



Frontiers in Antennas: Next Generation Design & Engineering

By Frank Gross

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The state of the art in antenna design and engineering Edited by one of the world's foremost authorities on smart antennas and featuring contributions from global experts, *Frontiers in Antennas* discusses the latest advances in antenna design and engineering. This pioneering guide deals primarily with frontier antenna designs and frontier numerical methods. Many of the concepts presented have emerged within the last few years and are still in a rapid state of development. Each chapter provides in-depth details on a unique and modern antenna technology. *Frontiers in Antennas* covers: Ultra-wideband antenna arrays using fractal, polyfractal, and aperiodic geometries Smart antennas using evolutionary signal processing methods The latest developments in Vivaldi antenna arrays Effective media models applied to artificial magnetic conductors and high impedance surfaces Novel developments in metamaterial antennas Biological antenna design methods using genetic algorithms Contact and parasitic methods applied to reconfigurable antennas Antennas in medicine: ingestible capsule antennas using conformal meandered methods Leaky-wave antennas Plasma antennas which can electronically appear and disappear Numerical methods in antenna modeling using time, frequency, and conformal domain decomposition methods

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Editorial Review

From the Author

Having been involved in antennas for nearly 30 years I have seen many developments in antenna design and performance. Occasionally innovative antennas emerge but often new antennas are simply variations on tried and true antennas such as loops, dipoles, traveling wave, patches, spirals, bowties, reflectors, and horns. The excellent classic textbooks still continue to serve as a guide for many modern antenna designs. Also, many of the new antenna books faithfully repeat material from the classic books with an occasional parenthetical mention of new innovations. Many modern commercial-off-the-shelf (COTS) antennas are based upon classic antenna concepts which trace their roots all the way back to the days of Heinrich Hertz, Alexander Popov, and Guglielmo Marconi in the late 1800s. These very first antenna innovators were obviously at the "frontier" of development in their day. In retrospect, it is amazing to see how these scientists conceived their clever antennas without the benefit of prior examples. Thus, it is no surprise that antennas in common use today, such as dipoles, loops, and reflectors, still owe their legacy to concepts dating back 100's of years. However, we should also open our minds to innovative and new approaches which may not have their roots in Hertzian, Popovian, or Marconian thinking.

I often hear customers complain that antennas are either too big, too narrow band, or have too little gain. The incessant call and demand is for small form factor antennas with extreme bandwidth and gain. In an attempt to satisfy this demand often the modern antenna designer returns to the tried and true antennas of the past and tries to squeeze out a few more dB here and a few more Hertz there. There is something to be said for thinking outside of the "antenna box". I am reminded of a quote by Claude Bernard that says:

"It is what we think we know already that often prevents us from learning"

Sometimes in order to become innovative in antenna design, we must let go of the concepts and recipes we already know in order to make room for new perspectives. While showing appreciation and respect for traditional designs, we need to loosen our tether to the past in order to have fresh insights.

That being said, there has been an emergence of modern innovations which have forged new ground. These modern designs are truly at the frontier of antennas and, with some effort, can be found in recent journal articles or interspersed with traditional antennas in some modern antenna textbooks. Rather than forcing the antenna engineer to forage for the latest innovations it seemed imperative to provide a new and unique book that exclusively highlights modern innovations. Therefore, I humbly present to you the "**Frontiers in Antennas**" reference book. This text deals primarily with frontier antenna designs and frontier numerical methods under current development. Many of the concepts presented have emerged within the last few years and are still in a rapid state of development.

Within these pages, the reader will enjoy learning the progress made on *Ultra-Wideband Antenna Arrays* using fractal, polyfractal, and aperiodic geometries, *Smart Antennas* using evolutionary signal processing methods, the latest developments in *Vivaldi Antenna Arrays*, effective media models applied to *Artificial Magnetic Conductors and High Impedance Surfaces*, novel developments in *Metamaterial Antennas*, *Biological Antenna Design Methods* using genetic algorithms, contact and parasitic methods applied to *Reconfigurable Antennas*, *Antennas in Medicine: Ingestible Capsule Antennas* using conformal meandered antennas, enhanced efficiency *Leaky Wave Antennas*, *Plasma Antennas* which can electrically appear and disappear, and lastly *Numerical Methods in Antenna Modeling* using time, frequency, and conformal domain decomposition methods.

It goes without saying that the quality and depth of this book owes itself completely to the thirty skilled contributors who are established and recognized experts in their respective antenna disciplines. I am grateful that these experts have agreed to participate in this project and have delivered such lucid and spectacular chapters. I am also extremely grateful to Wendy Rinaldi (Editorial Director) and to Joya Anthony (Editorial Coordinator) who have both been completely supportive and excited about this project from the beginning and who have been patient in allowing time for the contributors to produce their best work. A special thank you is extended to Robert Kellogg and Argon ST for being flexible with my schedule in support of this project.

Finally, I would like to thank my beautiful and supportive wife Jane who never fails to love and believe in me in spite of my many distracting projects.

Frank B. Gross
Technical Fellow
Boeing
Fairfax, VA U.S.A.
27 June 2010

From the Back Cover

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Frontiers in Antennas covers:

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- Smart antennas using evolutionary signal processing methods
- The latest developments in Vivaldi antenna arrays
- Effective media models applied to artificial magnetic conductors and high impedance surfaces
- Novel developments in metamaterial antennas
- Biological antenna design methods using genetic algorithms
- Contact and parasitic methods applied to reconfigurable antennas
- Antennas in medicine: ingestible capsule antennas using conformal meandered methods
- Metamaterial leaky-wave antennas
- Plasma antennas which can electrically appear and disappear
- Numerical methods in antenna modeling using time, frequency, and conformal domain decomposition methods

About the Author

Frank B. Gross is a Technical Fellow at Boeing currently working in the areas of smart antennas, antenna design, direction finding, metamaterials, and propagation. He obtained his Ph.D. from The Ohio State University in 1982. Subsequently he became a professor at The Florida State University teaching and performing research in the areas of electromagnetics, antennas, electrostatics, smart antennas, and radar. He received the Tau Beta Pi "Best Teacher of the Year Award" and the University Teaching Incentive (TIP) award. After serving eighteen years as a professor, Dr. Gross departed academia and entered into industry. He formerly has worked as a Senior Research Engineer at The Georgia Tech Research Institute (GTRI), a Lead Engineer at The MITRE Corporation, and a Chief Scientist at SAIC.

Dr. Gross has written a chapter on *Bessel Functions* in *The Encyclopedia of Electrical and Electronics Engineering* (Wiley, 1998), a book on *Smart Antennas for Wireless Communications with MATLAB* (McGraw-Hill, 2005), and a chapter on *Smart Antennas in the Antenna Engineering Handbook* (McGraw-Hill, 2007). He has published numerous journal and conference articles on the topics of radar waveform design, radar scattering and imaging, frequency selective surfaces (FSS), Martian electrostatics, Bessel function approximations, and smart antennas.

Users Review

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