20; engineer + -ing[1]

en·gi·neer
/ˌenjəˈni(ə)r/

verb
gerund or present participle: **engineering**

design and build (a machine or structure).
"the men who engineered the tunnel"

- skillfully or artfully arrange for (an event or situation) to occur.
  "she engineered another meeting with him"
  synonyms: bring about, arrange, pull off, bring off, contrive, maneuver, manipulate, negotiate, organize, orchestrate, choreograph, mount, stage, mastermind, originate, manage, stage-manage, coordinate, control, superintend, direct, conduct; More
- modify (an organism) by manipulating its genetic material.
  "genetically engineered plants"

en·gi·neer·ing
/ˌenjəˈni(ə)riNG/

noun
noun: **engineering**

the branch of science and technology concerned with the design, building, and use of engines, machines, and structures.

- the work done by, or the occupation of, an engineer.
- the action of working artfully to bring something about.
  "if not for Keegan's shrewd engineering, the election would have been lost"

en·gi·neer·ing ***noun*** \-ˈnir-iŋ\

: the work of designing and creating large structures (such as roads and bridges) or new products or systems by using scientific methods

: the control or direction of something (such as behavior)

Full Definition of ENGINEERING Cite! g+1 Like

1 : the activities or function of an engineer

2 a : the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people

b : the design and manufacture of complex products <software *engineering*>

3 : calculated manipulation or direction (as of behavior) <social *engineering*> — compare GENETIC ENGINEERING

See engineering defined for English-language learners »
See engineering defined for kids »

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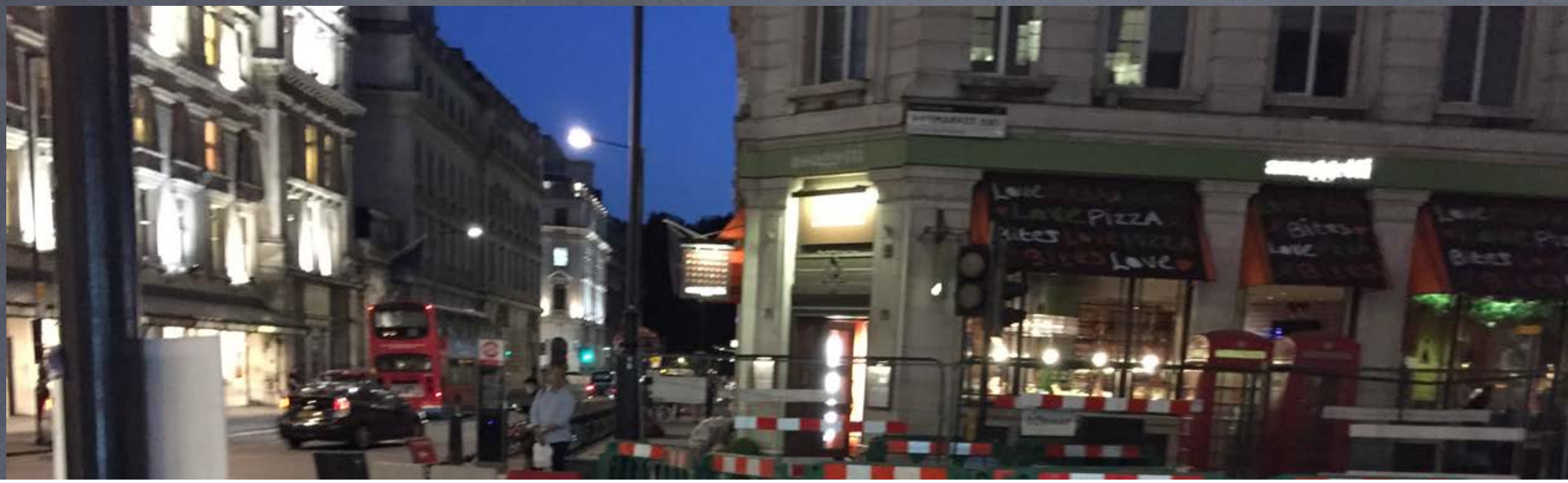
What do engineers do?

- Or, you may have heard it stated that "engineers solve problems..."
- What engineers really do is:
- *Engineers understand how to use techniques of engineering analysis to design (i. e., synthesize) substances, devices and processes even though they have an imperfect understanding of important physical, chemical or biological issues. Furthermore engineers operate under constraints caused by a need to produce a product or service that is timely, competitive, reliable, and consistent with the philosophy and within the financial means of their company.*
- *We need to use all that we know to produce the best answer to a problem!!*



Underlined words

- 1. Engineering analysis

- Engineers use "mathematical models" to describe reality in sufficient detail to produce quantitative results.

- (It is not engineering until we produce some numbers!!)

Underlined words

- 2. Imperfect understanding

- Most significant engineering problems cannot be analyzed and solved exactly.

-

- Thus we need our models or our understanding of phenomena gained by experiment to capture the important features and (usually) ignore a lot of unessential detail.

Curveball vs. knuckle ball

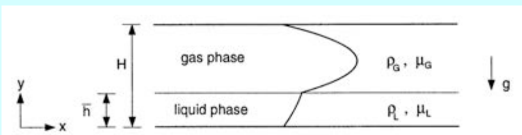
- We tried to make the argument that the imperfectness of a baseball is important to the pitching of a knuckleball, which does not spin and not important in the pitching of a curveball which spins fast. The same effect can either be important or incidental. This is because important issues always as ratios between competing effects. Engineers need to make the decision about what is important!!

