THE ART OF SYSTEM SELECTION

Niss Feiner, C.Tech, CHD, RASDT, RHDT, RVDT
Delta-T Designs Inc.

ASHRAE Alaska Chapter

ASHRAE YEA

MECHANICAL SALES, INC.
Your Source for Green System Solutions

ASHRAE CODE OF ETHICS

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In this and all other ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, inclusiveness and respect for others, which exemplify our core values of excellence, commitment, integrity, collaboration, volunteerism and diversity, and we shall avoid all real or perceived conflicts of interests.

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HOW TO SIZE EQUIPMENT


creativity doesn't need limits.
@thecreative_exchange

"WE ARE IN THE SOLUTIONS INDUSTRY"

David Underwood, P.Eng
ASHRAE President 2015-2016

DEFINE THE PROBLEM

Thoroughly define the problem which you are attempting to solve, and establish the constraints.

You cannot possibly hope to provide a good solution if you don't know what the real problem is.

DEFINE THE PROBLEM

I need to find a home for my books.

DEFINE THE PROBLEM

The problem is never as simple as it first seems:

- What are the physical dimensions of the books?
- How much to the books weigh?
- Is there a colour scheme or style we need to stick to?
- Are there limitations to wall or floor space?
- Are they being archived, or to be used?
- What is my budget?

DEFINE THE PROBLEM

We need to define similar constraints in a mechanical project:

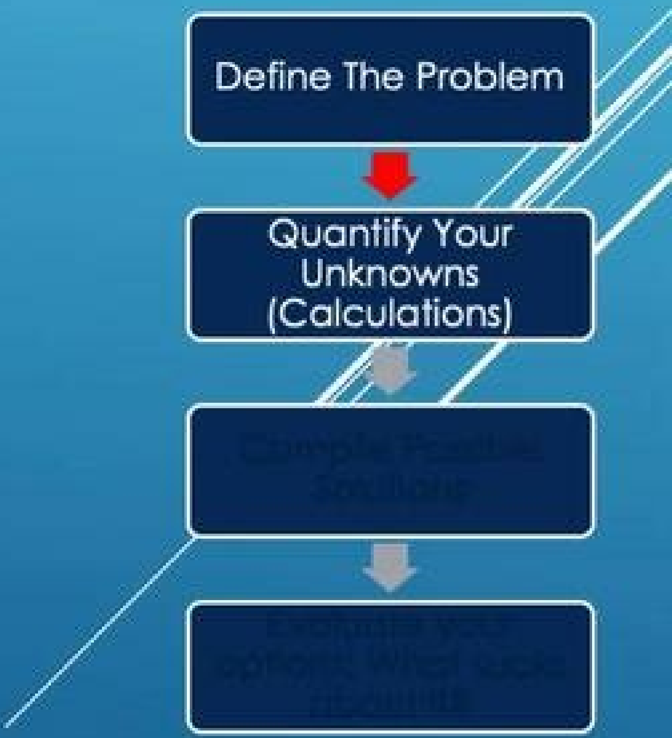
- Are there specific concerns relating to occupancy or process?
- Are there occupants or rooms that need to be treated differently?
- Are there specific codes or standards that apply to this occupancy or process?
- What is the project budget?

Once the problem has clearly and thoroughly been defined we can then.........

QUANTIFY THE UNKNOWNS

Compile a list of unknown values which the design will need to address.

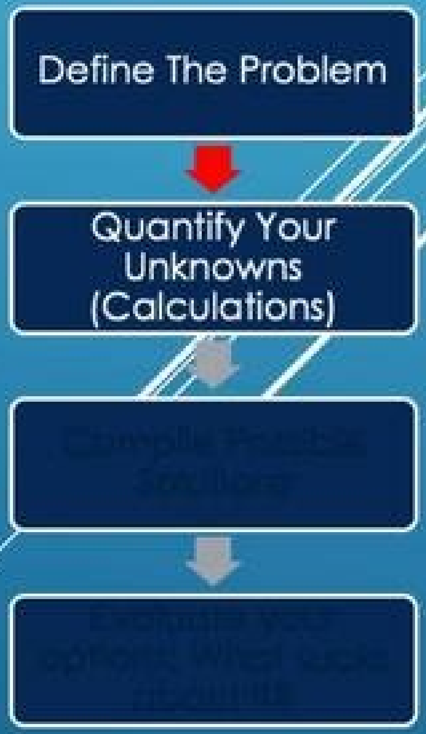
Defining the problem is a conceptual step, where as this stage is more technical and establishes project variables that need to be designed to.



QUANTIFY THE UNKNOWNS

Relevant variables affecting my book problem:

- What structure is available?
- Are we able to support from the wall?
- Are there studs that can be anchored to?
- Are there any windows or doors that can be obstructed?
- Are there any children or pets that may be affected?

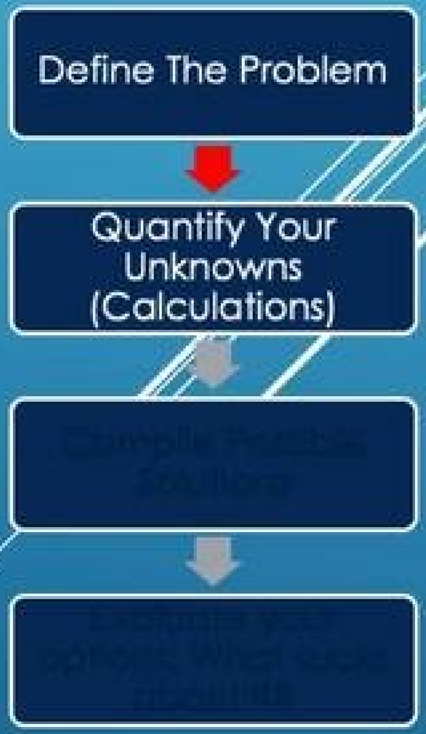


QUANTIFY THE UNKNOWNS

Relevant variables affecting typical mechanical projects:

- Building load calculations (Heat Loss & Gain)
- Ventilation loads (ASHRAE 62.1)
- Site services
- Inter-discipline coordination

This stage focuses on information and calculations that are not system-specific and will have great influence on the potential designs.



COMPILE POSSIBLE SOLUTIONS

Until this stage, discussing possible solutions was premature because:

- You do not have enough information to provide a solution that effectively solves your problem.
- You risk biasing the process. You should be led to a solution, not by one.

COMPILE POSSIBLE SOLUTIONS

All options should be treated as equally viable as this is a brainstorming session.

You do not need to justify or disqualify any option at this stage, but each option must be informed by and address the problems and variables previously established.

COMPILE POSSIBLE SOLUTIONS

Possible solutions for my books:

- Shelves
- Crates
- Bookcase

COMPILE POSSIBLE SOLUTIONS

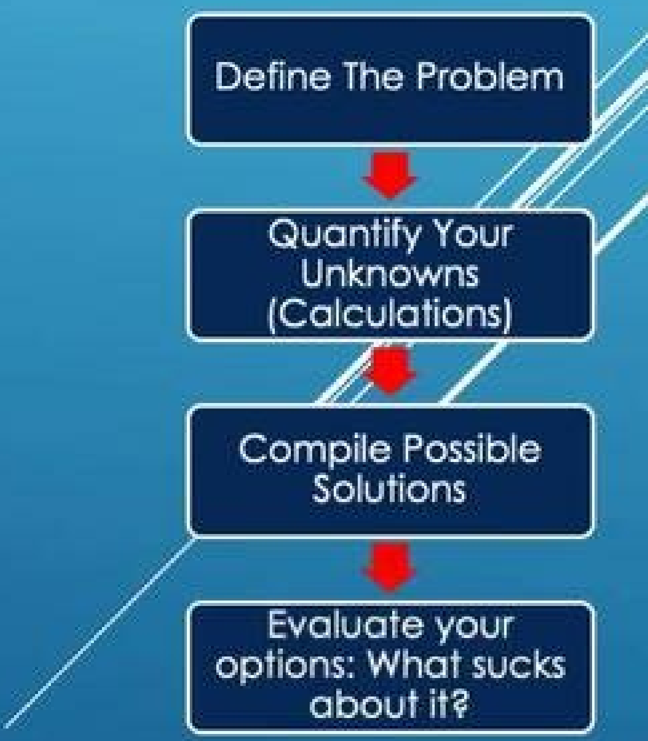
Possible mechanical solutions:

- Forced Air
- Hydronic
- VRF
- Zoned/not zoned
- Energy recovery
- etc

WHAT SUCKS ABOUT IT?

This stage involves critical review of each option to determine which should be disqualified.

I consider this to be a Darwinian approach to design.



WHAT SUCKS ABOUT IT?

I consider this to be a Darwinian approach to design.

WHAT SUCKS ABOUT IT?

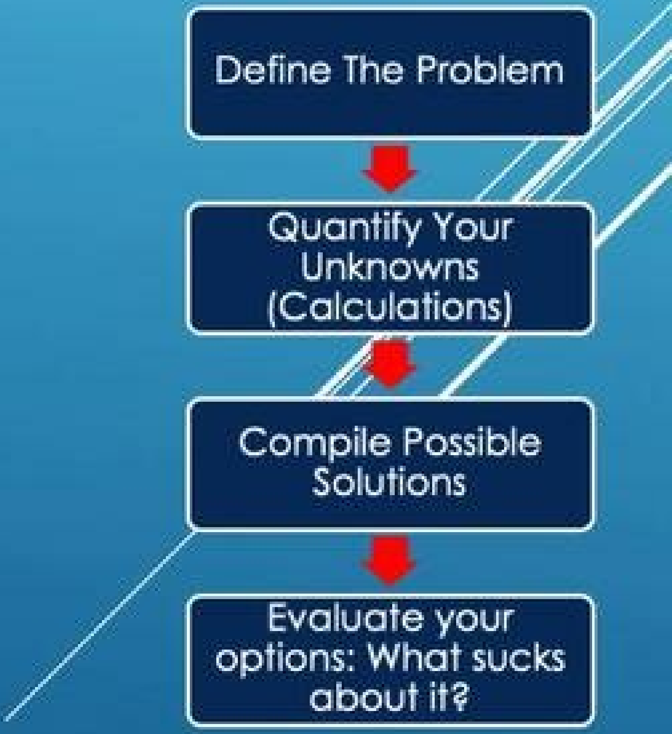
Red hair in humans is not typically a barrier for passing along genes.

Prince Harry and Meghan expecting 2nd child

'Duke and Duchess of Sussex are overjoyed,' says spokesperson

Thomson Reuters · Posted: Feb 14, 2021 2:59 PM ET | Last Updated: February 14

Prince Harry and Meghan are shown with their son, Archie, in Cape Town, South Africa, in September 2019, when Archie was four months old. (Toby Melville/Getty Images)



WHAT SUCKS ABOUT IT?

The same mutation in an Arctic Hare would be quite problematic for it.

WHAT SUCKS ABOUT IT?

