NSERC/MPR Teltech Industrial Research Chair
In Radio Frequency Engineering

ACTIVITY REPORT*

Report No. 5 *April 1, 1996 to March 31, 1997*

MESSAGE FROM THE CHAIRHOLDER

This annual report covers the fifth year of the Chair's research activities, from April 1, 1996 to March 31, 1997. This was the last year of the first five-year term of the Chair. Unfortunately, it was also the last year of existence of our industrial partner, MPR Teltech. With the dissolution of this company, British Columbia has lost a major center of activities in telecommunications technology.

I would like to take this opportunity to thank Dr. Alan Winter, former President and CEO of MPR Teltech, for his encouragement and generous support of our research activities. Thanks are also due to Dr. Josef Fikart, head of MPR's Microwave Department, for finding time in his busy schedule to interact with the Chair's team. At the University of Victoria, Dr. James W. Provan, Dean of Engineering, and Dr. Alex McAuley, Associate Vice-President Research, have provided invaluable support to the Chair, as have the Departmental Heads, Dr. Stan Stuchly and Panajotis Agathoklis. Mr. Rick Warner, Director of Programs at SCBC, and Mr. Brent Sauder, President of ASI as well as their highly competent staff have provided vital financial and operational support throughout these past five years. I am deeply indebted to them.

During the entire five year term the principal research objectives remained focused on electromagnetic field modeling and simulation with emphasis on applications to information technology. Of particular significance is our newly developed ability to model entire integrated circuits together with the effects of their packages. At the same time our research effort in time domain modeling of rf/vacuum wood drying and electromagnetic sensing of soil moisture content has grown substantially. These activities are of particular interest to BC companies. The obvious success of our TLM modeling has resulted in substantial new research support from both industry and governments.

Poman So and Leo de Menezes have successfully defended their Ph.D. theses this year. A major new initiative was the incorporation of a spin-off company, *Faustus Scientific Corporation*, on September 25, 1996. It was the final logical step in the fulfillment of our mission

Wolfgang J.R. Hoefer
Victoria, June 1997

*This report can be accessed on the Chair's World-Wide Web Server "http://www-wjrh.ece.uvic.ca".

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THE RESEARCH GROUP

Chairholder and Research Director

Wolfgang J.R. Hoefer received the Dipl.-Ing. degree in Electrical Engineering from the Technische Hochschule Aachen, Germany, in 1965, and the D. Ing. degree from the University of Grenoble, France, in 1968.

During the academic year 1968/69 he was a Lecturer at the Institut Universitaire de Technologie de Grenoble and a Research Fellow at the Institut National Polytechnique de Grenoble, France. In 1969 he joined the Department of Electrical Engineering, the University of Ottawa, Canada where he was a Professor until March 1992. Since April 1992 he holds the NSERC/MPR Teltech Industrial Research Chair in RF Engineering in the Department of Electrical and Computer Engineering, the University of Victoria, Canada.

During sabbatical leaves he spent six months with the Space Division of AEG-Telefunken in Backnang, Germany (now ATN), and six months with the Electromagnetics Laboratory of the Institut National Polytechnique de Grenoble, France, in 1976/77. During 1984/85 he has been a visiting scientist at the Space Electronics Directorate of the Communications Research Centre in Ottawa, Canada. He spent a third sabbatical year in 1990/91 as a visiting professor at the University of Rome "Tor Vergata" in Italy, the University of Nice - Sophia Antipolis in France, and the Technical University of Munich in Germany.

