

## ECE 528 – Understanding Power Quality

<https://webpages.uidaho.edu/ECE/power/ECE528/>

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### Lecture 31

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## Today

- Engineering Work
- Avoiding errors
- Parting comments on engineering in general....

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## Engineers - what we sell

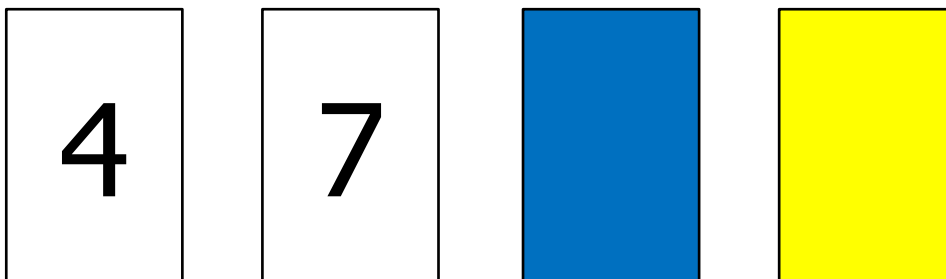
- Fundamentally, engineers sell their opinions  
(Based on math, physics, chemistry, experiments, etc.)
- What influences the value of our opinions?
  1. Accuracy and basis
    - Are you right? How do you know?
  2. Integrity
    - Know the limits of your expertise and be clear about those limits
    - If you discover a mistake, say so, work to solve it, learn from it, teach it, and move on
  3. Communication
    - The ability to help those with different technical backgrounds understand

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## An experiment: Four cards...



The cards have numbers on one side and are blue or yellow on the other side.

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## Four card experiment



1. Circle or write down which card or cards must be flipped over to test the truth of the statement **“If a card has an even number on one side, it will be blue on the other side.”**
2. Rate your confidence in your answer.
  1. 25% - I made a choice but I’m not very sure about this.
  2. 50% -
  3. 75% -
  4. 100% - I’m absolutely sure I’m right.

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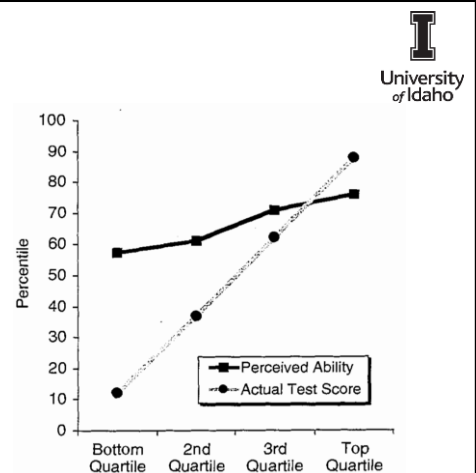
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## Dunning – Kruger effect:

- People generally overestimate their expertise.
- It takes expertise to recognize incompetence.
- True experts tend to underestimate their expertise.
- Learning about this phenomenon can help you identify your own limits, so you can address them.

[1] “Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments” – Justin Kruger and David Dunning, Cornell University, 1999

[2]<https://www.psychologytoday.com/us/basics/dunning-kruger-effect#>



From [1]

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## An engineer's responsibilities

1. Recognize when they've reached the end their expertise and say so - "I don't know....yet."
2. Work to push their understanding farther.
  - If we continue past what we know, or provide an opinion that lacks a sound basis, we are speculating.
  - We have a duty to recognize when we are speculating and to let others know.

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## Pushing your understanding, (and career) forward

- Your instructor's opinions...
- Basis: Career experience
  - Continuously employed as an engineer since 1991
  - I still like what I do
  - Often asked to teach

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## Intellectual humility

- What is it
  - The understanding that what we “know” or believe may be wrong.
- Why it’s a valuable trait for engineers (and others)
  - Improves accuracy, decision-making and basis
  - Increases learning
- Fostering intellectual humility
  - Understand that overconfidence can predispose us to confirmation bias – a dangerous cycle
  - Create work environments where mistakes are learning opportunities
  - Even company experts need ways to check their work
  - Ask yourself – “How do I know what I think I know?”
  - “Owning your mistakes” is humanizing and builds trust

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## Improving Accuracy, Basis, Integrity, and Communication

- Ideally, we’ll avoid the Dunning-Kruger effect, maintain intellectual humility, get the math and science right, and be able to explain it to a range of audiences
- Some tools that can help:
  - Awareness
  - Teaching
  - Learning
  - Collaboration

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## Awareness:

Metacognition – being aware of our own thinking

- To boost accuracy, basis, and intellectual humility:
  - Study the Dunning-Kruger effect and our propensity for overconfidence
  - Familiarize yourself with common numeric and logical fallacies
  - Be aware of natural biases
  - Use tools to challenge your own ideas

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## Awareness; Common logical fallacies

- False dilemma
  - Black and white/True-false, all or none representations. The real world usually has a range of options.
- Argument from ignorance
  - Absence of evidence used as evidence of absence. It's not been shown to be 100% safe, therefore it's dangerous.
- Post hoc fallacy
  - First A, then B; therefore, A caused B.