Mathematical Analysis

- We would like to know how a device, process or system behaves "before" we build it
  - The only way that this is possible is with accurate mathematical "models" (collections of mathematical equations, that could be based on physical laws or verified observations that represent **reality** sufficiently well)

Mathematical modeling can be complex

Geometry of interest



We will look at the linear stability problem for

- Steady flow
-
- Purely Oscillatory (Couette flow)

Gas-liquid flow interfacial stability problem

turbulence model: k-ε

Solve the base state with either a smooth or rough interface (try to match data).

then

Solve the differential stability problem the best we can

Liquid-phase: $0 \le y^\bullet \le d_1$

$$\rho_1\left[\frac{\partial u_i^\bullet}{\partial t^\bullet} + u_j^\bullet \frac{\partial u_i^\bullet}{\partial x_j^\bullet}\right] = -\frac{\partial p^\bullet}{\partial x_i^\bullet} + \rho_1 g^\bullet \sin(\theta) + \frac{\partial}{\partial x_j^\bullet}\left[(\mu_1 + \mu_t^\bullet)(2s_{ij}^\bullet)\right]$$

$$\rho_1\left[\frac{\partial k_i^\bullet}{\partial t^\bullet} + u_i^\bullet \frac{\partial k^\bullet}{\partial x_i^\bullet}\right] = \frac{\partial}{\partial x_i^\bullet}\left[\left(\mu_1 + \frac{\mu_t^\bullet}{\sigma_{ke}}\right)\left(\frac{\partial k^\bullet}{\partial x_i^\bullet}\right)\right] + \mu_t^\bullet(2s_{ij}^\bullet)\frac{\partial u_i^\bullet}{\partial x_j^\bullet} - \rho_1\varepsilon^\bullet - 2\mu_1\left(\frac{\partial\sqrt{k^\bullet}}{\partial x_i^\bullet}\right)^2$$

$$\rho_1\left[\frac{\partial \varepsilon^\bullet}{\partial t^\bullet} + u_i^\bullet \frac{\partial \varepsilon^\bullet}{\partial x_i^\bullet}\right] = \frac{\partial}{\partial x_i^\bullet}\left[\left(\mu_1 + \frac{\mu_t^\bullet}{\sigma_\varepsilon}\right)\left(\frac{\partial \varepsilon^\bullet}{\partial x_i^\bullet}\right)\right] + c_1 f_1 \mu_t^\bullet \frac{\varepsilon^\bullet}{k^\bullet}(2s_{ij}^\bullet)\frac{\partial u_i^\bullet}{\partial x_j^\bullet} + 2\mu_1\mu_t^\bullet\left(\frac{\partial^2 u_i^\bullet}{\partial x_j^\bullet \partial x_l^\bullet}\right)^2 - \rho_1 c_1 f_1 \frac{\varepsilon^{\bullet 2}}{k^\bullet}$$

Stability equations continued

Gas-phase: $d_1 \le y^\bullet \le d_1 + d_2$

$$\rho_2\left[\frac{\partial u_i^\bullet}{\partial t^\bullet} + u_j^\bullet \frac{\partial u_i^\bullet}{\partial x_j^\bullet}\right] = -\frac{\partial p^\bullet}{\partial x_i^\bullet} + \rho_2 g^\bullet \sin(\theta) + \frac{\partial}{\partial x_j^\bullet}\left[(\mu_2 + \mu_t^\bullet)(2s_{ij}^\bullet)\right]$$

$$\rho_2\left[\frac{\partial k^\bullet}{\partial t^\bullet} + u_i^\bullet \frac{\partial k^\bullet}{\partial x_i^\bullet}\right] = \frac{\partial}{\partial x_i^\bullet}\left[\left(\mu_2 + \frac{\mu_t^\bullet}{\sigma_{ke}}\right)\left(\frac{\partial k^\bullet}{\partial x_i^\bullet}\right)\right] + \mu_t^\bullet(2s_{ij}^\bullet)\frac{\partial u_i^\bullet}{\partial x_j^\bullet} - \rho_2\varepsilon^\bullet - 2\mu_2\left(\frac{\partial\sqrt{k^\bullet}}{\partial x_i^\bullet}\right)^2$$

$$\rho_2\left[\frac{\partial \varepsilon^\bullet}{\partial t^\bullet} + u_i^\bullet \frac{\partial \varepsilon^\bullet}{\partial x_i^\bullet}\right] = \frac{\partial}{\partial x_i^\bullet}\left[\left(\mu_2 + \frac{\mu_t^\bullet}{\sigma_\varepsilon}\right)\left(\frac{\partial \varepsilon^\bullet}{\partial x_i^\bullet}\right)\right] + c_1 f_1 \mu_t^\bullet \frac{\varepsilon^\bullet}{k^\bullet}(2s_{ij}^\bullet)\frac{\partial u_i^\bullet}{\partial x_j^\bullet} + 2\mu_2\mu_t^\bullet\left(\frac{\partial^2 u_i^\bullet}{\partial x_j^\bullet \partial x_l^\bullet}\right)^2 - \rho_2 c_1 f_1 \frac{\varepsilon^{\bullet 2}}{k^\bullet}$$