Why do we ask what sucks about our ideas?

- It forces you to take an objective and hard look at your idea. If it deserves to be carried out it should stand up to rigorous scrutiny.

- It prepares you to defend your ideas to others. Peer reviewers, contractors and clients will question you on your design and often tear it apart.

The time to find faults in the design are when it is still on paper, not when it is being tendered or built.

WHAT SUCKS ABOUT IT?

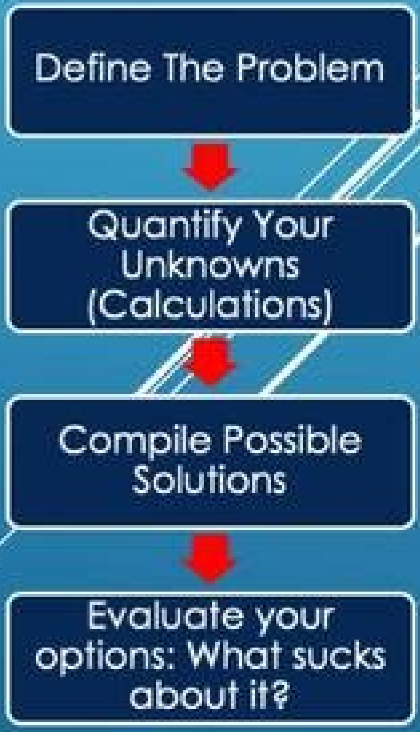
When selecting design options, you should not evaluate them based on the pros. It will only reinforce ideas without evaluating the weaknesses.

If you tell someone an option is the cheapest, many will stop listening after that and just approve it.

WHAT SUCKS ABOUT IT?

The process should be dispassionate and indifferent, but not cruel.
There must be boundaries:

- You must have the upmost respect others involved <u>and</u> yourself.
- This must not be personal. This should not be considered a reflection of anyone involved or their contribution to the project.
- Strictly about ensuring that the solution to be executed is the fittest in terms of addressing project requirements and variables.
- There is no room for ego.
- Maintain the highest degree of professionalism, as well as an awareness of your colleagues' feelings, and your own.



WHAT SUCKS ABOUT IT?

What sucks about Shelves?

- Put holes in the wall, which are tedious to repair.
- Open on all sides and top, allowing items to fall off the end.
- There is only one supporting surface per shelf.

Define The Problem

Quantify Your Unknowns (Calculations)

Compile Possible Solutions

Evaluate your options: What sucks about it?

WHAT SUCKS ABOUT IT?

What sucks about Crates?

- Put holes in the wall, which are tedious to repair.

- Some people may think ugly.

Define The Problem

Quantify Your Unknowns (Calculations)

Compile Possible Solutions

Evaluate your options: What sucks about it?

WHAT SUCKS ABOUT IT?

What sucks about a bookcase?

- Most expensive option.
- Requires most floor area and wall space.

WHAT SUCKS ABOUT IT?

Can we mitigate any of these issues?

- I can put bookends on the shelves to prevent things from falling off the end, but I cannot do anything about the wall repairs or lack of secondary support surfaces.

- I can't do anything to mitigate the wall repairs on the wall crates, but the aesthetic qualities can be addressed by looking for crates of specific styles and finishes.

- I can mitigate the bookcase cost by looking for something used, but that also brings quality issues as well as a limited selection of styles and finishes. There is also nothing that can be done to mitigate the floor/wall area issue.

WHAT SUCKS ABOUT IT?

WHAT SUCKS ABOUT IT?

- Should be a collaborative process to allow for maximum diversity in perspective and opinion.

- Must never be personal and maintain upmost care and professionalism.

- Participants should feel free to critique and defend ideas to eliminate the solutions that fit the least.

Remember, these are still good ideas. They may very well be the best idea for *another* project. They just don't fit *this* project.


HOW CAN WE APPLY
THESE CONCEPTS TO
A REAL PROJECT?

SAMPLE PROJECT

Church in the Greater Toronto Area, Ontario and built in 1993.

Existing heating is provided by electric baseboard heaters, electric fan forced heaters, electric furnace with split a/c in the sanctuary, and PTAC units in the Pastors study & church office.

Construction is concrete foundation with hollow core slab between floors and the upstairs is wood frame with brick.

The client would like to retrofit to natural gas and have mechanical cooling throughout the building.

They also have completed an agreement with an organization to rent the lower level as a daycare.

Budget, including all construction, consultants, permits and taxes = $333,000.00

<u>Glossary</u>

Split a/c: mechanical air conditioning where there is an indoor evaporator coil, and an outdoor condensing unit.

PTAC: Packaged Terminal Air Conditioner. A through the wall style heater & air conditioner often seen in motels.

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DEFINE THE PROBLEM

How to heat, cool, and ventilate the building to applicable codes and standards.

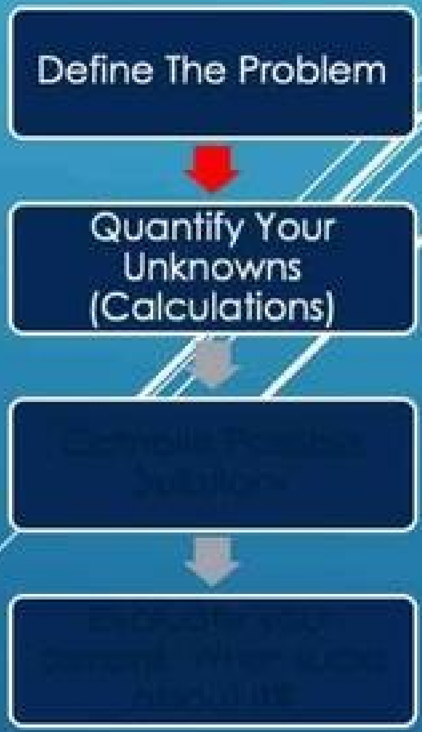
But, more specifically:

- We need to heat the building using natural gas.
- We need to distribute the heat throughout the building respecting structural and architectural criteria.
- We need to ensure that design and construction have a quick turnaround time. New gas service must be brought in and the client needs basement portion ready for occupancy in time for the daycare to start.
- We need the design to respect health & safety requirements for a licensed daycare.
- We need the design & construction work including all consultants and permit fees to not exceed the budget of $333,000. There is no opportunity for additional funding.

QUANTIFY THE UNKNOWNS

We need to start doing some calculations to determine our unknowns:

- What is the heat loss & gain loads?
- What are the ventilation and exhaust requirements?
- How much power is available for this project?
- What is the current gas capacity?
- What specific challenges are posed by the daycare downstairs?
- What are the client's priorities in terms of finances and capital vs operation cost?



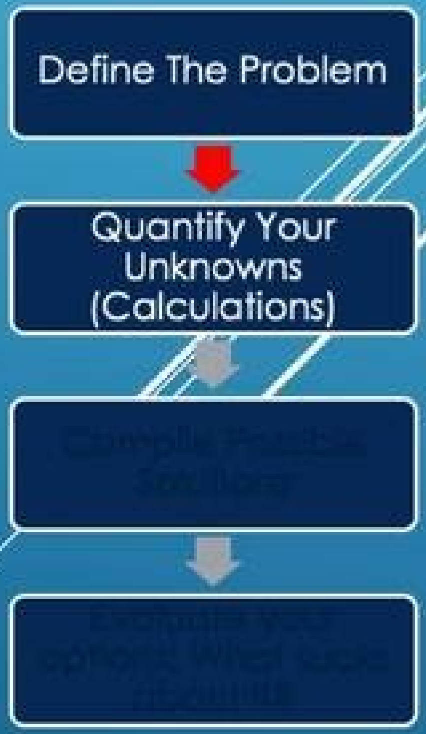
QUANTIFY THE UNKNOWNS

- What are the heat loss & gain loads?
  - Heat Loss & Gain Calculations were performed resulting in a total of 315,903 btu/h heat loss and 332,168 btu/h heat gain for the entire envelope.

- What are the ventilation and exhaust requirements?
  - ASHRAE 62.1 Ventilation calculations were also completed resulting in a total of 3,028 cfm of outdoor air, and 690 cfm of exhaust.

- How much power is available for this project?
  - As the existing heating system throughout was electrical heat it was found that there is sufficient capacity for future cooling systems.

- What is the current gas capacity?
  - In this example we need to arrange for a new service, so capacity will not be an issue, however the timelines to execute the new service is potentially problematic.



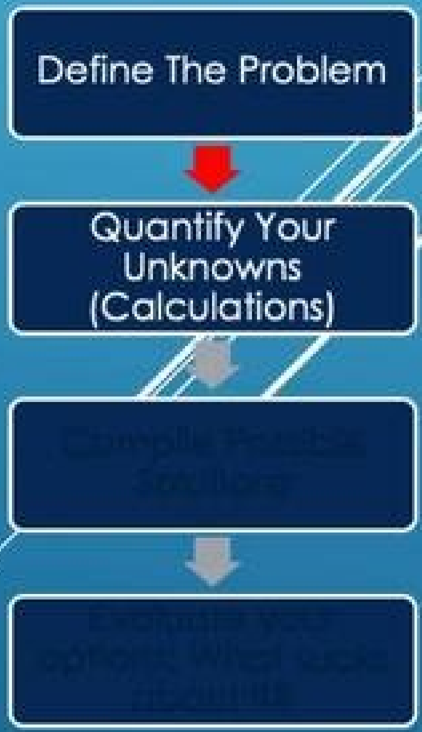
QUANTIFY THE UNKNOWNS

What specific challenges are posed by the daycare downstairs?

- The floor partition between the levels is core slab, which is pre-stressed concrete with hollow cores running the length of the panel. Cutting openings in core slab is a costly and slow endeavor and requires coordination with a structural engineer to confirm the hole sizes and locations do not negatively impact the structure. There is no guarantee we can put openings where we want to.

- In consultation with the daycare operator, we have determined that the existing window space meets the bare minimums and new mechanical systems cannot obstruct the windows reducing effective area of natural light and view to the outdoors.

- The proposed daycare tenant expressed concern that mechanical equipment must not be reachable by the children to avoid any injuries.

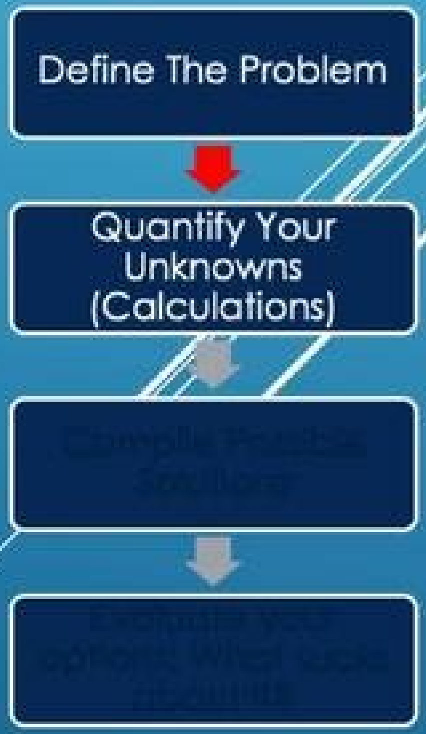


QUANTIFY THE UNKNOWNS

What are the client's priorities in terms of finances and capital vs operation cost?