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## Awareness; Common logical fallacies

- Personal attacks (ad hominem)
  - Attacking the person rather than the idea. “of course, they’d say that they’re...”
- Appeal to Authority
  - Experts yes, authorities no. A person in authority may not be an expert in the field in question.
- Anonymous Authority
  - “Studies, experts, etc. (unnamed) agree that...”

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## Awareness: Common logical fallacies

- Complex question (form of begging the question)
  - Unrelated questions connected in a yes/no format that cannot be answered with a yes/no answer. “Has your company stopped lying about electromagnetic fields?”
- Non sequitur – affirming the consequent
  - If A then B; B, therefore A.
- Non-sequitur – denying the antecedent
  - If A then B; Not A; Therefore, not B

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## Awareness: Common numerical fallacies

- **Observational Selection - Cherry Picking**
  - Picking data that support your claim while ignoring other data
- **Gambler's fallacy**
  - Believing that because some event has happened more (or less) frequently than usual, it is now less (or more) likely to happen in the future. "We are about due for X to happen, since it hasn't happened in a while."
- **Summary metrics issues (mean, variance, etc.)**
  - Very different data can have similar summary metrics
  - This can make us think the data itself is similar when it isn't
  - Look at the raw data

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## Awareness: Common biases

- **Confirmation bias**
  - Only being receptive to data that supports our preconceptions.
- **Publication bias**
  - Occurs when positive results are more likely to be published than negative ones
- **Apophenia**
  - The tendency to see patterns or connections in random data

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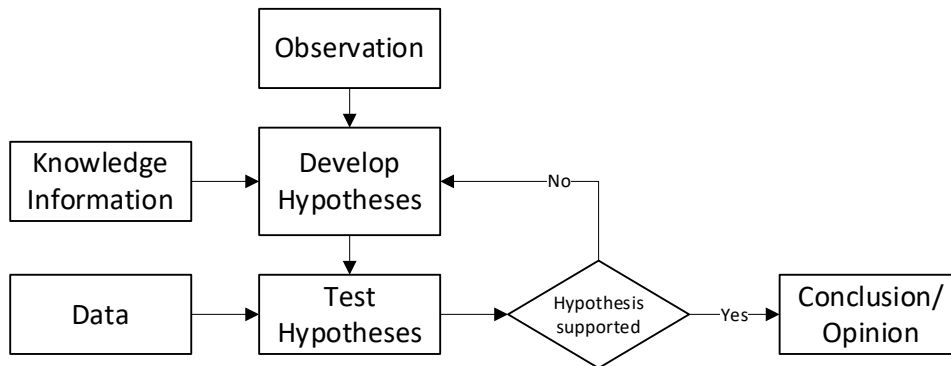
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## More tools: Scientific Method

- Helps avoid bias and produce accurate results



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## More tools to help with Accuracy and Basis

- From Carl Sagan's "Baloney Detection Kit" (See his book "The Demon Haunted World: Science as a Candle in the Dark")
  - Independently confirm the "facts" whenever possible.
  - Form and test more than one hypothesis.
  - Work to avoid confirmation bias for your own hypothesis.
  - Quantify. Measurement makes comparison easier.

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## Carl Sagan's "Baloney Detection Kit"

Selected fallacies to avoid:

- Misunderstanding Statistics – “half are below average”
- Confusing correlation with causation
- Observational selection – a form of confirmation bias – choosing what to look at based on what we want to find.

## Teach

- You do not need to know everything, to teach something
  - Tutor math, or engineering
  - Give presentations on electricity to elementary, middle, and high school students
  - Learn something and then share it with coworkers
  - It is not our job to be irreplaceable

## Teach

- Preparing to teach forces you to develop analogies, diagrams, etc., boosting your own understanding
- You'll learn which concepts tend to be challenging for others
- Your ability to explain technical concepts will improve
- You will be more comfortable in presentations

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## Learn

- Formal study is only part of an engineer's education
  - Continue on a topic, even after the question that brought you to it is answered
  - Read technical articles, and not just in your field
  - Build things and take things apart
  - Invite yourself
  - Ask people to teach you something
  - Experiment

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# Collaborate

- Get input from others
  - Different backgrounds bring different perspectives
  - Do not rely on just the more experienced people

*“We must not only learn to tolerate our differences. We must welcome them as the richness and diversity which can lead to true intelligence.” Albert Einstein*
- Share ideas
  - Have a question about a technical paper? – email the author
  - Ask to be part of projects you want to learn about
  - Attend conferences, ask questions

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# Some final suggestions

1. Don't believe everything you think.
2. If you think you know what someone else thinks, see #1.
3. People who “have it all together” are just good at making it look like they have it all together.
4. Things work out. Maybe not the way you hoped they would, but they do work out.  
*“Remember that sometimes not getting what you want is a wonderful stroke of luck.” - Dalai Lama XIV*
5. Life isn't fair. Instead, the deck is stacked in your favor.
6. Give something no one else can give; your time and attention.

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## References:

- “Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments” – Justin Kruger and David Dunning, Cornell University, 1999
- <https://www.psychologytoday.com/us/basics/dunning-kruger-effect#>
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- “The Demon-Haunted World – Science as a Candle in the Dark”, Carl Sagan, 1997, ISBN 0-7472-5156-8
- “Flow”, Mihaly Csikszentmihalyi, 1990 ISBN 9780061876721

Thank you.

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