



## “How GPS Changes Everything”

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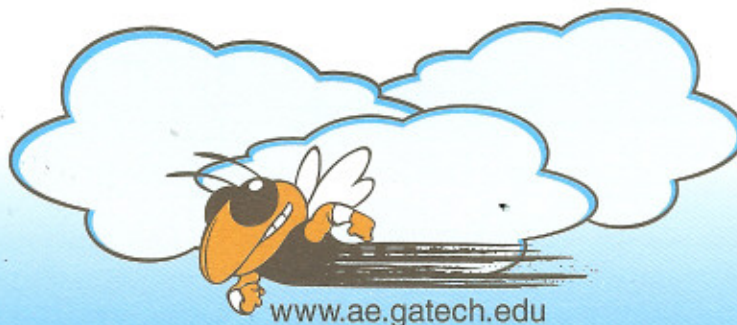
**Abstract:**

The Global Positioning System (GPS), fully operational since 1995, has revolutionized navigation and positioning in myriad ways that benefit individuals and society. GPS receivers regularly guide airplanes, taxi drivers, tractors, and satellites. GPS timing synchronizes power grids, telecommunications networks, and bank transactions. GPS instruments measure minute changes in the Earth's crust, variations in its gravity field, and activity in its atmosphere. Even sensing of ocean surface winds, soil moisture, snow depth, and vegetation can now be performed with GPS technology.

How is it that a system originally intended to support worldwide military operations, has had such broad-reaching benefits? This presentation will describe the key technological elements and serendipitous parallel developments that contribute to the unprecedented impact of GPS. Specifically, I will discuss the stability of the orbiting atomic clocks, the use of spread spectrum codes, the transmission and reflection properties of the GPS carrier signals, and the fact that the open GPS interface has resulted in an enormous world-wide user base actively involved in sharing data and improving orbit and clock estimates. I will also explore where things are headed in terms of the risks to continued GPS utility, and the future opportunities offered by Global Navigation Satellite System modernization internationally.

**Bio:**

Penina Axelrad has been a faculty member in the Department of Aerospace Engineering Sciences (AES) and the Colorado Center for Astrodynamics Research (CCAR) at the University of Colorado Boulder since 1992. Her research interests include technology and algorithms for GPS-based orbit and attitude determination for spacecraft in LEO and HEO, multipath characterization and correction for spacecraft, aircraft, and ground reference stations, and remote sensing using GPS based bistatic radar and occultation measurements. Dr. Axelrad has published 47 technical papers, 90 conference papers, and served as PI or Co-I on 50 research grants and contracts totaling over \$6M. She is an active member of the Institute of Navigation (ION), having served in numerous positions including President of the institute and associate editor of *Navigation*. She is a Fellow of the ION and the American Institute of Aeronautics and Astronautics (AIAA), a senior member of IEEE, and a member of Sigma Xi. Dr. Axelrad has been honored with several awards for her contributions to the GPS field, including the 1996 Lawrence Sperry Award from the AIAA and the 2009 Johannes Kepler Award from the ION.



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