Stability equations continued

k=1 (liquid-phase) $0 \le y \le 1$

k=2 (gas-phase) $1 \le y \le n_2 + 1$

$$\frac{(\hat{\mu}_k u'_{b,k})''}{m_k} + (\Gamma_{b,k}\hat{\phi}''_k)'' - 2\alpha^2(\Gamma_{b,k}\hat{\phi}_k)' + \alpha^4\Gamma_{b,k}\phi_k = i\alpha R\frac{r_k}{m_k}\left\{(u_{b,k} - c)(\hat{\phi}''_k - \alpha^2\hat{\phi}_k) - u''_{b,k}\hat{\phi}_k\right\}$$

$$\frac{(\hat{\mu}_k k'_{b,k})' + \hat{\mu}_k u''_{b,k}}{m_k} + \Gamma_{b,k}(\hat{k}''_k - \alpha^2\hat{k}_k) + \Gamma'_{b,k}\hat{k}_k + 2\frac{\hat{\mu}_{b,k}u'_{b,k}}{m_k}(\hat{\phi}''_k + \alpha^2\hat{\phi}_k) + \frac{k'_{b,k}}{k_{b,k}}\left(\frac{k'_{b,k}}{2k_{b,k}}\hat{k}_k - \hat{k}'_k\right)$$

$$= i\alpha R\frac{r_k}{m_k}\left\{(u_{b,k} - c)\hat{k}_k - k'_{b,k}\hat{\phi}_k\right\}$$

$$\frac{(\hat{\mu}_k \varepsilon'_{b,k})'}{m_k} + \Gamma_{b,k}\Gamma_{b,k}(\hat{\varepsilon}''_k - \alpha^2\hat{\varepsilon}_k) + \Gamma'_{b,k}\hat{\varepsilon}_k + 2c_1 f_1\frac{\hat{\mu}_{b,k}u'_{b,k}}{m_k}(\hat{\phi}''_k + \alpha^2\hat{\phi}_k) + r_k R c_2 f_2\frac{\varepsilon_{b,k}}{k_{b,k}}\left(\frac{\varepsilon_{b,k}}{k_{b,k}}\hat{k}_k - 2\hat{\varepsilon}_k\right)$$

$$+ \frac{(u''_{b,k})^2}{m_k}\left[c_1 f_1\frac{\varepsilon_{b,k}}{k_{b,k}}\left(\hat{\mu}_k + \hat{\varepsilon}_k - \frac{m_k\mu_{b,k}}{k_{b,k}}\hat{k}_k\right) + \frac{2m_k}{r_k R}(\hat{\mu}_k + 2\mu_{b,k}\hat{\phi}''_k)\right]$$

$$= i\alpha R\frac{r_k}{m_k}\left\{(u_{b,k} - c)\hat{\varepsilon}_k - \varepsilon'_{b,k}\hat{\phi}_k\right\}$$

$$\hat{\mu}_k = c_\mu f_\mu r_k R\frac{k_{b,k}}{\varepsilon_{b,k}}\left(2\hat{k}_k - \frac{k_{b,k}}{\varepsilon_{b,k}}\hat{\varepsilon}_k\right)$$

Stability Equations cont.

Boundary conditions

$$\hat{\phi}_1 = \hat{\phi}_2 \qquad \text{(3-18c)}$$

$$\hat{\phi}_1 + u_{b,1}\hat{h} = c\hat{h} \qquad \text{(3-18d)}$$

$$\hat{\phi}_1 - \hat{\phi}_2 = \hat{h}(u'_{b,1} - u'_{b,2}) \qquad \text{(3-18e)}$$

$$\hat{\phi}''_1 + \alpha^2\hat{\phi}_1 + \hat{h}u''_{b,1} = m_2(\hat{\phi}''_2 + \alpha^2\hat{\phi}_2 + \hat{h}u''_{b,2}) \qquad \text{(3-18f)}$$

$$\left(\hat{\phi}'''_1 + \Gamma'_{b,1}\hat{\phi}''_1 + u'_{b,1}\hat{\Gamma}'_1 - 3\alpha^2\hat{\phi}'_1\right) + i\alpha R(u'_{b,1}\hat{\phi}_1 - u_{b,1}\hat{\phi}'_1) - m_2\left(\hat{\phi}'''_2 + \Gamma'_{b,2}\hat{\phi}''_2 + u'_{b,2}\hat{\Gamma}'_2 - 3\alpha^2\hat{\phi}'_2\right)$$

$$- i\alpha r_2 R(u'_{b,2}\phi_2 - u_{b,2}\phi'_2) - i\alpha R\left[(1 - r_2)F + \alpha^2 S\right]\hat{h} = i\alpha Rc(r_2\hat{\phi}'_2 - \hat{\phi}'_1) \qquad \text{(3-18g)}$$

$$\hat{k}_1 = \hat{\varepsilon}_1 = \hat{\mu}_1 = \hat{k}_2 = \hat{\varepsilon}_2 = \hat{\mu}_2 = 0 \qquad \text{(3-18h)}$$

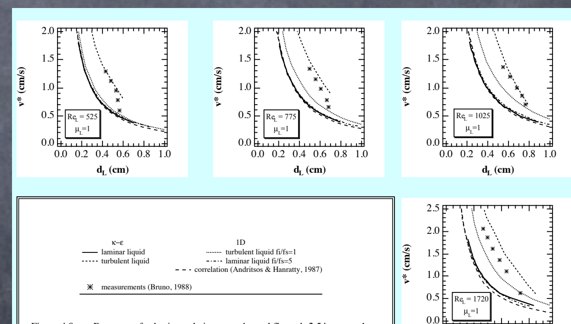


Figure 4.9 Basestates for horizontal air-water channel flow, d=2.54 cm, μ_L=1 cp. Gas phase is *turbulent* for all calculations.

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LET'S DO AN ENGINEERING PROBLEM RIGHT NOW

- A "field" of 40 wind turbines covers about 1400 acre
- This field is producing 56 MW of power for a wind speed of 10 m/s (22 mph) — which is about the optimal/maximal value
  - This is .04 MW/acre
    - A coal fired power plant would produce about 10 MW/acre!
- If the wind speed drops to 5m/s, how much power will the field produce?
  - With no reference to "formulas" is it possible to get an answer?
  - Does engineering analysis have to be really complex?