His research interests include numerical techniques for modeling electromagnetic fields and waves, computer aided design of microwave and millimeter wave circuits, microwave measurement techniques, and engineering education. He serves regularly on the Technical Program Committees of IEEE-MTT and AP Symposia, is the co-chairman of the MTT Technical Committee on Field Theory, and the co-founder and managing editor of the International Journal of Numerical Modelling. He serves on the editorial boards of the IEEE-MTT Transactions, Proceedings of the IEE, the International Journal of Microwave and Millimeter-Wave Computer Aided Engineering, the Journal of Electromagnetics, and the Microwave and Optical Technology Letters. He was an "Invited Lansdowne Lecturer" of the University of Victoria, B.C., in. 1989, and was awarded the "Peter B. Johns Prize" for the best paper published in the International Journal of Numerical Modelling in 1990. He was elected Fellow of the IEEE for "contributions to the modeling and design of passive microwave and millimeter-wave circuits" in 1991. He is President and CEO of Faustus Scientific Corporation.

Research Engineers

Mario Righi was born in Perugia, Italy, in 1965. He received the degree (summa cum laude) in electronics engineering from the University of Ancona, Ancona, Italy, in 1991. In June 1993 he was awarded the IEEE Graduate Student Fellowship Award from the MTT Society. He successfully defended his Ph.D. thesis in December 1995, and received an NSERC Postdoctoral Fellowship in Electrical Engineering, at the University of Victoria, Victoria B.C., Canada. Since Jan. 1997 he is a Research Engineer in the Computational Electromagnetics Research Laboratory at the University of Victoria and, effective July 1, 1997, will be Adjunct Assistant

Professor in the ECE Department. He is also Head of Corporate Research and Development of Faustus Scientific Corporation. His work is mainly in the area of analytical and numerical modeling of electromagnetic fields and waves.

Poman P.M. So received the B.Sc. degree in computer science and physics from the University of Toronto, Toronto, Ontario, Canada, in 1985. He obtained the B.A.Sc. (summa cum laude) and M.A.Sc. degrees in electrical engineering (summa cum laude) from the University of Ottawa, Ottawa, Ontario, Canada, in 1987 and 1989 respectively. In 1996 he received the Ph.D. degree in Electrical and Computer Engineering from the University of Victoria. He is also the author of several 2D-TLM and 3D-TLM simulators.

In April 1997 he joined SPAR Aerospace at Ste-Anne-de-Bellevue, Quebec, as a Senior Staff Engineer

Channabasappa Eswarappa received the B.E. degree in electronics and communication from Mysore University, India, in 1980, and the M. Tech degree in electrical engineering from the Indian Institute of Technology, Kanpur, in 1982. He worked as an Assistant Executive Engineer, and later as an Executive Engineer in the Transmission Research Development Laboratory, Indian Telephone Industries, Bangalore, India. He was mainly engaged in the design and development of microwave circuits and the characterization of microstrip discontinuities. Since 1986 he has been engaged in research on numerical techniques for solving electromagnetic problems. He received the Ph.D. degree in electrical engineering from the University of Ottawa, Ottawa, Ontario, Canada, in 1990.

In June 1992, Dr. Eswarappa joined the research team of the NSERC/MPR Teltech Industrial Research Chair in RF Engineering as a Research Engineer. Since January 1997 he is Principal Design Engineer at MACOM, Lowell, MA, USA.

Postdoctoral Fellow

Jonathan L. Herring was born in Middlesbrough, England, in 1966. He received the M.Eng. degree in Electrical & Electronic Engineering from the University of Nottingham, UK in 1989 and received the Ph.D degree from the same university in 1993. From July 1989 to October 1993 he was employed as a Research Assistant at the University of Nottingham, where he worked on the modelling of EMC problems using the transmission-line matrix (TLM) technique. In November 1993 he joined the Research Chair as a Post-Doctoral Fellow and has pursued research on development of the TLM method. He is a member of the IEEE and an associate member of the Institution of Electrical Engineers (IEE). In January 1997 he joined Schlumberger GeoQuest in Abingdon, UK, as a software engineer.

Graduate Students

Leonardo R.A.X de Menezes was born in Brasilia, Brazil, in 1966. He received his B.S. degree in 1990 and his M.Sc. degree in 1993, both from the University of Brasilia (UnB). He is the recipient of a scholarship of the Government of Brazil. He has been working on TLM modelling of general media, with emphasis in frequency-dependent and nonlinear dielectric material. His interests include numerical modelling in electromagnetics, guided-wave structures and antennas. After receiving his Ph.D. from the University of Victoria in Sept. 1996 he returned to Brazil to accept a position as Assistant Professor at the University of Brasilia.