- Client has a budget of $330K. This is the maximum for the project, and it is entirely financed.

- Client is a house of worship. Funding is difficult for these sorts of organizations. Typically, they have no problem fundraising for capital projects, however they constantly struggle with operational expenses. Members are willing to open their wallets to fundraise for new signs, additions, etc, however ongoing dues and memberships which are used to pay for energy costs, staff salaries, etc are always lacking. That is the reason that this client and many others like them rent out space to daycares.



COMPILE POSSIBLE SOLUTIONS

Solution A – Forced Air

Solution B – Hydronic

Define The Problem

Quantify Your Unknowns (Calculations)

Compile Possible Solutions

COMPILE POSSIBLE SOLUTIONS

Solution A – Forced Air

A Roof Top Unit

Main Floor:

- RTU to serve sanctuary, offices and additional rooms or corridors complete with new ductwork distributes heat, cooling, and ventilation throughout.

Lower Floor:

- Furnaces with split DX air conditioners, and HRV's to distribute heating, cooling, and ventilation throughout.

In evaluating the forced air options, we see the benefits:

- Lowest capital expense – RTUs & Furnaces are the cheapest options available
- Equipment is off the shelf and common, allowing for a quick turnaround, and service companies are very familiar with them.

This is a very conventional approach to this type of building.

Glossary

RTU: A Roof Top Unit is a single piece of equipment located on a roof providing heating, cooling, and ventilation.

DX: Direct Expansion. Conventional air-conditioning that exploits the relationship between temperature and pressure in refrigerants.

HRV: Heat recovery ventilator. An appliance which exhausts warm stale air from a building and exchanges that energy to a colder incoming stream of fresh air.

<u>Glossary</u>

Hydronic: A heating system that uses hot water as a heating medium.

Ceiling Cassettes: Indoor component of a ductless split air conditioning system surface mounted or recessed into a ceiling.

Wall Cassettes: Indoor component of a ductless split air conditioning system surface mounted on a wall.

COMPILE POSSIBLE SOLUTIONS

Solution B – Hydronic

Heating provided by condensing boilers and accessories providing hot water to baseboard convectors located throughout building on exterior perimeter walls.

Cooling provided by split a/c in the sanctuary, and ductless ceiling cassettes recessed in a false bulkhead on the interior partition. Cooling in lower floors provided by ductless ceiling cassettes and wall mounted cassettes throughout.

Ventilation provided by HRVs ducted to the return of the air handler in the sanctuary and directly to other occupied rooms on the main floor. Ventilation in the basement was to be provided by HRVs ducted directly into ceiling cassettes where available and directly into remaining occupied rooms.

COMPILE POSSIBLE SOLUTIONS

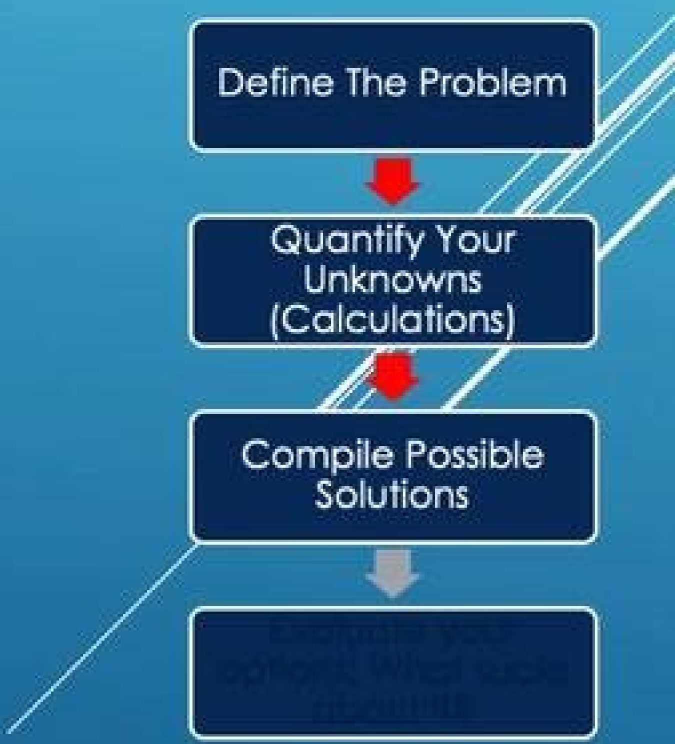
Solution B – Hydronic

In evaluating the hydronic option, we see the benefits:

- Due to the highly transient nature of this building's occupancy (primarily occupied for a few hours one day a week), this option allows a high degree of controllability and operating specific rooms in un-occupied setback.

- By applying the heat directly to the perimeter in setback rather than attempting to condition the large volume of air we can operate more efficiently in unoccupied times.

- By having the heating/cooling/ventilation as independent pieces of equipment, we can run only at the bare minimum capacities during unoccupied times.



WHAT SUCKS ABOUT IT?

Glossary

AFUE: Annual Fuel Utilization Efficiency. A method of measuring the combustion efficiency of some natural gas appliances.

Solution A – Forced Air

Highest operating cost of natural gas options due to:
- Lower efficiency. Currently there are no condensing roof top units on the market. The AFUE of the roof top units would be around 80%, and we're putting our heat source outside of the building in a metal box that is partially insulated with 1" of fiberglass.
- Poor control to meet diverse building loads. Conventional RTU's & furnaces have 2 stages of heating, and one or two stages of cooling.
- Relatively costly to zone with poor degree of control. While we can add a VAV system we still have a single RTU with 2 stages of heat and 2 stages of cooling. There is little ability to load match.

High ancillary costs. This option requires substantial structural modifications to the roof to provide a location for the RTU. The structural and architectural modifications to suit just the one RTU accounted for approx. 15% of the total budget.

Requires relatively large ducting. On the main floor this translates into additional architectural costs in terms of bulkheads etc to hide them, however in the basement there is insufficient head room to hide them, and we cannot block any of the windows on the perimeter.

Due to the concrete construction of the basement, larger ducts add difficulty and costs in providing openings in the concrete walls between rooms.

WHAT SUCKS ABOUT IT?

Solution A – Forced Air

Can we mitigate any of these issues?

- We might be able to find higher efficiencies on the cooling side, but due to the nature of RTU's and their primary markets the efficiencies and operating costs are what they are. There is no real way to improve upon that while still consuming natural gas.

- Structural costs could normally be reduced if we were able to put the RTU at grade on a concrete pad, however this option was disqualified by the client. The costs to hide the ductwork in bulkheads would remain unchanged.

WHAT SUCKS ABOUT IT?

$$W_1 = W_2 \times \left(\frac{P_1}{P_2}\right)^{3/2}$$

W_1 Initial fan power consumption
W_2 Final fan power consumption
P_1 Initial fan pressure
P_2 Final fan pressure

Solution A – Forced Air

- The issues posed by large ducting are not feasibly mitigated in this project. We can reduce the size of the duct a bit but that brings about several issues:

  - Increased pressure drop of the ducting system. This doesn't sound like much of an issue, but if we reduce the cross-sectional area of our duct, we increase the pressure drop of the system. If you recall your affinity laws, the difference in fan power is relative to the difference in pressure raised to the power of 1.5.

  - So, by increasing our External Static Pressure from say 0.5" to 0.6", we've increased the fan power consumption by 31.6%. This further compound our operating cost issues.

  - Reducing the duct size increases noise due to raising the air velocity and "duct rumbling". These additional noises are not suitable for a daycare where young children are to sleep or a house of worship during services.

  - We cannot really exceed a duct aspect ratio of 4:1 in terms of width to height. Beyond that turbulence and pressure drops become excessive.

WHAT SUCKS ABOUT IT?

Solution B – Hydronic

- Higher equipment counts. This system requires multiple boilers, pumps, HRVs and Ductless split systems increasing the overall complexity of the system.

- Higher equipment costs. Due to the technical differences between the equipment types the equipment costs are higher when comparing equipment cost per btu/h of heating or cooling.

- Children may be exposed to convectors or pipes causing burns or other injuries.

- Ongoing maintenance is more complicated than forced air, requiring the addition of corrosion inhibitor, and glycol where it may be exposed to air temperatures below freezing (in the case of using a hydronic coil to temper air from the HRV).

WHAT SUCKS ABOUT IT?

Solution B – Hydronic

Can these issues be mitigated?

Higher equipment counts and complexity can't really be helped, but it should be asked: is this actually a negative? By having multiple pieces of equipment, we have gained the following:

- Increased zoning: by having all these additional pieces of equipment we're able to precisely control which rooms are provided heating/cooling/ventilation and put all unoccupied spaces in setback.

- Increased control: by having multiple boilers we can effectively increase our turndown ratio allowing for more precise control of the loop temperature. Multiple ductless splits in larger zones allow us to stage the cooling delivered to the space, and inverter drives in the splits provide further precision in terms of capacity control.

- Increased redundancy: By having multiple boilers, as well as ductless splits that are also heat pumps, we have additional redundancy if a piece of equipment fails.

Complexity is not necessarily a bad thing if it can be justified.

WHAT SUCKS ABOUT IT?

Solution B – Hydronic

Can the cost issues be mitigated?

When evaluating cost, it is never as simple as just looking at cost per btu/h of equipment.

In this project the structural and architectural modifications just to suite the new RTU alone accounted for approximately 15% of the total budget. These funds can be transferred to the mechanical budget if we eliminate the RTU from the design.

It is always worth having discussions with your client relating to their operational vs capital expenses. These conversations can have large impacts in the direction a design goes.

WHAT SUCKS ABOUT IT?

Solution B – Hydronic

- Risk to injury of children can easily be mitigated. The prospective tenant disqualified the use of perimeter convectors, however we proposed using low profile radiant panels suspended from the ceiling. A small setback from the wall perimeter would satisfy any requirements to not obstruct the windows. Further, all piping would be insulated throughout, and any areas prone to contact with occupants would have been encased in a bulkhead.

- Ongoing maintenance. This also cannot be reduced or mitigated. This type of maintenance is inherent to the system.

WHICH DESIGN OPTION DID I CHOOSE?

Solution B – Hydronic

Based on this exercise I opted to go with the hydronic option over the forced air option. At the end of the process this decision was based on the following:

- It was able to still work with the total project budget.

- It had the fewest negative aspects that could not be mitigated.


Questions
Answers

Bridging the Gap: Avoiding conflict between Engineers & Contractors.

WHAT ARE THE COMMON ISSUES, AND HOW DO WE RESOLVE THEM?

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Bridging the Gap: Avoiding conflict between Engineers & Contractors.

