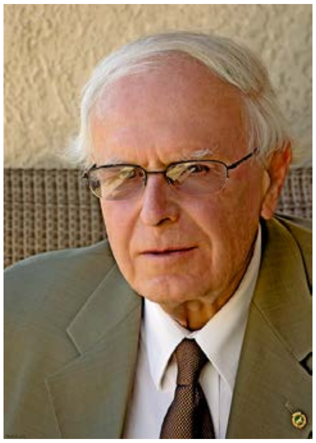

Zdeněk P. Bažant's Prepared Acceptance Speech upon Conferral of the ASCE Alfred M. Freudenthal Medal at ASCE-EMI Conference at MIT on May 31, 2018

(*presented in an abbreviated form***)**

(623 words, 110 words/min)

President Deodatis, Ladies and Gentlemen:

It is an exalting, thrilling moment for me to join the ranks of the famous previous recipients of this medal. I wish to express my gratitude to the EMI, to my university, to my sponsors, to my wife Iva, and to my students. Without their help, I would not be standing here today.

I have actually two reasons to cherish this medal.

1) Freudenthal's life story is echoed in mine. Like me, he got both his engineering and doctoral degrees in Prague. Like me, he started his career by designing bridges in Prague. Like me, he fled an oppressive regime, although in his case it was a life-saving move, to Palestine. Like me, he immigrated to America on a Czechoslovak passport. And, like me, he apparently had not touched probability until he reached 40.

2) Freudenthal's work epitomizes my favored dictum — that probabilistic mechanics of strength cannot ignore mechanics of the material failure process. Indeed, about half of Freudenthal's numerous seminal papers deal with mechanics – residual stresses in fatigue, effect of material flaws on strength, strength of airframes, work-hardening laws for metals, viscoplasticity, plastic shells, shrinkage stresses, consolidating media, shear dilatancy in rock, seismic waves, orthotropic sandwich plates and shells, relaxation spectra, etc. Besides, he wrote great books on solid mechanics and on viscoelasticity.

At the same time, he became the father of structural safety. His works dealt with the statistics of microscopic flaws, statistics of cumulative fatigue damage, integration of joint material and load randomness (now called the Freudenthal integral), random lifetime, random failure of structures with multiple load paths, reliability of nuclear reactor components, reliability of aircraft and of offshore platforms in seismic regions, extreme-value risk assessment, safety of prestressed concrete, structural optimization, risk control, etc.

Freudenthal obviously perceived the fields of:

1) structural safety, and

2) mechanics and physics of materials and structures, as inseparable. He mastered both, and tackled both at the front of research of his time.

After him, unfortunately-- a *schism*. On one side, there have been outstanding probabilists who developed and successfully marketed sophisticated computer programs to assess the safety, reliability and lifetime of concrete structures without noting that their failure probability cannot be predicted with simplistic material models that eschew fracture mechanics and size effect. Or there have been experimenters who conducted extensive histogram testing of strength of tough ceramics and fiber composites but did not realize that testing the size effect would have invalidated their conclusions.

On the other side, there have been mechanicians who constructed sophisticated constitutive and computational models for the failure of concrete, geomaterials, composites, etc., without recognizing that, aside from load randomness, big prediction errors stem from their assumed probability distribution conflicting with the material failure process. We have stochastic finite element codes, but they deliver hardly more than the standard deviation. They tell us nothing about extrapolation to the probability tail.

Yet the tail where the devil is. It is agreed that bridges, aircraft, microelectronics, etc., must be designed for the failure probability of less than one in a million. But extrapolation to the tail of such a small probability is a major challenge, which cannot be overcome without modeling the mechanics of material failure. The distances from the mean to the tail of the Gaussian and Weibull distributions differ enormously, by about 2:1.

For quasibrittle materials such as concrete, composites, toughened ceramics, the distance to the tail can be anywhere in between. This is especially important for developing new architected materials. A new material with a superior mean strength can be way inferior at the tail. Material scientists and NSF—please take note.

Hopefully, the choice of this year's Freudenthal medal would signal the end of the probability-mechanics schism.

Thank you for listening!