Qi Zhang was born in Xiamen, Fujian, China, in 1957. She received the B.S. degree in Physics from Xiamen University, Xiamen, China in 1982 and the M.S. degree in electrical engineering from the University of Regina, Regina, Canada, in 1992. From 1982 to 1985, she was an Assistant Engineer, and from 1986 to 1989 an Electrical Engineer in Nanjing Electronics Devices Institute, Nanjing, China, where she was involved in III-V semiconductor material research and microwave semiconductor devices measurement techniques. Since September 1992, she has been working as a Teaching Assistant and was a full-time graduate student in the Department of Electrical & Computer Engineering, at the University of Victoria, Victoria, B.C., Canada. She successfully defended her Ph.D. thesis in April 1996. She is presently a Staff Engineer at Nortel in Ottawa, Ontario.

Lucia Cascio was born in Fano, Italy, in 1967. She received the degree (summa cum laude) in electronic engineering from the University of Ancona, Ancona, Italy, in 1993. In 1993 she was awarded a scholarship from the Italian National Research Council for a research program in electro-optic technologies. In June 1997 he was awarded the IEEE Graduate Student Fellowship Award from the MTT Society. Currently she is a full-time research assistant, and graduate student, working toward her Ph.D. in the Department of Electrical and Computer Engineering, at the University of Victoria, Victoria, B.C., Canada. Her work is mainly in the area of analytical and numerical modelling of microwave circuits.

Giampaolo Tardioli was born in Foligno, Italy, in 1967. He received the degree (summa cum laude) in electronic engineering from the University of

Ancona, Ancona, Italy, in 1993. Currently he is a full-time research assistant, and graduate student, working toward his Ph.D. in Department of Electrical and Computer Engineering, at the University of Victoria, Victoria, B.C., Canada. His work is mainly in the area of analytical and numerical modelling of microwave circuits.

Masafumi Fujii was born in Osaka, Japan, in 1966. He received the B.S. and M.S. degrees in electrical engineering from Kobe University, Kobe, Japan in 1989 and 1991, respectively. In 1991 he joined Sumitomo Metal Industries (SMI), Ltd., Japan, where he conducted research on numerical modeling of microwave and high-speed digital components using electromagnetic field analysis. Currently he is a Ph.D student in the Electrical andComputer Engineering, at the University of Victoria, Victoria, B.C., Canada, with financial support of SMI. His research interest is in the area of numerical modeling of active and passive components for high-frequency circuits.

Jean-Michel Amen , a graduate from the University of Rennes, France, spent four months (from March 1st to June 30, 1997) as a Research Trainee in the Computational Electromagnetics Research Laboratory, completing a research project on the formulation and implementation of two- and three-dimensional TLM schemes in circularly cylindrical co-ordinates.

MISSION OF THE CHAIR

The mission of the Chair comprises three mandates, namely research, education, and technology transfer.

Research:

To advance and generate new knowledge in Radio Frequency Engineering for the benefit of humanity.

Education:

To educate competent RF engineers at both undergraduate and graduate levels, enabling them to become technical leaders of international caliber.

Technology Transfer:

To translate research results into practical tools and procedures for industrial product development, and to transfer technical know-how to industry through seminars, short courses, and exchange of researchers.

RESEARCH OBJECTIVES

Using advanced computer techniques, develop novel methods and procedures for the numerical modeling of guiding and radiating structures for electromagnetic waves,

- Develop analysis and design procedures for structures of arbitrary geometry and electrical composition.
- Create user-friendly CAD tools which link geometry, layout, physical and processing parameters of practical components and circuits with their system specifications and their desired time and frequency performance.

Applications include microwave and millimeter-wave communications, Radar, remote sensing, RF drying of softwood lumber, and soil moisture measurements using electromagnetic waves.