WHAT ARE THE COMMON ISSUES, AND HOW DO WE RESOLVE THEM?

per·spec·tive

noun

A particular attitude toward or way of regarding something; a point of view.

Who am I?

- Has been in the HVACR and Plumbing industry on the contracting end since 2006.
- Has been providing mechanical designs since 2010.
- Established Delta-T Designs in 2015 providing HVAC & Plumbing design services for single & multi-dwelling buildings, as well as commercial and light industrial applications.
- By being active on both ends of the engineering/contracting relationship, has gained a unique perspective, and insight in the motivations, and decision-making process of both parties.

Niss Feiner, C.Tech, CHD
Delta-T Designs

Why do we have conflict between engineers and contractors in the construction industry?

The reason we have conflict between the two parties, are mostly the same reasons we have conflict anywhere in life.

It arises due to:

Lack of Cognitive Empathy

Poor Communication.

What is Cognitive Empathy?

"Cognitive Empathy refers to the extent to which we perceive or have evidence that we have successfully guessed someone else's thoughts and feelings."*

*Hodges & Myers (2007) – The Encyclopedia of Social Psychology (https://pages.uoregon.edu/hodgeslab/files/Download/Hodges%20Myers_2007.pdf)

What is Cognitive Empathy?

- Differs from Emotional Empathy in that:
- Emotional Empathy is the ability to feel the same emotion as another person.
- Cognitive Empathy has no emotion involved, only cognition.

What is Cognitive Empathy?

Cognitive Empathy is the ability to recognize and appreciate someone else's perspective.

Why does it matter?

Engineers are not necessarily contractors, and contractors are not necessarily engineers.

≠

Without understanding the other party's perspective, you filter all their actions through your own prejudice, and your emotions towards them are biased towards negative.

Emotional Bias

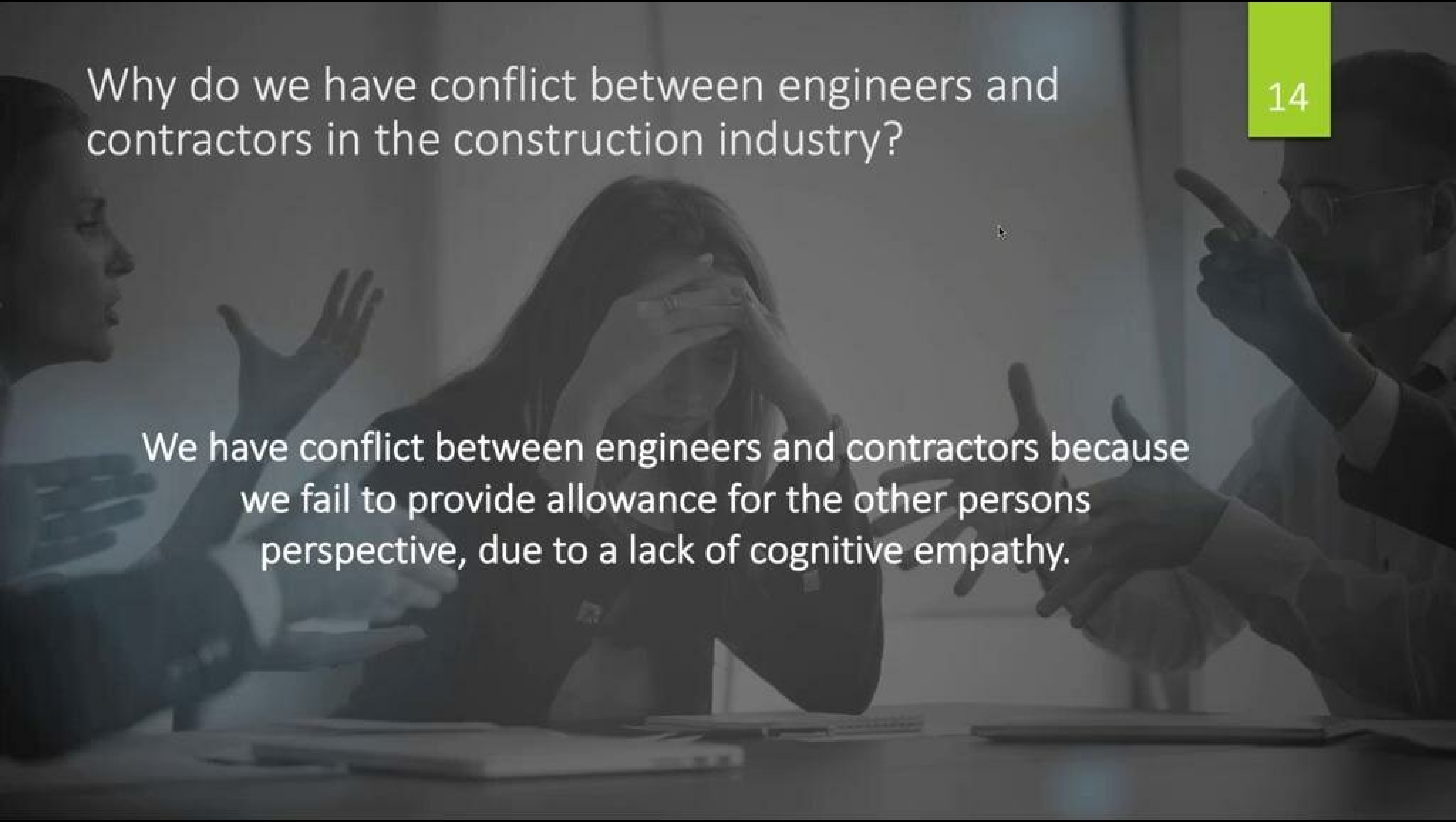
Every time the other person speaks in a meeting, you are going to run their words through this filter, and what results will reinforce your bias towards that person.

Emotional Bias

- Sports franchises have many little tricks to create a fun and positive environment including:
  - Door giveaways
  - Section prizes
  - Sirens & Lights when the home team scores
  - Contests & giveaways

Emotional Bias

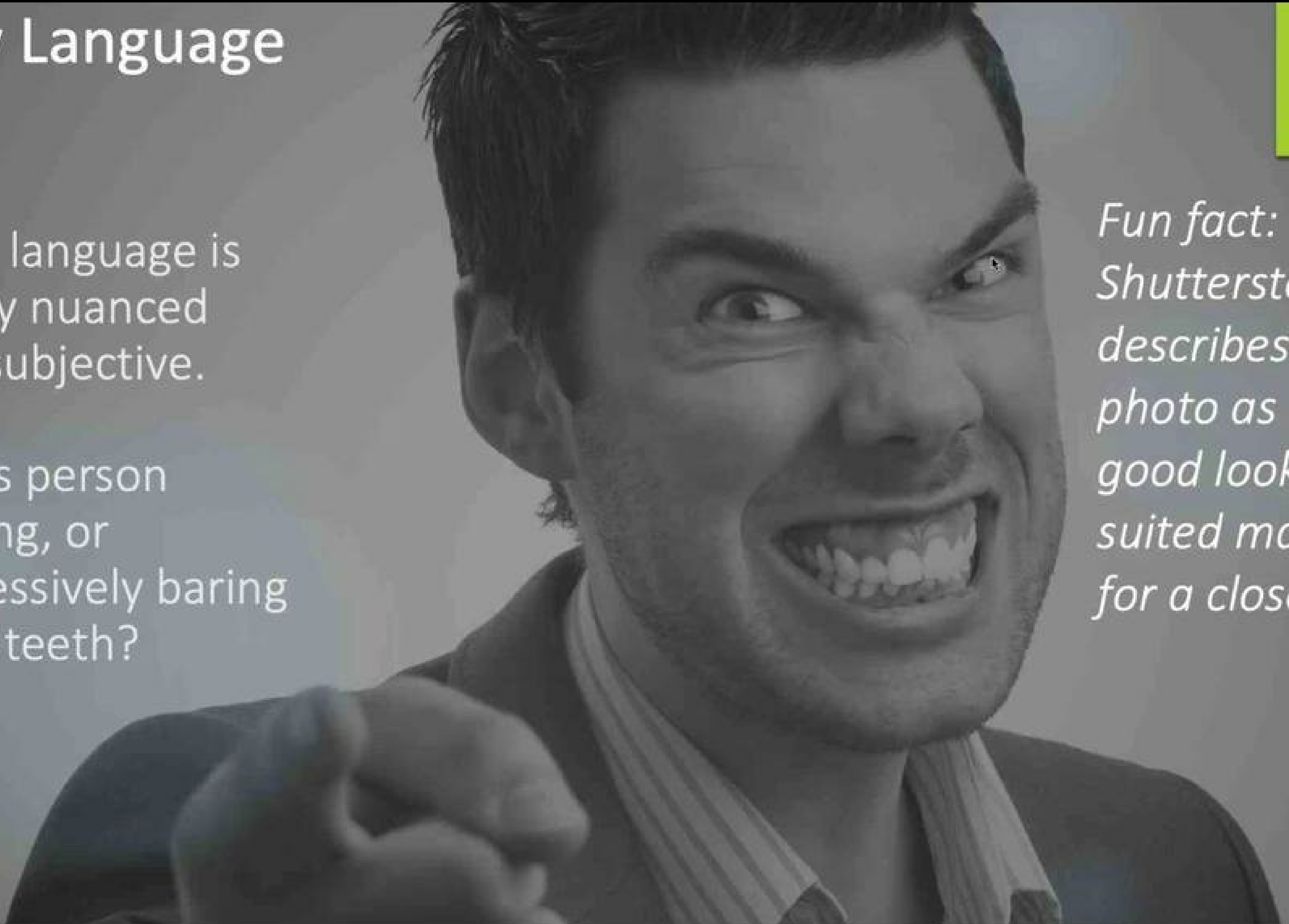
- Sports franchises have many little tricks to create a fun and positive environment including:
  - Door giveaways
  - Section prizes
  - Sirens & Lights when the home team scores
  - Contests & giveaways
- These tricks help bias you emotionally towards the brand. You aren't coming to this event because you may win a free t-shirt. You do it because of the feelings you associate with the last time you were there.
- This emotional bias can be so strong, that you still have a positive feeling towards it despite your teams ranking, ticket price, parking and food/drink prices.
- If emotional bias can work so well in favor of getting people to see a team, imagine what it can do against a person you disagree with.


Why do we have conflict between engineers and contractors in the construction industry?
14
We have conflict between engineers and contractors because we fail to provide allowance for the other persons perspective, due to a lack of cognitive empathy.

Poor Communication

"Communication is the act of conveying meaning from one entity or group to another through the use of mutually understood signs, symbols, and semiotic rules"

Body Language



Body language is highly nuanced and subjective.

Is this person smiling, or aggressively baring their teeth?

Fun fact: Shutterstock describes this photo as "Young good looking suited man smiling for a close-up"

Body Language

Body language and gestures can vary greatly between cultures and societies.

Never assume a common understanding.

