ENGR/PHL 482
Engineering & Ethics

William LeMessurier and the CitiCorp Center
A case study in engineering and ethics.

Background
- William LeMessurier was the structural engineer in responsible charge of the 1977 CitiCorp building.
- Site constraint--historic St. Peter's Lutheran Church obstructed part of the site.
- Innovative design solution used "air rights" above the church, built a new church.
- Required unusual first floor column layout.

Citicorp Center Statistics
- Located in New York City.
- 59 stories, 915 ft, steel skeleton.
- Engineer: William LeMessurier and Assoc.
- First tall building to include a tuned-mass damper to improve serviceability under wind loading.
- Completed 1977 at a cost of $175 million.

LeMessurier's innovative column layout

Citicorp building site challenge...

Conventional column layout
Innovative column layout

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Design of the structure

To employ the innovative column layout, LeMessurier developed a series of diagonal braces to transfer the upper floor loads to the four columns.

Design of the steel structure

Then he performed an otherwise conventional structural analysis. To analyze wind loads, he adopted the usual simplifying assumption that the critical wind direction was perpendicular to the widest side of the building.

Design of the steel structure, cont’d...

An innovative tuned mass damper system was designed to reduce building sway in design winds.

Completion, 1977

The Citicorp Center building was completed in 1977.

In 1978, LeMessurier got a telephone call from an engineering student...

A new, and serious question is raised...

Stimulated by the student’s question, LeMessurier initiated additional analyses which led him to discover that, because of the unusual column layout, the critical wind direction was not what he had assumed, but rather, a direction diagonal to the building.

Analysis for diagonal winds...

His calculations indicated that there would be more wind load in the diagonal members than he had anticipated, so he reviewed their design.
Review of structural capacities...

- LeMessurier had previously learned that a change order during construction had resulted in the substitution of (weaker) bolted connections in the diagonal members rather than the called-for welded connections.
- At the time, the bolted connections appeared to have adequate capacity, so his staff approved the change order.

His disturbing conclusions:

- The structural analysis error (incorrect critical wind direction assumption) coupled with the weaker bolted connections in the diagonal members meant that the diagonal members were overloaded by a design wind from a quartering direction.
- Basically, the Citicorp Center building could collapse in a moderate hurricane.

So.....

- You have just learned that your prize project could, with reasonable likelihood, collapse with casualties in the thousands and losses in the billions.
- What do you do?

What did LeMessurier do?

- Advised his architect client’s lawyer and client’s insurance company
- Advised Citicorp, the building owner
- Advised the city authorities
- Installed back-up generators for the tuned mass dampers
- Retained a team of meteorological experts to determine the risk of damaging windstorms

What did LeMessurier do, cont’d?

- Initiated a repair plan whereby the bolted diagonal splices would be reinforced with welded plates to increase their capacity
- Developed an emergency evacuation plan for the area within a 5-block radius of the structure, involving 2000 Red Cross volunteer workers

What did LeMessurier do, cont’d?

- Created a cover story to provide for the press, to explain the night-time welding operations in progress as an upgrade to reflect a recent change in the NYC building codes.