RESEARCH TOPICS

Absorbing Boundary Conditions in TLM
Automatic TLM Mesh Generation
Canonical Problem Solution

Dynamic Field Visualization
Combination of TLM Analysis with Optimization
Modeling of Fields at Singularities
Hybrid Numerical Modeling Techniques
TLM Modeling of Dispersive Media
TLM Modeling of Nonlinear Media
Johns Matrix Techniques and Diakoptics
Modeling of Moving Boundaries
TLM Modeling of Nonlinear Devices
TLM Modeling of Nonreciprocal Devices
Implementation of TLM on Parallel Computers
RCS Computations with TLM
S-Parameter Extraction from TLM Analysis
Signal Processing of Short Transient Responses
TLM Modeling of Skin Effect
Implementation of Nodes with Special Properties
Modeling of Superconducting Walls with TLM
Modeling of RF Drying of Wood
Modeling of Soil Moisture Probes

EQUIPMENT

The research group associated with the Chair occupies the **Computational Electromagnetics Research Laboratory**. The following computing equipment is presently installed in this laboratory:

1 HP Series 700 Model 735 Workstation
1 HP Series 700 Model 755 Workstation
1 IBM RISC 6000 Workstation, Model 350;
3 HP X-terminals, Model 19Ca;
1 IBM 486DX2-50 Personal Computer;
2 Macintosh IIsi computers;
1 mackintosh IIci computer;
1 Quadra 700 Computer;
1 Powerbook 170 4AB laptop computer;
1 Apple Laserwriter IIg;
2 Apple Personal LaserWriter;
1 HP Deskjet 500C;
1 HP 4Si MX Laserprinter.

The group also has access to the Microwave Laboratory of the Department of Electrical and Computer Engineering, which comprises a complete range of test equipment for frequencies up to 60 GHz.

RESEARCH BUDGETY FOR 1996/97

NSERC:	$ 39,360
MPR Teltech Direct:	$ 45,000
MPR from SCBC:	$ 25,000
University of Victoria:	$ 43,640
ASI Strat. Grant CRD:	$ 6,250*
NSERC CRD:	$ 8,750*
Industry Contributions to CRD:	$ 8,750*
Forest Renewal BC:	$ 79,000
Total Research Budget :	**$ 255,750**

* Grant jointly held with S. Avramidis of UBC. Amounts represent 50 percent of total received

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Eswarappa, C. and Hoefer, W.J.R., “Bridging the Gap between TLM and FDTD”, Microwave and Guided Wave Letters, Vol. 6, No. 1, pp. 4-6, January 1996.

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de Menezes, L.R.A.X. and W.J.R. Hoefer, “Modeling of General Constitutive Relationships in SCN TLM”, IEEE Trans. Microwave Theory and Techniques, Vol. MTT-44, No. 6, pp. 854-861, June 1996.

Eswarappa, C. and Hoefer, W.J.R., “Absorbing Boundary Conditions for Time Domain TLM and FDTD Analysis of Electromagnetic Structures”, Electromagnetics, Vol. 16, No. 5, pp. 489-519, Sept./Oct. 1996.

de Menezes, L.R.A.X. and Hoefer, W.J.R., “Accuracy of TLM Solutions of Maxwell's Equations”, IEEE Trans. Microwave Theory and Techniques. Vol. MTT-44, No. 12, pp. 2512-2518, Dec. 1996.

Cascio, L., Tardioli, G., Rozzi, T. and Hoefer, W.J.R., “A Quasi-Static Modification of TLM at Knife Edge and 90o Wedge Singularities”, IEEE Trans. Microwave Theory and Techniques. Vol. MTT-44, No. 12, pp. 2519-2524, Dec. 1996.