Engineers like to compare things

- If I asked: ".. how far is it to Chicago?"
  - would you answer?
    - "a couple of hours" or...
    - "about 90 miles"
- If I asked: ".. is a meter a long distance?" what would you say
  - "No", compared to the distance to Chicago
  - "Yes", compared to a micron
- For our conclusion to be valid we need to
  - **compare** <u>like</u> (same dimensions) quantities.

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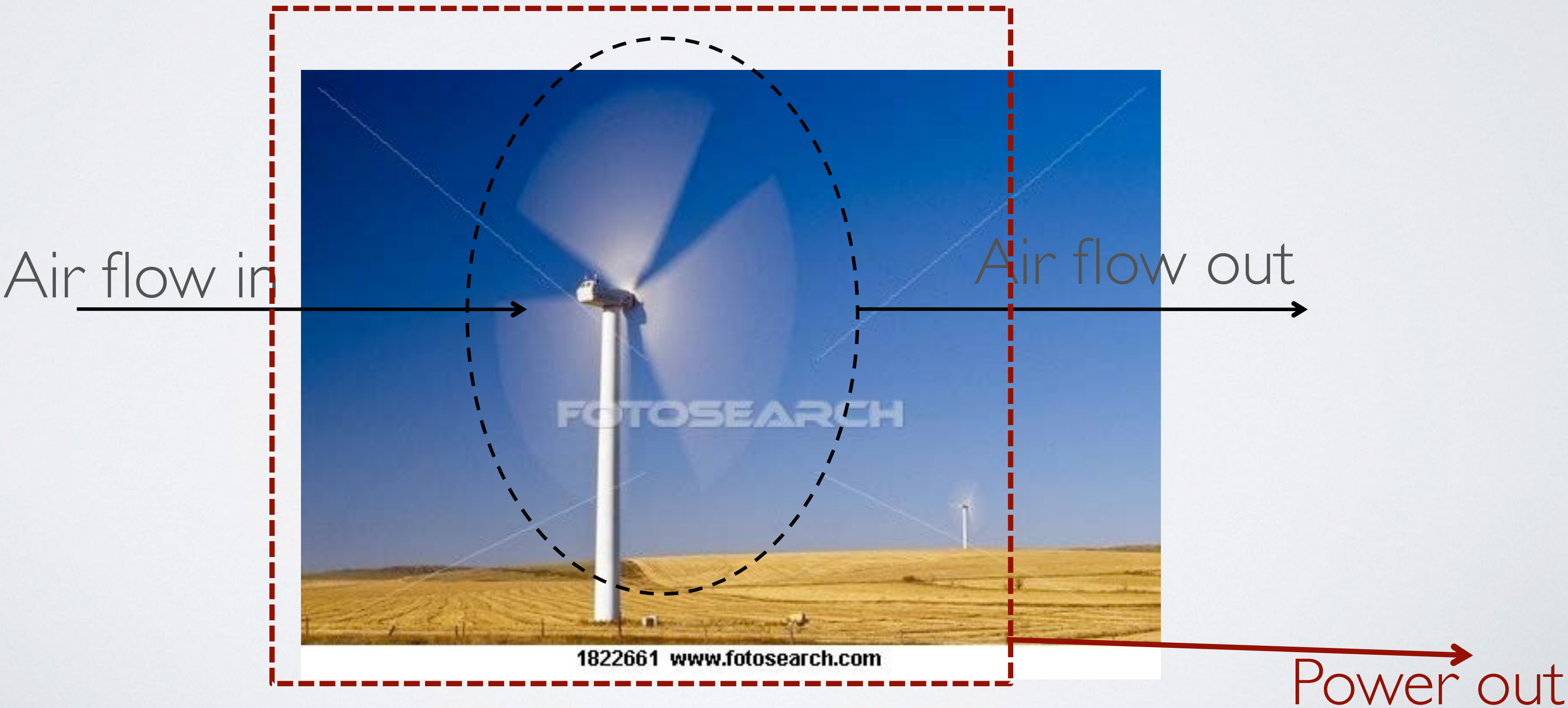
POWER AND WIND SPEED?

- How does the power generated by the windmill change with wind speed?
  - How is power being generated?
    - Wind flows through area swept by blades
    - Windmill converts this kinetic energy to electric power



POWER AND WIND SPEED?

- How does the power generated by the windmill change with wind speed?
  - Let's see if we can figure this out based on dimensional reasoning
    - Power is work/time which is force * distance/time which is mass* acceleration *distance/time
    - Thus we could write

$$power = m\ l/t^2 l/t = \frac{ml^2}{t^3}$$

    - What variables could be used?

