

# Monday, January 23<sup>rd</sup>

## ARFTG Awards Dinner

7:30 pm

The Story of the Telegraph and Transmission Line Engineering

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9:00 pm

Ed Godshalk (George Fox University)

### Award Dinner Talk

Transmission lines, often referred to as Interconnects, are a major component in integrated circuits, printed circuit boards, and communications systems. This talk traces the formative years of electrical engineering and the evolution of transmission line design and theory that enabled a global communications network over 100 years ago. The lessons learned are still relevant today and enabled the modern circuit simulator.

The story begins with the invention of the “Victorian internet”, the telegraph, generally regarded as the first practical use of electronics. This is followed by transatlantic telegraph cable, which some historians equate as the 19<sup>th</sup> century equivalent of landing a man on the moon. These systems were a catalyst for improved battery design, insulated wire, coaxial cable and using the earth as a conductor. The transatlantic cable gave engineers a rude introduction to the concept of the RC time constant, which had a detrimental effect on data rate. To examine this problem in detail, a physical multi-section lumped element model was constructed by the author to investigate the performance of the first transatlantic cable, and how the slow data rate was mitigated in later designs. Many great minds of the 19<sup>th</sup> century worked to understand and solve the telegraph data rate problem, resulting in the Telegrapher’s equations that were later used to make long distance telephone service a reality. These equations are still used today in many circuit simulators to model transmission line properties. A goal of this talk is to remind us of origin of electrical engineering and appreciate some of the important discoveries that were made along the way.



**Ed Godshalk** has been an Electrical Engineer for over 40 years, including several startups, his own company, Tektronix and Maxim Integrated. While at Cascade Microtech (1989-94) he invented the world’s first waveguide input wafer probe and the Air Coplanar Probe (ACP). During his 22 years at Maxim, from which he retired in 2019, he created the Electromagnetics Group, which made many notable contributions to the semiconductor industry. He has over a dozen issued patents and numerous articles.

In 2020 he was elevated to the grade of Fellow by the Institute of Electrical and Electronic Engineers (IEEE) “For the development of microwave on-wafer probing and measurement techniques” which helped to enable the development of microwave integrated circuits (ICs).



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Ed is now the Engineer in Residence at George Fox University, and finds great pleasure in teaching the next generation of microwave engineers. He emphasizes the history and origin of technical ideas to help students innovate and have a deeper understanding of engineering.

In his younger days he was a climbing guide, and in 1993 he organized an expedition that successfully climbed Denali, in Alaska, the tallest peak in North America. In his retirement he restores vintage sports cars, enjoys backcountry skiing and being in the mountains.

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