Herring, J.L., Hoefer, W.J.R., “Developments in the Transmission-Line Modelling (TLM) of Microwave Components”, Invited Paper, Yugoslavian IEEE MTT Chapter Informer, Broj 4, pp 15-19, Dec. 1996

JOURNAL PAPERS IN PRESS OR SUBMITTED

Righi, M., Tardioli, G., Cascio, L., Hoefer, W.J.R., “Time Domain Characterization of Packaging Effects via Segmentation Technique”, accepted for publication in Special Issue on Packaging and Interconnects, IEEE Trans. Microwave Theory and Techniques. Vol. MTT-45.

Eswarappa, C. and Hoefer, W.J.R., “Radar Cross-Section of Metallic and Dielectric Cubes Computed with SCN-TLM and FD-TD Methods”, IEEE Trans. Antennas and Propagation, (Submitted)

PAPERS PRESENTED AT REFEREED CONFERENCES

de Menezes, L. and W.J.R. Hoefer, “Modeling gyromagnetic media in symmetrical condensed node TLM”, 12th ACES Conf. Dig., Vol. 1. pp. 294-301, Monterey, CA, March 18-22. 1996.

Eswarappa, C. and W.J.R. Hoefer, “A Comparative Performance Study of Absorbing Boundary Conditions in TLM and FDTD”, 12th ACES Conf. Dig., Vol. 1. pp. 302-309, Monterey, CA, March 18-22, 1996.

Cascio, L., G. Tardioli, T. Rozzi and W.J.R. Hoefer, “Quasi-Static Correction of a Knife Edge Corner in 2D TLM Algorithm”, 12th ACES Conf. Dig., Vol. 1, pp. 317-324, Monterey, CA, March 18-22. 1996.

Zhang, Q. and W.J.R. Hoefer, “Dispersion Analysis of TLM Node for Modeling General Anisotropic and Gyromagnetic Materials”, IEEE Intl. Microwave Symp. Dig., Vol. 2, pp. 1039-1042, San Francisco, CA, June 17-21, 1996.

Herring, J.L. and W.J.R. Hoefer, “Improved Excitation of 3D SCN TLM Based on Voltage Sources”, IEEE Intl. Microwave Symp. Dig., Vol. 2, pp. 1031-1034, San Francisco, CA, June 17-21, 1996.

Eswarappa, C. and W.J.R. Hoefer, “A Hybrid 3D TLM-FDTD Model of Microwave Fields”, IEEE Intl. Microwave Symp. Dig., Vol. 2, pp. 1063-1066, San Francisco, CA, June 17-21, 1996.

Righi, M. and W.J.R. Hoefer, “Efficient Hybrid TLM/Mode Matching Analysis of Packaged Components”, Student Paper, in IEEE Intl. Microwave Symp. Dig., Vol. 2, pp. 447-450, San Francisco, CA, June 17-21, 1996.

de Menezes, L. and W.J.R. Hoefer, “Accuracy of TLM Solutions of Maxwell's Equations”, in IEEE Intl. Microwave Symp. Dig., Vol. 2 pp. 1019-1022, San Francisco, CA, June 17-21, 1996.

Cascio, L., G. Tardioli, T. Rozzi and W.J.R. Hoefer, “A Quasi-Static Modification of TLM at Knife Edge and 90˚ Wedge Singularities”, in IEEE Intl. Microwave Symp. Dig., Vol. 2, pp. 443-446, San Francisco, CA, June 17-21, 1996.

Eswarappa, C., and Hoefer, W.J.R., “Real Time Interface Between 3D Expanded-TLM and Yee's FDTD Modules”, in 1996 IEEE APS Intl. Symposium Dig., Vol. 1 pp. 104-107, Baltimore, Maryland, July 21 - 26, 1996.

Zhang, Q., J. Huang, Ke Wu, W.J.R. Hoefer, “Dispersion Analysis of TLM Node for Modeling Anisotropic and Gyromagnetic Materials”, in 1996 Symposium on Antenna Technology and Applied Electromagnetics Dig., (ANTEM) Aug. 7-9, 1996.