Is this man saying everything is “ok”?

Evil Eye

The Evil Eye is a curse that is said to cause harm in varying degrees. This curse, and its symbolism is affiliated with cultures in the Mediterranean basin and the Levant.

Photo courtesy of: https://www.vice.com/en_us/article/59qwd8/i-accidentally-gave-myself-the-evil-eye


CENSORED

Verbal Non-Linguistic Communication

Verbal non-linguistic communication makes things very difficult. Just ask a new parent what their baby wants.

Does this scream mean their hungry? Tired? A dirty diaper?

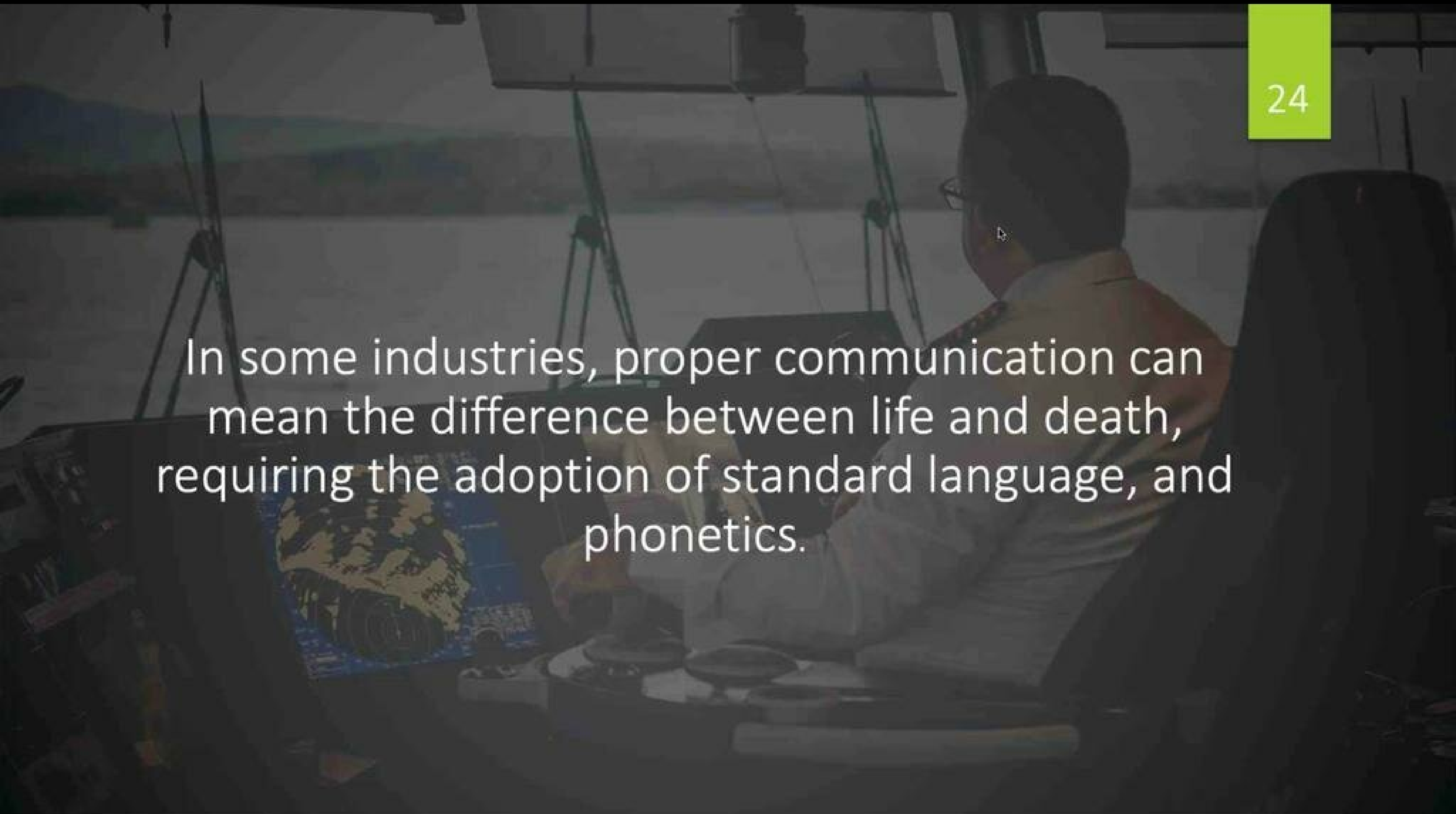
Verbal, Linguistic Communication

- Verbal, Linguistic communication has many drawbacks. The rules are arbitrary, and do not span cultures and experiences.
- Even cultures that share the same language have different words with different meanings.

Written Communication

Written language has all the same drawbacks as verbal communication however also requires adequate muscle control and visual acuity.

A person's ability to communicate through writing may be hampered by education, mental development, and physical limitations.


24
In some industries, proper communication can mean the difference between life and death, requiring the adoption of standard language, and phonetics.

B	=	BRAVO
C	=	CHARLIE
D	=	DELTA
E	=	ECHO
SAY AGAIN	=	REPEAT LAST TRANSMISSION
REPEAT	=	SEND SAME VOLUME AND INTENSITY OF FIRE AS LAST

Why do we have conflict between engineers and contractors in the construction industry?

We have conflict between engineers and contractors because we fail to properly communicate our intents, opinions and perspectives.

Profile of a Professional Engineer (P.Eng)

Professional Engineers typically have taken an undergraduate program at a university that covers math and theory as it relates to engineering, including:

- Calculus & Algebra
- Statics & Dynamics
- Chemistry
- Structure & Properties of Materials
- Electrical Circuits & Instrumentation
- Thermodynamics
- Fluid Dynamics
- Heat Transfer
- Etc.

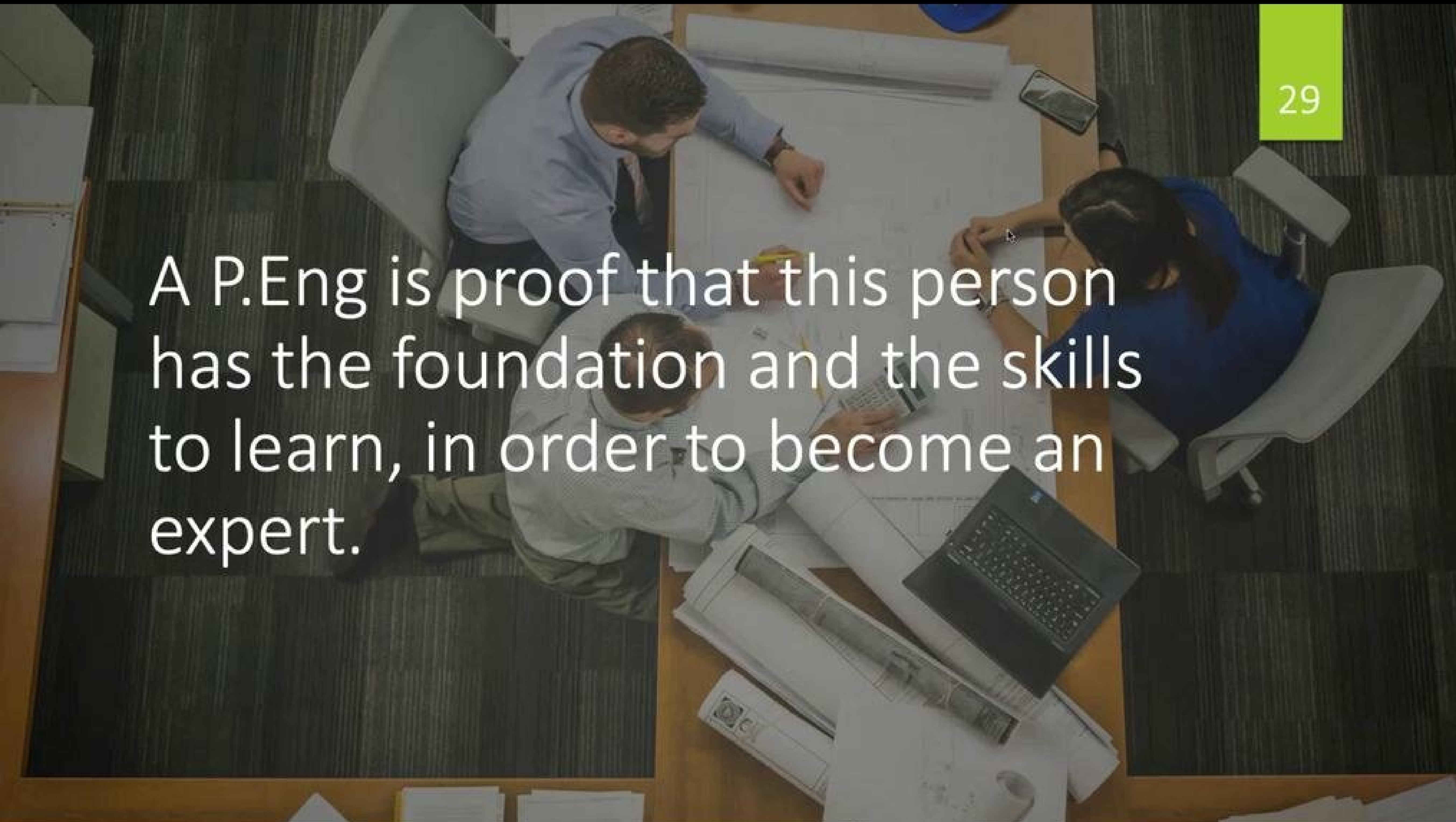
Profile of a Professional Engineer (P.Eng)

PEO (Professional Engineers Ontario) P.Eng Candidates must:

- Meet the academic requirements
- Pass a Professional Practical Exam covering:
  - PEO as an organization
  - Canadian Law
  - Ethics
- 4 Years of work experience consisting of:
  - Application of theory;
  - Practical Experience;
  - Management of Engineering;
  - Communication skills; and
  - Awareness of the social implications of engineering.

https://www.peo.on.ca/licence-applications/become-professional-engineer/general-academic-requirements
https://www.peo.on.ca/licence-applications/become-professional-engineer/professional-practice-exam
https://www.peo.on.ca/licence-applications/become-professional-engineer/experience-assessment

Professional Engineers Ontario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A P.Eng is proof that this person has the foundation and the skills to learn, in order to become an expert.

Profile of a Contractor

Profile of a Contractor

- Trades are regulated by a legislative body vs self regulated.
- In Ontario, the trades fall under the Ministry of Labour, Training and Skills Development.
- Licensed Tradespeople are referred to as Journeyperson (JP).
- Journeypersons & apprentices are confined to practicing only within the scope of their trade certification:
  - 313D - Residential Refrigeration Mechanic cannot work on systems larger than 5 Tons, which requires a 313A – Refrigeration and Air Conditioning Systems Mechanic.
  - 309A – Construction and Maintenance Electrician cannot change the breaks on your car, which requires a 310E – Alignment and Brakes Technician.
- It does not matter how knowledgeable a person is in the topic, a person can only practice the scope of work in the trade for which they are either a Journeyperson or Registered Apprentice.