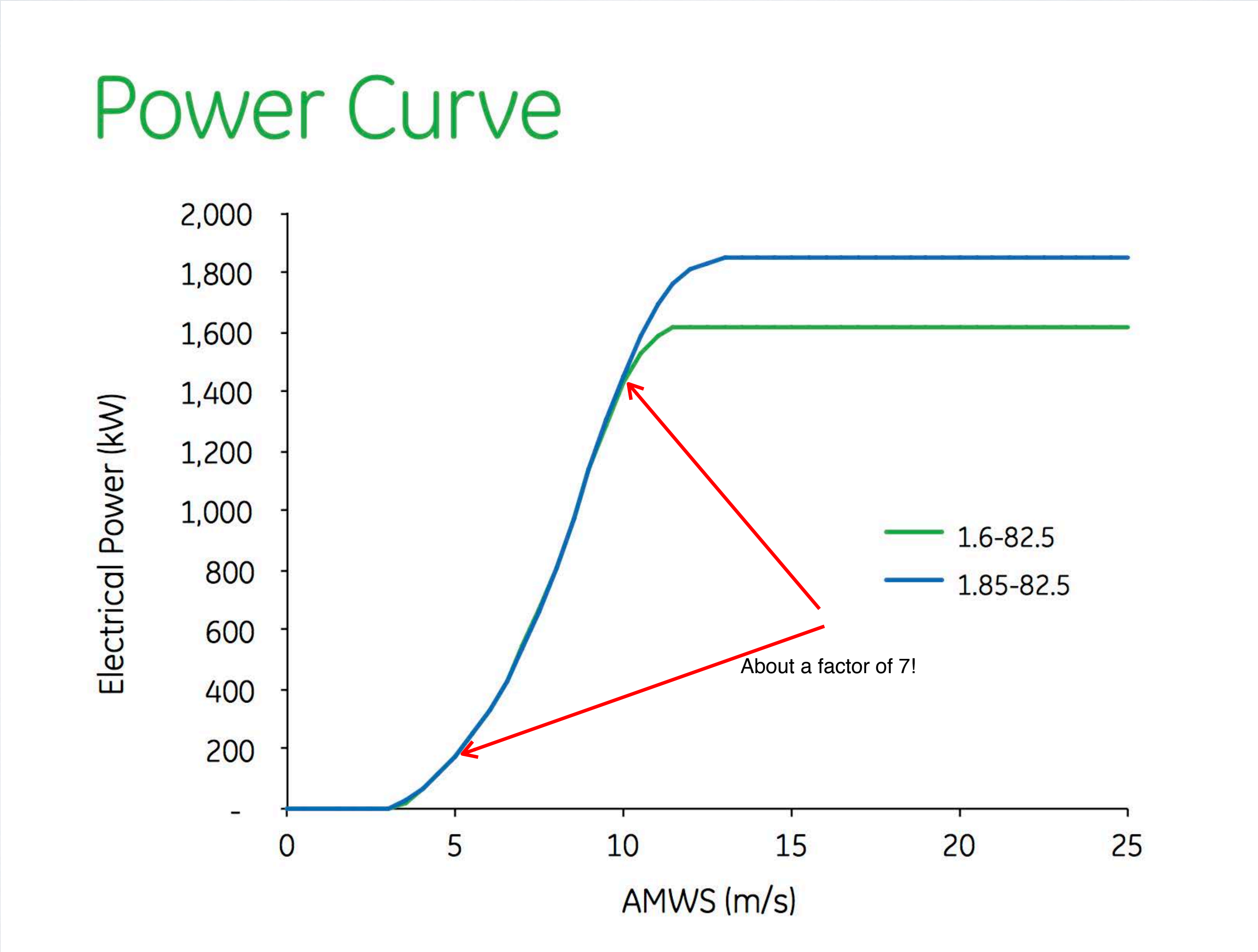
EQUATION FOR POWER FROM WIND

- Windspeed, blade diameter, air density
  - v [=] l/t
  - d, r [=] l
  - Density of air ρ [=] m/l^3
  - Arrange these variables to get dimensions of power:

$$power \sim \rho v^3 d^2 [=] \frac{ml^2}{t^3}$$

  - If the wind speed is cut in half, the power reduced to 1/8!
  - So our 40 wind turbines will produce about….
    - 7 MW!

WIND TURBINE POWER



https://www.gerenewableenergy.com/content/dam/gepower-renewables/global/en_US/downloads/brochures/wind-onshore-turbine-1.85-82.5-gea18755g-r1.pdf

Engineering

- Engineers seek to develop technologies that make the world a better place for humanity!
  - There are elements of creativity involved
- However, we need to realize there are limitations...
  - The laws of nature!

Physical Laws

$$\mathbf{F} = \frac{\mathrm{d}\mathbf{p}}{\mathrm{d}t} = \frac{\mathrm{d}(m\mathbf{v})}{\mathrm{d}t}.$$

he second law can also be stat

$$\Delta U = Q + W$$

$$\mathrm{d}S > \frac{\delta Q}{T}$$

Differential equations

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

Incompressible Navier–Stokes equations (*convective form*)

$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla)\mathbf{u} - \nu \nabla^2 \mathbf{u} = -\nabla w + \mathbf{g}.$$

Deflection at Any Given Point

$$y = \frac{Wx(l-x)}{24EIl}[l^2 + x(l-x)]$$

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Different engineering disciplines

- Mechanical: $\mathbf{F} = \frac{\mathrm{d}\mathbf{p}}{\mathrm{d}t} = \frac{\mathrm{d}(m\mathbf{v})}{\mathrm{d}t}$ other classic laws… generally a macroscopic view of the world and an interest it detailed workings of devices
  - "Glory job": Robots, making everything work
- Electrical: $\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$ detailed and somewhat abstract view of the world
  - Glory job: Streaming 4K video to your phone

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Different engineering disciplines

- Civil: $y = \frac{Wx(l-x)}{24EIl}[l^2 + x(l-x)]$ + other classic laws… generally a macroscopic view of the world
  - "Glory job": Building large structures and supporting the civil infrastructure
- Chemical: Rectangular (x, y, z, t)

$$\frac{\partial C_i}{\partial t} + v_x \frac{\partial C_i}{\partial x} + v_y \frac{\partial C_i}{\partial y} + v_z \frac{\partial C_i}{\partial z} = D_i\left[\frac{\partial^2 C_i}{\partial x^2} + \frac{\partial^2 C_i}{\partial y^2} + \frac{\partial^2 C_i}{\partial z^2}\right] + R_{Vi}$$