Hoefer, W.J.R., “Comprehensive Electromagnetic Modelling of Microwave Circuits with TLM”, Invited Paper, XXVth URSI General Assembly, Lille, France, Aug. 28 - September 5, 1996.

Hoefer, W.J.R., “Time Domain Modeling of High Speed Circuit Structures With TLM”, in EPEP'96 Dig., Napa, California, October 27-31, 1996.

Eswarappa, C. and W.J.R. Hoefer, “Analysis of Microwave Structures Using Time-Domain TLM and FDTD Electromagnetic Simulations”, **Invited Paper**, in APMC'96 Conference Dig., Vol. 3, pp. 1045-1048, New Delhi, December 17 - 20, 1996.

So, P.P.M., Herring, J., and Hoefer, W.J.R., “Design of Electromagnetic Structures with TLM”, in PIERS '97 Conference Dig., Vol. 1, pp. 167, Hong Kong, January 6-9, 1997

Hoefer, W.J.R., “Transmission Line Matrix (TLM) Models of Electromagnetic Fields in Space and Time”, **Invited Paper**, in 12th Intl. Zürich Symposium and Technical Exhibition on Electromagnetic Compatibility Dig., Zürich, February 18 - 20, 1997.

Righi, M., Eswarappa, C., Hoefer, W.J.R., “Analysis of Passive Components for Wireless Applications Using TLM Electromagnetic Simulations”, **Invited Paper**, MTT-S Intl. Topical Symposium on Technologies for Wireless Applications, Vancouver, BC, February 23 - 26, 1997.

de Menezes, L., Eswarappa, C. and Hoefer, W.J.R., “A Comparative Study of Dispersion Errors Performance of Absorbing Boundaries in SCN-TLM and FDTD”, in 13th Annual Review of Progress in Applied Computational Electromagnetics Dig., Monterey, California, March 17-21, 1997.

Herring, J.L. and Hoefer, W.J.R., “Comparison of 3-D TLM Meshing Techniques for Modeling Microwave Components”, in 12th Annual Review of Progress in Applied Computational Electromagnetics Dig., Monterey, California, March 17-21, 1997.

Tardioli, G., Cascio, L., Righi, M., and Hoefer, W.J.R., “Special 3D-TLM Corner Nodes for Singular Field Regions”, in 1997 IEEE-MTT-S Intl. Microwave Symposium Dig., pp. 317-320, Denver, Colorado, June 9-13, 1997.

Herring, J.L., Righi, M., and Hoefer, W.J.R., “Modal Boundary Conditions for Waveguides of Arbitrary Cross-Section with SCN TLM”, in 1997 IEEE-MTT-S Intl. Microwave Symposium Dig., pp. 325-328, Denver, Colorado, June 9-13, 1997.

Cascio, L., Tardioli, G., and Hoefer, W.J.R., “Modeling of Nonlinear Active and Passive Devices in Three-Dimensional TLM Networks”, in 1997 IEEE-MTT-S Intl. Microwave Symposium Dig., pp. 383-386, Denver, Colorado, June 9-13, 1997

Righi, M., Tardioli, G., Cascio, L., and Hoefer, W.J.R., “Characterization of Surface Mount Package Effects with the TLM Method”, 1997 AP/URSI Symposium, Montreal, Quebec, July 14 - 19, 1997

Hoefer, W.J.R., “Some Thoughts on the Relationship between Finite Elements, Finite Differences and TLM”, 1997 AP/URSI Symposium, Montreal, Quebec, July 14 - 19, 1997 .

VISITORS TO THE CHAIR

March 7-13, 1996
Prof. P.Russer, Chair of High-Frequency Techniques, University of Technology, Munich Germany. Lansdowne Lecture on ATLM Method, collaboration on TLM modeling

March 1 to August 30, 1997
Prof. Thomas Weiland, Chair of Field Theory, University of Technology Darmstadt, Germany. Collaboration on time domain modeling of electromagnetic fields and waves.

COURSE TAUGHT AT UVIC

The following course was taught by Professor Hoefer in fulfillment of his teaching mandate.

