First – Do No Harm

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Hippocratic Oath

• First, do no harm.
• Not second or third – but FIRST!!
• Doesn’t seem like Hippocrates had much confidence in the doctors of his day.
• Can we learn something?
Where did the problem start?

- Started with Qin Shi Huang, first emperor of China, in 220 BCE
- He asked his favorite engineer Ying Zheng to design a small wall around his garden to keep out rabbits
- Zheng wanted to impress his emperor so...
He also built a ditch around the royal palace to prevent flooding
Why do we over-design and over-build?

Are we good engineers...
Are we lazy...
Do we want to impress the “emperor”? 
Americans like WINNERS!!
Won’t deal with Second National Bank or America’s Second Best Eyeglasses
We Want the BIGGEST and BEST

First National Bank

America's Best Value Inn
Would you shop at the SECOND BEST BUY?
Or stay at the *Second Best Western*?
Not only BEST... but BEST PLUS!!
Water Industry

• Are we in the water industry sometimes guilty of “doing harm” when we are trying to “do good”? 
• Possibly...
Example – Sizing a Water Main

\[
\int e^{-(p+x)y} \frac{\sin (a \sqrt{x})}{\pi (p+x)} dx = -\sinh (a \sqrt{P}) \\
+ \frac{e^{-a \sqrt{P}}}{2} \text{erf} \left( \frac{a}{2 \sqrt{P}} - \sqrt{P} \right) + \frac{e^{a \sqrt{P}}}{2} \text{erf} \left( \frac{a}{2 \sqrt{P}} + \sqrt{P} \right) \\
\int \frac{\sqrt{x} e^{-(p+x)y}}{\pi (p+x)} \cos (a \sqrt{x}) dx = \frac{e^{-p_1^2 + x^2}}{\sqrt{\pi y}} + \\
\sqrt{P} \left[ -\cosh (a \sqrt{P}) - \frac{e^{-a \sqrt{P}}}{2} \text{erf} \left( \frac{a}{2 \sqrt{P}} - \sqrt{P} \right) + \frac{e^{a \sqrt{P}}}{2} \text{erf} \left( \frac{a}{2 \sqrt{P}} + \sqrt{P} \right) \right]
\]

• My schooling was not wasted.
• Eureka! I have calculated the perfect pipe size!
This is the pipe size we need
But, the future is uncertain. Better to err on side of caution.
Then we need to choose a standard size. Can’t go smaller, so...
Can’t forget safety factors, so bump it up a bit...
Did you know that it costs only pennies more to install a larger pipe?
What we need; what we build
Yep. Better to err on the side of caution...right?

• Sure, but engineers/designers are supposed to be able to minimize the “err”

• Why are we SOOO afraid to under-size but not concerned about over-sizing?

• Wrong-sizing (including both under- and over-sizing) is bad, or at least lazy, engineering
Water systems vs. Highway systems

• We design water systems to meet peak demand that may only occur one day every few years
  – Turn on the tap – water always flows
• Highways are designed to meet high traffic flows – but not peak flows
  – This is why rush hour occurs twice each day when traffic slows
  – But everyone gets to work or home eventually
What if Water Engineers Designed the Apollo 11 Lunar Lander...

The rocket would never have left the ground.
What was Needed...
Safety & Functionality
Over-building ≠ Good Engineering

• Hunter’s Curves – can provide results that are 200% of actual flows (1940)
• Fire flows often dictate pipe size but new pumper trucks are powerful and can “suck” water from hydrant
• Increasing water service sizes because there are more fixtures in new homes – even though each fixture uses less water
• Drain sizes – fixtures use less water
• Drain slopes – increase slopes?
Over-building

- Water distribution piping – over-sizing leads to water quality issues, excess flushing, waste
- Pumping stations / treatment plants – often designed to meet demands with largest pump out of commission
- Large city in Alberta takes water from 2 different rivers, has 2 WTPs AND wants each plant to have capacity to supply entire system!
Excesses

- High pressures (more leaks, higher energy demands)
- 100% potable in many cases (less than 10% consumed)
- Potable water used for irrigation
- Need to keep prices low for low-income customers (many of which have cell phones, high-speed internet, and drink bottled water)
“Price is Right” Example

• In 2007 a contestant made it to the final showcase
• He was either totally confused or not very familiar with the cost of things (but then how did he make it to the final showcase?)
He originally bid $250,000!!
Bob Barker asked him to “think about that for a moment” – so he changed his bid to $60,000
The idea is to get close to the actual price without going over

- Everyone in the studio (except the contestant) knew that the $60,000 bid was WAYYYYY too high.
- The other contestant knew too.
- But they had to ensure that their bid (on a different set of prizes) was also not too high.
- If their bid was very close to the right price and not over, they would win all of the prizes.
Human nature being what it is – what do you think she bid?
She bid $1
$1

• She could have bid $100 or $1,000 or even $10,000 and still been under the true cost, and had a better chance of winning both showcases

• But – because there was no compelling reason to take ANY TYPE of risk...

• She played the “safety factor” card as hard as she could and bid $1

• Needless to say – she won only her showcase
Back to engineers and designers

• Just because it is not your money...
• Just because the project may not personally affect you...
• Please design water systems as though IT IS your money and as though the outcome DOES AFFECT YOU
• Be cautious but don’t be lazy
Nation’s Infrastructure is Aging

Golden Opportunity to build it right!
Remember

• ANDSNNTBB
First, Do No Harm

Always Never Don’t Not Stop Trying To Be Better

Thank you

Questions?

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