Profile of a Contractor

https://www.collegeoftrades.ca/wp-content/uploads/Refrigeration-and-Air-Conditioning-Mechanic-313A-EN-TS3.pdf

Profile of a Contractor

- Path to becoming a licensed Journeyperson is an apprenticeship.

https://www.collegeoftrades.ca/wp-content/uploads/Refrigeration-and-Air-Conditioning-Mechanic-313A-EN-TS3.pdf

Profile of a Contractor

- Path to becoming a licensed Journeyperson is an apprenticeship.
- Apprenticeships vary in length and in-class requirement depending on the trade.
- 313A – Refrigeration and Air Conditioning Systems Mechanic requires:
  - 5 periods of 1800 hours of training, instruction and on the job experience.
  - Typically achieved in 5 years with 3 two-month trade school sessions:
    - Basic
    - Intermediate
    - Advanced
  - JP candidate requires demonstrating proficiency in various skills including:
    - Troubleshooting AC components
    - Evacuating and charging refrigeration circuits
    - Verify operating parameters
    - Planning, assembling, brazing piping, etc.

https://www.collegeoftrades.ca/wp-content/uploads/Refrigeration-and-Air-Conditioning-Mechanic-313A-EN-TS3.pdf

Understand each others' roles.

- The role of the engineer is to understand the how and why of design, and the details surrounding it.
- The role of the contractor is to understand the how and why of implementing the design, from paper to the physical world.
- Respect that the other person is the expert in their role.

Why do we have conflict between engineers and contractors in the construction industry?

We have conflict between engineers and contractors because we lack a shared perspective (cognitive empathy) and poor communication.


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STORY TIME

1. Each story represents an amalgamation of my experiences throughout my career both on the contracting side, and on the engineering side.

1. Each story represents an amalgamation of my experiences throughout my career both on the contracting side, and on the engineering side.

2. These are all true, in that I have personally experienced, or witnessed each incident and/or emotion, but they have been spread between the stories in order to not single out or identify any person, project, or company.

Story #1 – Poor Drawings (Contractor's Perspective)

- This story outlines the problems that can arise from poor drawings.
- Drawings and specifications are one of the primary forms of communication on a project.
- It is important for engineers to understand the experience and perspective of contractors who bid and build based on their drawings.
- Contractors assume a large amount of financial liability based on the bidspec process, and poor communication (ie drawings & spec's) can greatly frustrate this process, and potentially cost a contractor a significant amount of money or damage their reputation.

Tender Process

1. Review all the drawings, specifications and assemble a list of pertinent suppliers, and subtrades.
2. Distribute tender documents to all the above-mentioned parties.
3. Perform an accurate material take-off to distribute to suppliers.
4. Quote labour for individual systems.
5. Assemble quote, review to ensure everything is covered, fill out appropriate tender documents.
6. Distribute to general contractors by the deadline in the proper format.

Experiment Time

This experiment will demonstrate the difficulty of communicating one's thoughts effectively.

The Curse of Knowledge

As the person doing the communicating, you have a clear understanding of what it is you are trying to communicate.

The person you are trying to communicate does not have this information, and it is up to you to provide proper context, and information in order to adequately communicate your idea or intent.

Avoid the curse of knowledge by:

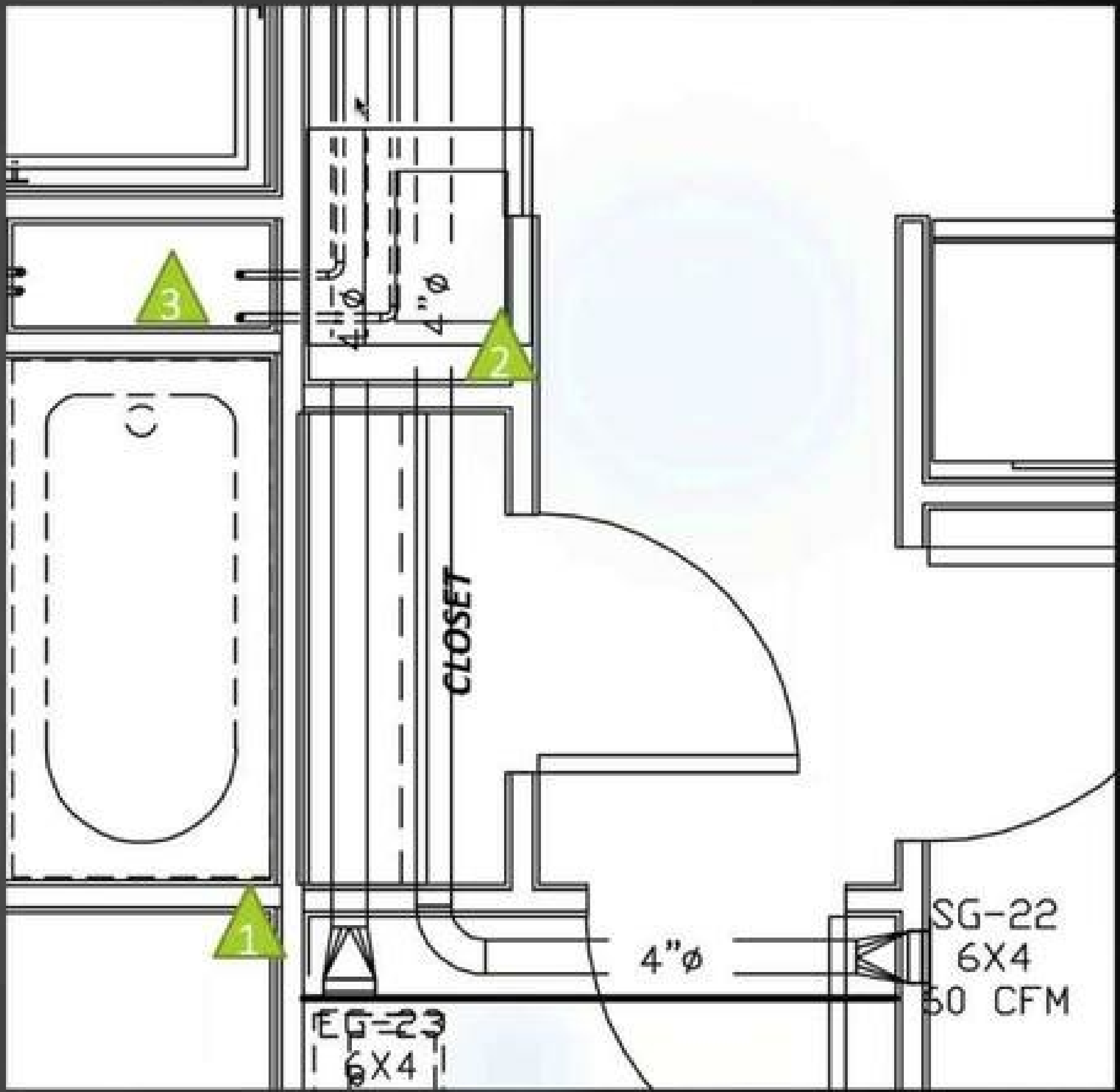
- Always be aware that you are creating drawings for someone with none of your knowledge. The person bidding or building these plans was not privy to the planning, calculating, and drafting stage. Write accordingly.
- Solicit a review from your peers who are completely removed from the project. You want someone who can understand the drawings but has no idea what led to the creation of them. You want someone who is objective and can attempt to infer your intent. If they ask for clarification, that needs to go on the drawings.

Poor Drawings

The following are examples of my own earlier work of drawings that do a poor job of communicating, to point out what you need to watch out for.

In this example:

1. Same pen weights make it impossible to distinguish between architectural underlay & mechanical pipes & ducts.
2. Pipe & duct sizes interfering with adjacent components. Causes confusion as to what is being referred to.
3. No notation about change in elevation. Forces reader to guess or hunt for further information.

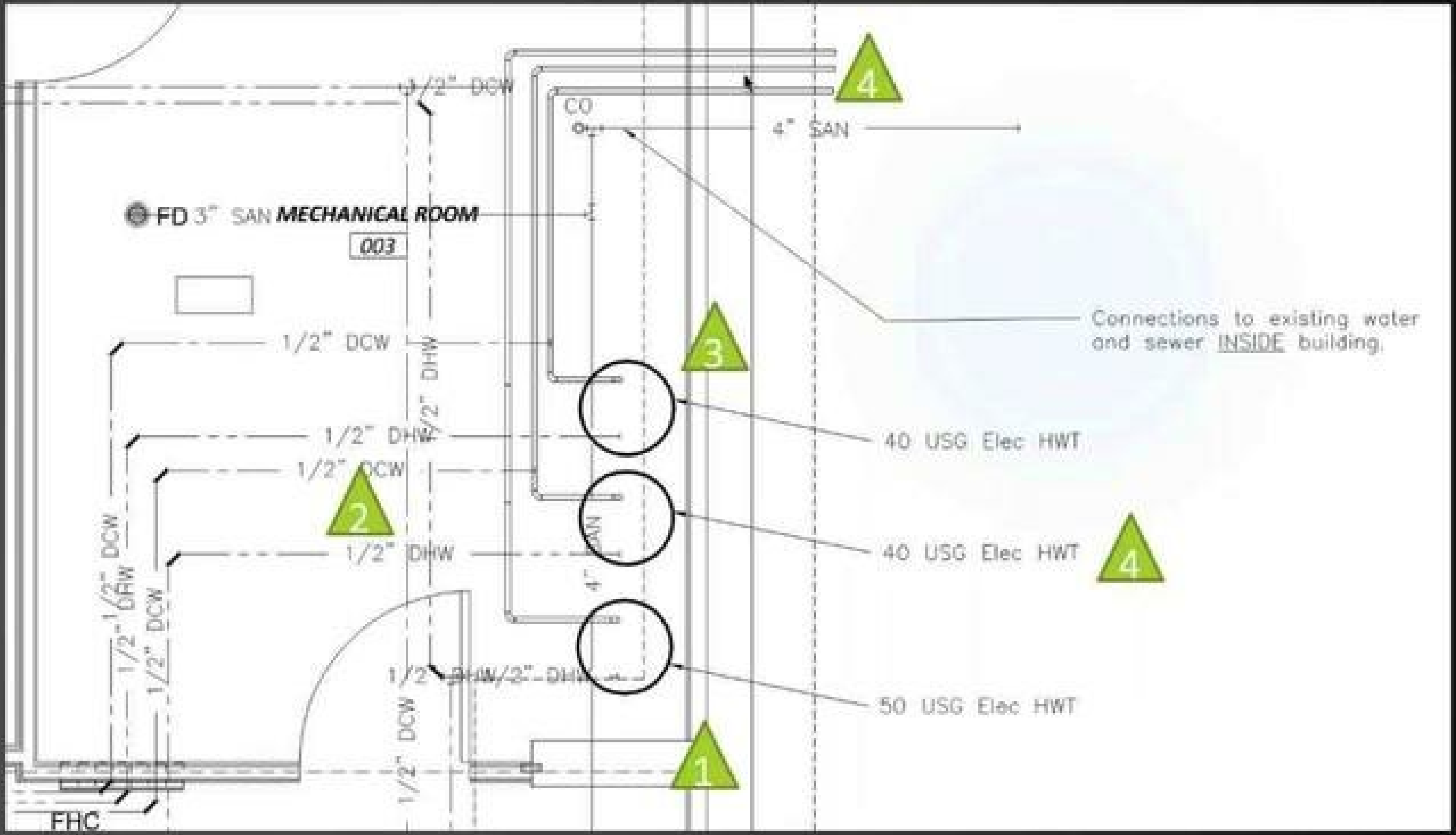


Poor Drawings

The following are examples of my own earlier work of drawings that do a poor job of communicating, to point out what you need to watch out for.