ELEC 454 “Microwave Engineering”, Fourth Year Undergraduate Elective Course and Laboratory, Undergraduate Course taught during Spring 1997.

SHORT COURSE TAUGHT

The following short course was taught by Professor Hoefer.

“Transmission Line Matrix (TLM) Modeling of Electromagnetic Fields in Space and Time”, Short Course taught on 17 March 1997 at the Naval Postgraduate School, Monterey, CA, in connection with the 1997 ACES Symposium.

PROFESSIONAL ACTIVITIES

The Chair was involved in a number of professional activities which had, as their main objective, the transfer of technology, dissemination of research results and interaction between researchers and industry:

Member of Technical Program Committee, 1996 IEEE MTT Intl. Microwave Symposium in San Francisco, California, June 1996.

Member of International Scientific Advisory Committee, Electrosoft 1996, San Miniato, Italy June 1996.

Organizer of two sessions at PIERS'97 in Hong Kong, January 1997.

Member of Technical Program Committee, 1997 IEEE MTT Intl. Microwave Symposium in Denver, Colorado, June 1997.

Member of Technical Program Committee, 1997 IEEE AP/URSI Symposium in Montréal, Quebec, July 1997.

Organizer of two sessions on TLM, ACES'97, Monterey, March 17-21, 1997

Member of International Steering and Program Committee, 2nd International Workshop on TLM Modeling, Univ. of Munich, Germany, October 29-31, 1997

Co-Chair of IEEE-MTT Technical Committee on Field Theory. (MTT-15)

Editorial Boards of IEEE Transactions on Microwave Theory and Techniques, IEEE Transactions on Antennas and Propagation, IEE Proceedings on Microwaves, Optics, and Acoustics, International Journal of Micro-wave and MM-Wave Computer Aided Design.

Managing Editor, International Journal of Numerical Modelling, (Electronic Networks, Devices and Fields).

Scientific Advisory Board, Ferdinand Braun Institut, Berlin, Germany.

Executive Committee, IEEE CEFC '98 Conference on Electromagnetic Field Computation, Tucson, Arizona, June 1-3, 1998

COLLABORATION WITH INDUSTRY.

Since the Research Chair has been working primarily on problems relevant to MPR Teltech, research activities have been geared towards telecommunication and information technologies. However, the electromagnetic field modeling research performed by the Research Chair has proven to be suitable for solving a much broader range of problems. Because of this, and following the recommendations of ASI and MPR Teltech, a spin-off company (Faustus Scientific Corporation) has been incorporated to develop software tools and to provide consulting services.

Faustus Scientific Corporation

Faustus Scientific Corporation is a knowledge-based company founded on September 25, 1996 by members of the Computational Electromagnetics Research Laboratory (CERL) at the University of Victoria. Its mission is to translate state-of-the-art research expertise and knowledge in electromagnetic modeling into world-class software tools and services. These shall empower educators, researchers and design engineers to solve challenging problems that involve electromagnetic fields and waves. At present, Faustus employs two persons.

At the present time, *Faustus Scientific Corporation* is developing a **M**ulti-Purpose **E**lectromagnetic **Fi**eld **Si**mulation **To**ol (MEFiSTo™) which can be fitted with specialized user interface modules suitable for specific modeling tasks such as waveguide components, antennas, EMI/C problems, and RF/Vacuum wood drying. Knowledge and expertise gained in the course of research funded partially by ASI will be implemented in MEFiSTo and thus contributes to the development of a tool set that will empower companies requiring such modeling capabilities. The wood-drying module is being developed in close collaboration with *Glade Technologies* (see below). In the short term, *Faustus Scientific Corporation* is also providing consulting and problem solving services to clients. In the area of RF drying, *Faustus* is performing electromagnetic simulations for *MacMillan Bloedel Research* (see below), thus extending research expertise gained in the course of this project to key players in the BC Forest Industry.