  - + chemistry
  - detailed, molecular bridging up to macro scale but possibly, (abstract) view of the world
  - Glory job: Making Pharmaceuticals.. and… all

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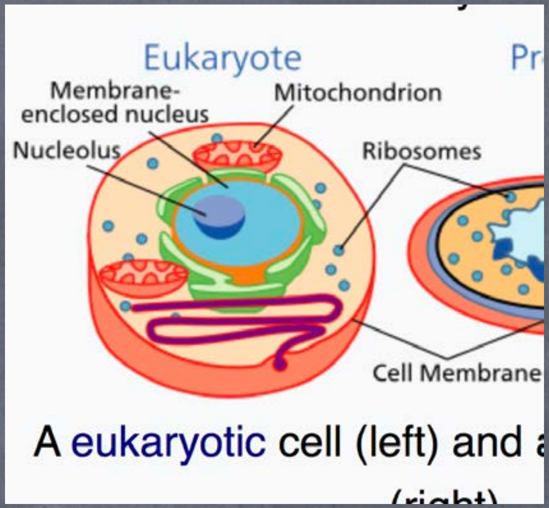
Different engineering disciplines

- Biological/biomedical:

$$\frac{d[\mathrm{P}]}{dt} = k_{\mathrm{cat}}\,[\mathrm{E}]_0\,\frac{[\mathrm{S}]}{K_\mathrm{M} + [\mathrm{S}]}.$$



$$\Delta U = Q + W$$

Rectangular (x, y, z, t)

$$\frac{\partial C_i}{\partial t} + v_x\frac{\partial C_i}{\partial x} + v_y\frac{\partial C_i}{\partial y} + v_z\frac{\partial C_i}{\partial z} = D_i\left[\frac{\partial^2 C_i}{\partial x^2} + \frac{\partial^2 C_i}{\partial y^2} + \frac{\partial^2 C_i}{\partial z^2}\right] + R_{Vi}$$

$$\mathbf{F} = \frac{\mathrm{d}\mathbf{p}}{\mathrm{d}t} = \frac{\mathrm{d}(m\mathbf{v})}{\mathrm{d}t}$$

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

- Detailed, on the level of cells, but otherwise integrative view of the world
  - "Glory jobs": Replacement limbs and joints, replacement organs, targeted treatments

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Do we already know everything?

- You might say…
  - “Maybe there is little that I could contribute.”
- Over the years, many claims of certainty have proven to be completely wrong!

It is OK to challenge accepted thinking!

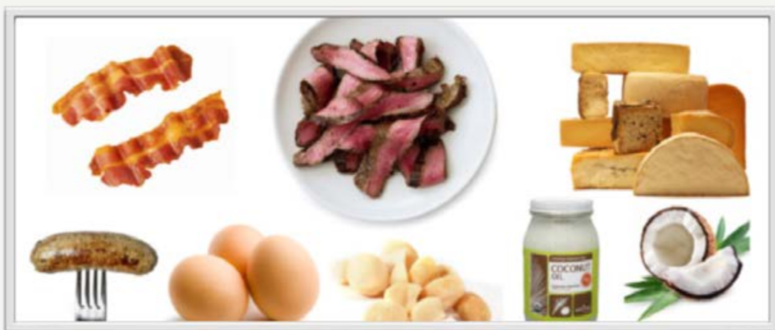
- Some things we thought we knew:
  - Margarine was considered a health food
  - Left-handed people die sooner because of the hazards of the right-handed word
  - Stomach Ulcers are caused by stress
  - Plants absorb CO2 and emit O2
  - The adult brain has no capacity to regenerate itself
  - Komodo Dragons bit their prey and waited for them to succumb to bacterial infections

SOME DOUBT BUT…

The Diet-Heart Myth: Cholesterol and Saturated Fat Are Not the Enemy

on APRIL 19, 2013 *by* CHRIS KRESSER 619 *comments*

How did we come to believe saturated fat and cholesterol are bad for us?



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CHOLESTEROL IS NOT BAD FOR YOU

Home > Blog > Cholesterol is not bad for you

Published on: Wednesday, 27 May, 2015

A sixty-year torrent of bad dietary advice is coming to an end

My Times column on the U-turn over cholesterol and saturated fat:

Cholesterol U-turn as research shows fatty foods might not be bad for us after all

Doctors are now focusing on sugar as the biggest danger to public health

SOME DOUBT?

The U.S. government is poised to withdraw longstanding warnings about cholesterol

By **Peter Whoriskey** February 10, 2015

Time to put eggs back on the menu? (Deb Lindsey for The Washington Post)

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1 The world's losers are revolting, and Brexit is only the beginning

2 The British are frantically Googling what the E.U. is, hours after voting to leave it

3 Brexit is a reminder that some things just shouldn't be decided by referendum

4 California may have a huge groundwater reserve that nobody knew about

5 Ginsburg smacks down a major abortion myth after historic SCOTUS ruling

LOW FAT?

Four reasons "fat-free" isn't good for you

on MARCH 18, 2013 *by* LIFE WITH GREENS *in* MISLEADING MONDAYS 27

The truth about low-fat foods

Kerry Torrens

Low fat foods stuffed with 'harmful' levels of sugar

SALT?

Go to Well Home

Well

HEART

A Low-Salt Diet May Be Bad for the Heart

By NICHOLAS BAKALAR MAY 25, 2016 1:45 PM 69

TAG Salt , sodium , Salt intake , Diet , Medical Controversy

Low-Salt Diet Bad For Your Heart? Not So Fast!

22 May 2016, 5:02 am EDT By James Maynard Tech Times

FOR SURE?