In this example:

1. Same pen weights make it impossible to distinguish between architectural underlay & mechanical pipes & ducts.
2. Pipes crossing with overlapping labels making it difficult to read.
3. Sanitary piping shown on same sheet as water piping and water heating equipment.
4. Conflicting information. Note says Hot Water Tank is electric, yet drawing shows presumed venting.

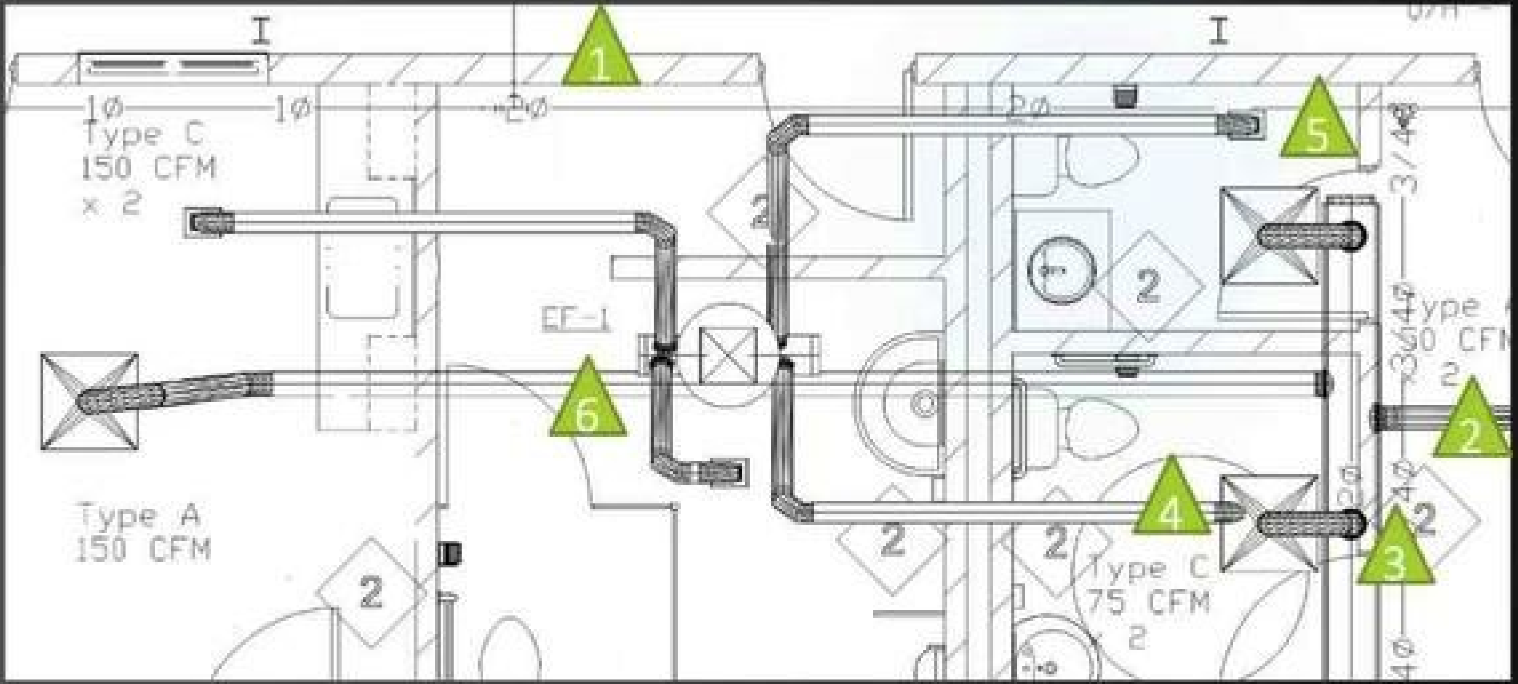


Poor Drawings

The following are examples of my own earlier work of drawings that do a poor job of communicating, to point out what you need to watch out for.

In this example:

1. Same pen weights make it impossible to distinguish between architectural underlay & mechanical pipes & ducts.
2. Pipes crossing with overlapping labels making it difficult to read. Also gas piping shown so close to ductwork making it difficult to identify as a separate system.
3. Obstructed duct label. Is it 12Ø or 22Ø?
4. Exhaust grille interferes with supply diffuser. Unclear as to what is intent.
5. Un-labeled grille.
6. No indication that EF-1 is on the roof, and exhaust trunk is not sized.



Why do we have conflict between engineers and contractors in the construction industry?

We have conflict between engineers and contractors in part because of poor communication.

AVOID THE CURSE OF KNOWLEDGE!

Story #2 – Engineer is forcing you to install something unnecessary. (Engineer's Perspective)

- This story outlines the problems that can arise from a lack of cognitive empathy.
- Engineers are expected to balance many competing considerations, like budgets, timelines, various codes and standards, good engineering practices, and professional ethics.
- It is important for contractors to understand the amount of effort, experience, and references that form an engineer's decision.
- Contractors assume a large amount of financial liability based on the bidspec process; however engineers assume a large legal, professional, and ethical liability for their designs.

Code & Standard References

- There are many, many different reference documents that go into a design.
- Some are clearly identified in the Ontario Building Code.
- Others are part of an ongoing learning process which is captured by the catch all phrase "good engineering practices" that is referenced in 6.2.1.1.

Code & Standard References

6.2.2. Ventilation

6.2.2.1. Required Ventilation

(1) Except as provided in Sentence (3), all *buildings* shall be ventilated in accordance with this Part.

(2) Except in *storage garages* and *repair garages* covered by Article 6.2.2.3., the rates at which outdoor air is supplied in *buildings* by ventilation systems shall be not less than the rates required by ANSI/ASHRAE 62.1, "Ventilation for Acceptable Indoor Air Quality".

(3) Self-contained mechanical ventilation systems that serve only one *dwelling unit* and that conform to the requirements of Subsection 9.32.3. shall be considered to satisfy the requirements of this Article.

(4) *Live/work units* shall be mechanically ventilated in accordance with the requirements of Sentence (1).

Section 6.2. Design and Installation

6.2.1. General

6.2.1.1. Good Engineering Practice

(1) Heating, ventilating and *air-conditioning* systems, including related mechanical refrigeration systems, shall be designed, constructed and installed to conform to good engineering practice appropriate to the circumstances such as described in,

(a) the ASHRAE Handbooks as follows:

(i) Fundamentals,

(ii) Refrigeration,

(iii) HVAC Applications,

(iv) HVAC Systems and Equipment, and

(v) ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings",

(b) the CAN/CSA-F280-M, "Determining the Required Capacity of Residential Space Heating and Cooling Appliances", and the outside winter design temperatures shall conform to MMAH Supplementary Standard SB-1, "Climatic and Seismic Data",

(c) the CAN/CSA-F326-M, "Residential Mechanical Ventilation Systems",

(d) the NFPA Fire Codes,

(e) the HRAI Digest,

(f) the Hydronics Institute Manuals,

(g) the SMACNA Manuals,

(h) the ACGIH, "Industrial Ventilation Manual",

(i) CAN/CSA-Z317.2, "Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities",

(j) the CCBFC NRCC 38730, "Model National Energy Code of Canada for Buildings",

(k) the CCBFC NRCC 54435, "National Energy Code of Canada for Buildings", and

- There are many, many different reference documents that go into a design.
- Some are clearly identified in the Ontario Building Code.
- Others are part of an ongoing learning process which is captured by the catch all phrase "good engineering practices" that is referenced in 6.2.1.1.

Understand what the drawings call for.

Understand what the drawings call for.

RETURN AIR PLENUM NOTE

THE DROP CEILING IS ACTING AS A RETURN AIR PLENUM. NO COMBUSTIBLE MATERIALS ARE PERMITTED TO BE IN THIS SPACE. ANY PLUMBING PIPE THAT IS ABS OR SYSTEM 15 SHALL TRANSITION TO EITHER XFR OR COPPER PIPING IN THIS CAVITY. ALL WIRING (THERMOSTAT INCLUDED) SHALL BE FT6 RATED. ANY PREVIOUSLY EXISTING COMBUSTIBLE MATERIALS SHALL BE REMOVED AND REPLACED BY NON-COMBUSTIBLE MATERIALS.

CONTOURS OF BUILDING.

9.4.2.2. WHERE CONTROL WIRE PASSES THROUGH AN AIR PLENUM (FALSE CEILING RETURN OR OTHERWISE), OR DUCTWORK, IT SHALL BE OF FT-6 RATING. NON FT-6 RATED CABLE MAY ONLY BE USED IF IT IS RUN IN A SEALED NON-COMBUSTIBLE CONDUIT.

Understand what the drawings call for.