Contacts: W. Hoefer, M. Righi

Glade Technologies Ltd.

A joint research program to model RF drying of softwood lumber is being conducted, and a contract with *Glade* has been completed to create appropriate software modules that could be used to verify the proper functioning of a RF/Vacuum Kiln by predicting the evolution of wood moisture content. *Glade Technologies* and its subsidiary *HeatWave Drying Systems* have a very keen interest in the modeling of RF/Vacuum kilns and has invaluable expertise in this technology, thus making it a very desirable industrial partner for the purpose of software tool development. *HeatWave* has agreed to be an alpha tester of MEFiSTo™, and a full set of MEFiSTo™ executable files for Pentium PC have been transferred to *HeatWave*. At present, MEFiSTo™ only covers the electromagnetic part from which initial heat dissipation can be extracted. As soon as the coupled models have been validated, they will be incorporated into MEFiSTo™ for further testing by other practitioners.

Terry Enegren of *HeatWave* has spent several days in the Computational Electromagetics Research Laboratory at UVic to familiarize himself with the software and to provide user feedback on the features of the software.

Contacts: R. Zwick, T. Enegren

Environmental Sensing and Agriculture Canada.

The Chair has conducted a joint research project with *Environmental Sensing* (formerly *Gabel Corporation* in Victoria) to model the propagation of electromagnetic impulses on various soil moisture probes fabricated by this BC company. The model not only predicts the performance of existing designs and visualizes their mode of operation, but it also allows for optimization of the probe cross section for maximum sensitivity to the moisture in the soil. Furthermore it can evaluate the effects of air and water films on the probe performance, and predict the impact of soil inhomogeneities (stones, water pockets, metal objects) on the measured results.

As a result of the preliminary research results that demonstrated the capability of our modeling approach, *Environmental Sensing* and *Agriculture Canada* have contracted *Faustus Scientific Corporation* to develop a new sensor that possesses superior sensitivity and measurement accuracy.

Contacts: R. McFarlane (Gabel), C. Topp (Agriculture Canada)

Macmillan Bloedel Research, Salton Fabrication, Glade Technologies.

A Industrially Oriented Research (IOR) project supported by *MB-Research, Salton Fabrication* and *Glade Technologies* as Industrial Partners is being pursued in collaboration with Dr. S. Avramidis of UBC. Industrial funds are matched by ASI and NSERC. This project has led to the development of a coupled electromagnetic/thermal/mass transfer model of wood, and experimental validation of this model using the vacuum/rf kiln at UBC is now being prepared.

Furthermore, research expertise and know-how generated in the course of this research, is presently supporting new technology developments at *MB Research* in Burnaby. For reasons of confidentiality these services are provided through *Faustus Scientific Corporation.* UVic and its spin-off company *Faustus* are the only providers of RF wood modeling and simulation support in B.C. By developing a wood drying module for the tool MEFiSTo™, *Faustus* intends to enable B.C. companies to do their own modeling in-house

Contacts: M. Churchland, N. Kott

COLLABORATION WITH OTHER CANADIAN AND INTERNATIONAL INSTITUTIONS

Research collaboration was established or continued with the following institutions):

- University of British Columbia (Prof. Stavros Avramidis) on the modeling of coupled electromagnetic/thermal/mass transfer behavior of wood, with applications in the industrial drying of softwood lumber.
- MacMaster University, Hamilton, Ont., (Prof. J. Bandler) on time domain optimization using electromagnetic simulators.
- University of Darmstadt (Visit of Dr. Weiland) involving the modeling of electromagnetic structures in the time domain.
- University of Ulm, Germany (Prof. W. Menzel) on software validation and comparison with measurements on mm-wave filters).
- Ferdinand Braun Institut for High Frequency Techniques, Berlin, Germany (Dr. W. Heinrich and B. Bader) involving the development of improved TLM procedures, and equivalent circuit parameter extraction from TLM responses of electromagnetic structures.
- University of Technology of Munich (Prof. P. Russer), on field modeling and simulation.