MAY 19, 2015 @ 09:53 AM 992,220 VIEWS

Updated NASA Data: Global Warming Not Causing Any Polar Ice Retreat

James Taylor, CONTRIBUTOR

I write about energy and environment issues. **FULL BIO**

Opinions expressed by Forbes Contributors are their own.

Updated data from NASA satellite instruments reveal the Earth's polar ice caps have

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Ice

Oct. 30, 2015

NASA Study: Mass Gains of Antarctic Ice Sheet Greater than Losses

A new NASA study says that an increase in Antarctic snow accumulation that began 10,000 years ago is currently adding enough ice to the continent to outweigh the increased losses from its thinning glaciers.

MUCH OF WHAT IS BEING PUBLISHED IS PROBABLY NOT CORRECT!

Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

Over half of psychology studies fail reproducibility test

Largest replication study to date casts doubt on many published positive results.

Monya Baker

ESSAY

Why Most Clinical Research Is Not Useful

John P. A. Ioannidis[1,2]*

Studies show only 10% of published science articles are reproducible. What is happening?

Posted on May 3, 2012 by Moshe Pritsker

Studies show a very low reproducibility for articles published in scientific journals, often as low as 10-30%. Here is a partial list:

EVEN THE TEMPERATURE? (YIKES!)

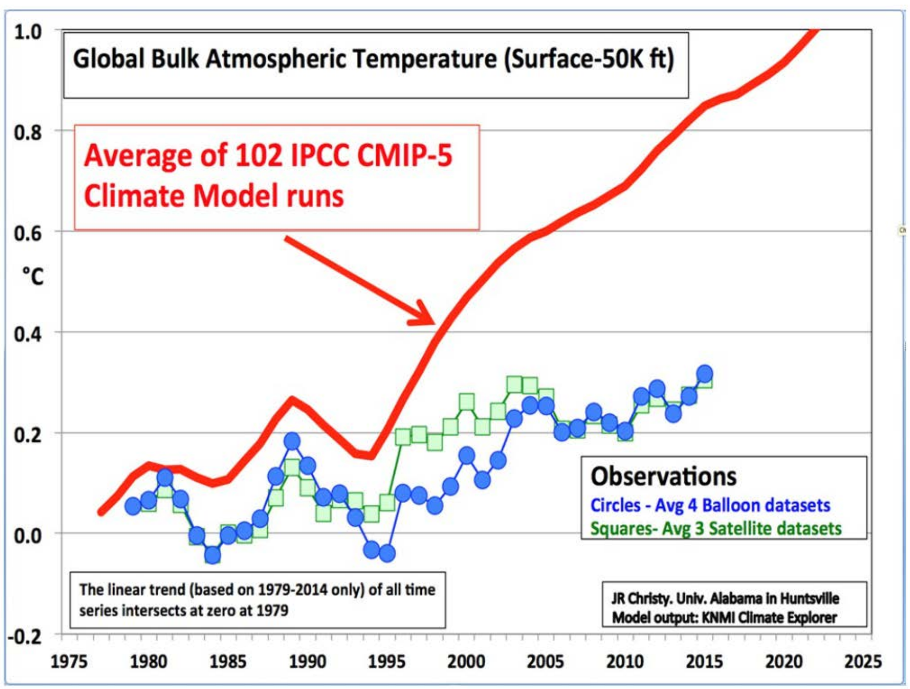
Earth is warming 50x faster than when it comes out of an ice age

A major new study includes some scary implications about how rapidly humans are changing the Earth's climate

THE DAILY CALLER NEWS FOUNDATION

Scientists Finally Admit Climate Models Are Failing To Predict Global Warming

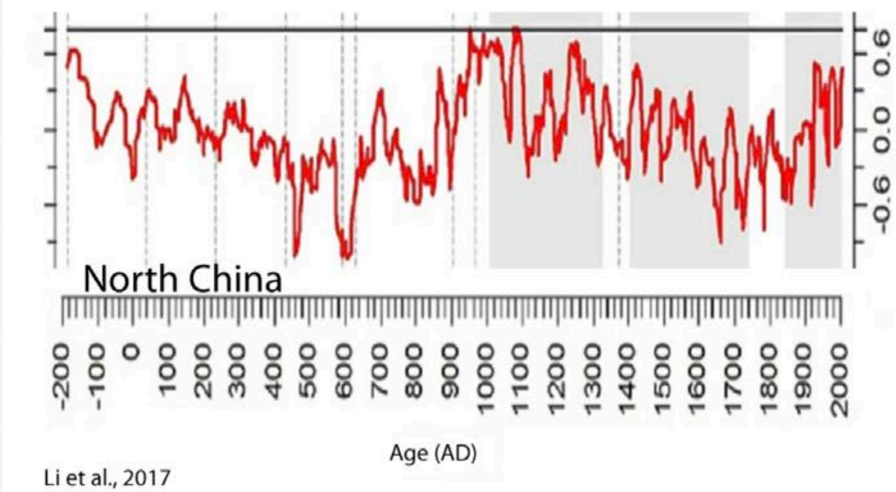
Committee of the U.S. House of Representatives on December 8.



Quantifying climatic variability in monsoonal northern China over the last 2200 years and its role in driving Chinese dynastic changes

Jianyong Li [a,*], John Dodson [a,b,**], Hong Yan [a,***], David D. Zhang [c], Xiaojian Zhang [d], Qinghai Xu [e], Harry F. Lee [c], Qing Pei [f], Bo Cheng [g], Chunhai Li [h], Jian Ni [i], Aizhi Sun [j], Fengyan Lu [a], Yongqiang Zong [k,l]

[a] State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710075, China



WE NEED YOU!

- Desperately!