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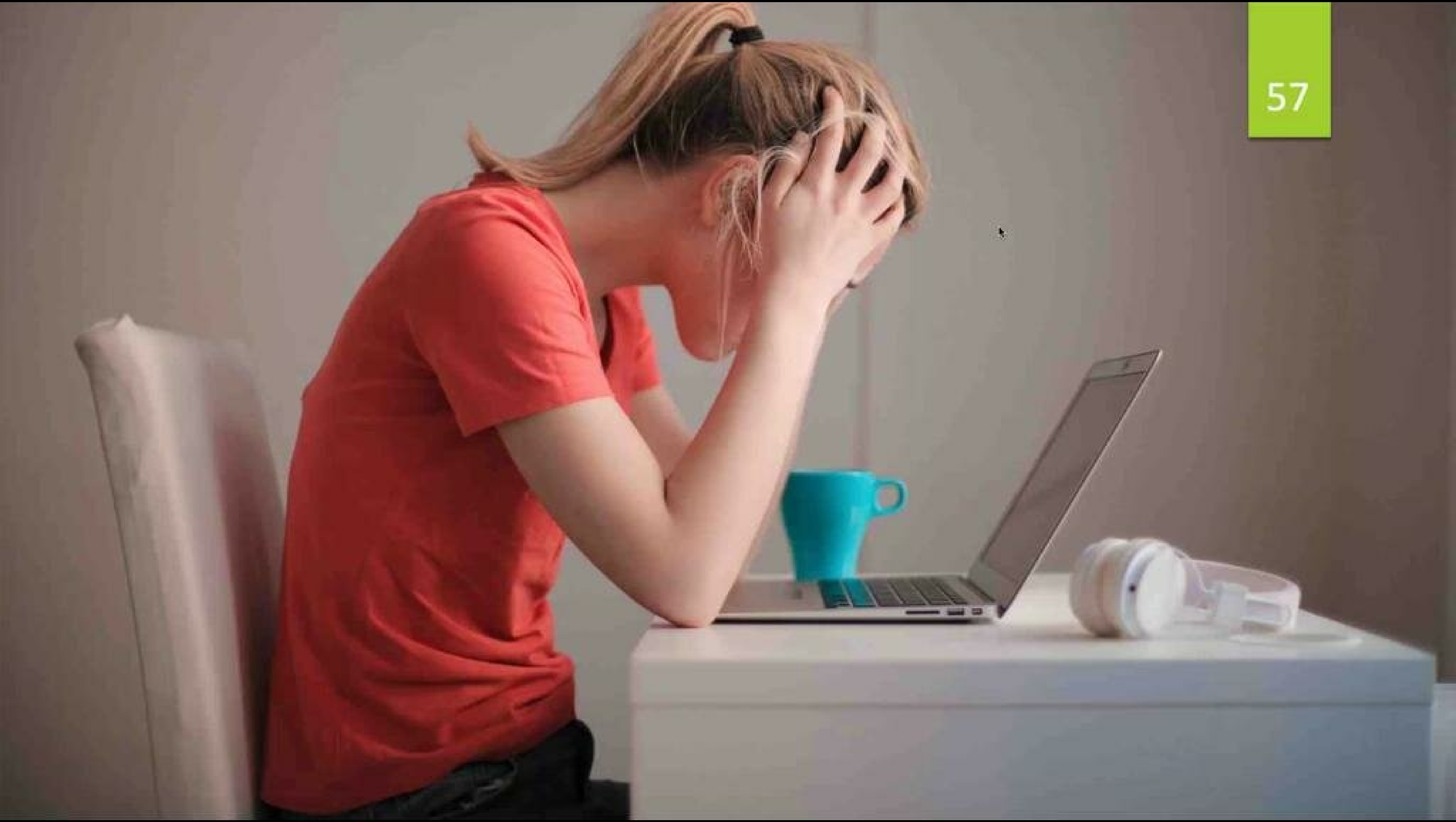
3.6.4.3. Plenum Requirements

(1) A concealed space used as a *plenum* within a floor assembly or within a roof assembly need not conform to Sentence 3.1.5.15.(1) and Article 6.2.3.2. provided,

(a) all materials within the concealed space have a *flame-spread rating* not more than 25 and a smoke developed classification not more than 50, except for,

(i) tubing for pneumatic controls,

(ii) optical fibre cables and electrical wires and cables that exhibit a flame spread not more than 1.5 m, a smoke density not more than 0.5 at peak optical density and a smoke density not more than 0.15 at average optical density when tested in conformance with the Flame and Smoke Test in the Appendix to CSA C22.2 No. 0.3, "Test Methods for Electrical Wires and Cables", (FT6 Rating),



Engineer's Obligations

- Engineers in Canada take a professional oath with a duty of care to society for the work for which they are responsible called the "Ritual Calling of an Engineer".
- There is a ceremony for Engineering graduates where they take the oath and are given an Iron Ring to be worn on their working pinky finger to remind them of their obligation.
- This ceremony was established in the 1920's in response to multiple bridge failures in Quebec City which resulted in deaths.
- These failures were directly attributed to faulty engineering, and it was recognized that Engineers needed to be held to a higher standard.

Professional Seal

5. Purpose of the Professional Engineer's Seal

For the public, the seal constitutes the distinctive mark of the professional engineer. It must be used to identify all work prepared by, or under the direct supervision of, a professional engineer as part of professional engineering services rendered to the public. It assures the document's recipient that the work meets the standards of professionalism expected of competent, experienced individuals who take personal responsibility for their judgments and decisions. The seal is important because it is a visible commitment to the standards of the profession and signifies to the public that a particular P.Eng. accepted professional responsibility for the document.

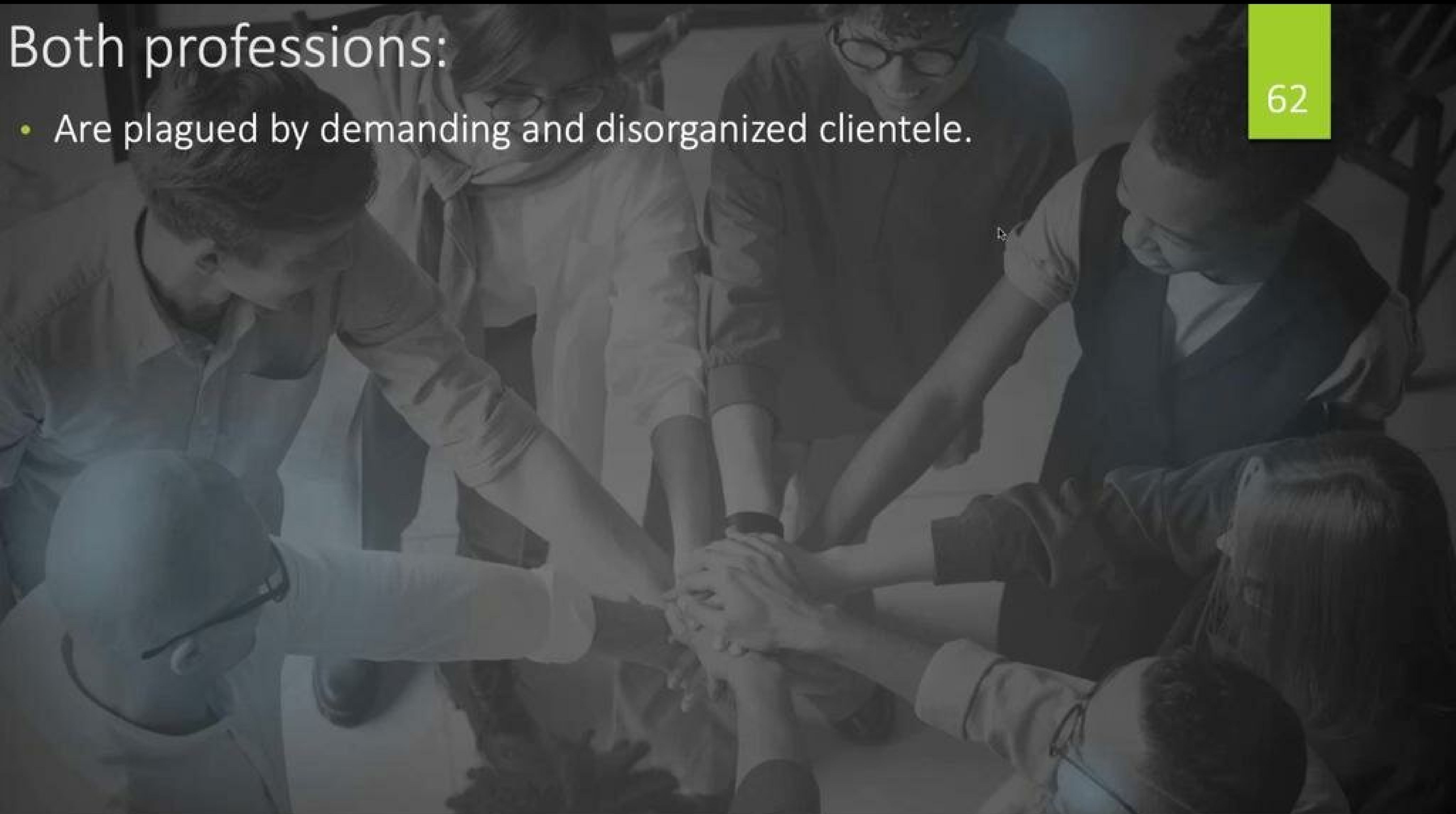
Affixing the seal to a document is a statement by a professional engineer to others that they can, with a high degree of confidence, depend upon the contents of the document for the furtherance of their projects. Since the outcome of a project depends on factors beyond the control of an engineer, however, a successful outcome cannot be guaranteed by an engineer. The seal is not, and should not be considered, a certification mark or warranty of correctness. According to the Supreme Court (*Edgeworth Construction Ltd. v. N. D. Lea & Associates Ltd.*), the "seal attests that a qualified engineer prepared the document. It is not a guarantee of accuracy". Instead, it should be considered a "mark of reliance", an indication that others can rely on the fact that the opinions, judgments, or designs in the sealed documents were provided by a professional engineer held to high standards of knowledge, skill and ethical conduct.

https://www.peo.on.ca/sites/default/files/2019-07/Use%20of%20Professional%20Engineer%27s%20Seal.pdf

Both professions:

Both professions:

- Are plagued by demanding and disorganized clientele.



Both professions:

- Are plagued by demanding and disorganized clientele.
    - Understand that the other party may be in the same boat you are with regards to the owner. Few of use are fortunate enough to choose our clients.
- Are greatly affected by circumstance of which they have no control.
    - Understand that the other party is likely just trying to do their best with the information that was available to them at the time, often at the fault of a third party.
- Are most likely acting in good faith.
    - Never assume malice. Beware of your own biases towards the other party.
- Need to do better and can do better.
    - Effort needs to be made by both parties to better understand the role of the other and try to behave accordingly. Try to improve your communication – AVOID THE CURSE OF KNOWLEDGE!

Why do we have conflict between engineers and contractors in the construction industry?

We have conflict between engineers and contractors because we fail to consider other people's perspectives, and we fail to communicate properly.

What can we do to make for a better work environment on a project?

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1. Never assume the worst of the other party. Apply the same presumption of good faith to the other party that you would hope to receive.

What can we do to make for a better work environment on a project?

1. Never assume the worst of the other party. Apply the same presumption of good faith to the other party that you would hope to receive.
2. Allow for a difference in perspective. Remember just how different the fields of the trades and engineering are. What each of you considers to be important or a priority is shaped by this perspective.
3. Respect the other persons expertise. Remember that each of you have put in a lot of time and work to be experts in your own field. Don't assume incompetence. Assume a difference in perspective.
4. Do not underestimate the difficulty of good communication. Remember that much of how we communicate is highly nuanced, and that is before you introduce the difficulties caused by a lack of common language and cultural experience.
5. Give careful consideration as to what, why, and how you are trying to communicate. Remember that the person on the receiving end does not know what you know. <u>Avoid the curse of knowledge!</u> Try getting a completely impartial observer to try to interpret your meaning. Revise accordingly!

QUESTIONS?