Significant Progress

- Gas mileage doubled since 1972

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Significant Progress

- Fuel use per passenger mile is about 30% of original passenger jets

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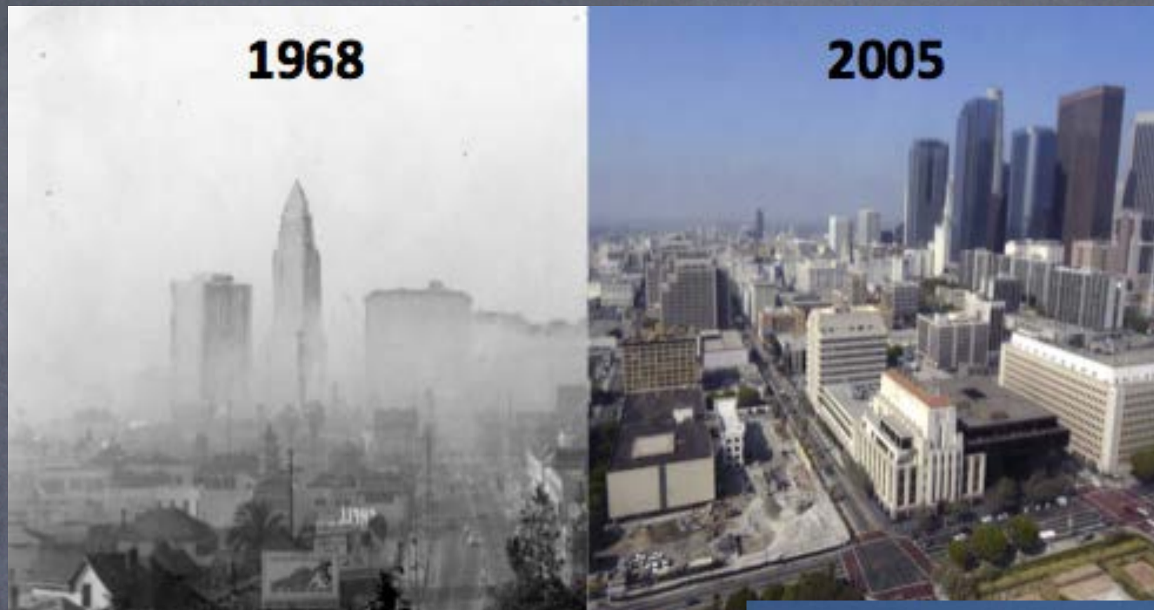
Success to date



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Some thoughts

- You will (soon) actually be in a position to make decisions on your own
  - some of which will determine your future path!
- It is possible that the issue of fulfillment is a bit complex:
  - You may have had discussions with your friends, and with yourself along the lines...
    - Should I try to make a lot of money?
    - Should I try to "save the world"?

Major issues for Humanity

- Healthcare
- Energy
- The Environment
- The Economy
- Engineers are critically involved in all of these and will chart the future course
- "Society" may call these issues "problems", engineers see these as challenges to be met!

RECAP

- Engineering involves analyzing a specific device or system using mathematical analysis based on physical laws or empirical understanding
- All problems of real importance have some degree of uncertainty and so judgement is needed
- Many big questions remain and you can contribute to their solution
- You may find fulfillment in the problems of global importance that are being addressed by engineers!

Dimensionless Confucius Proverb

$$Cr \equiv \frac{How\ \ Smart\ \ You\ Are}{How\ \ Smart\ \ You\ \ Think\ \ You\ \ Are}$$

- He who knows not and knows he knows not is a child, teach him, Cr~1
- He who knows not and knows not he knows not is a fool, shun him, Cr<<1
- He who knows and knows not he knows is asleep, awaken him, Cr>>1
- He who knows and knows he knows is wise, follow him Cr~1

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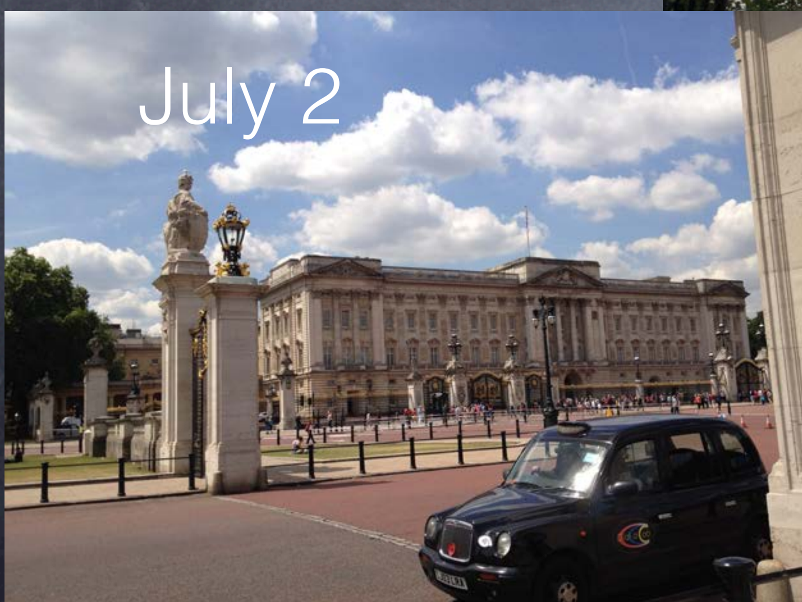
Some quotes falsely attributed to Winston Churchill

- "If you are not a liberal when you are 25 you have no heart. If you are not a conservative when you are 35, you have no brain!"
- "You make a living by what you get; you make a life by what you give!"

- Heart/mind conflict:
  - How does engineering fit in?

Summer 2014...



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