AMPERE NEWSLETTER

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After 42 Years, I'm Still Microwaving

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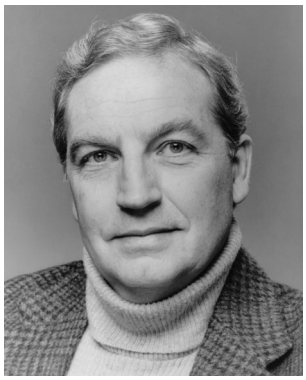

My initiation into the world of microwave heating was quite accidental. With an undergraduate degree in Pharmacy and a graduate degree in Analytical and Physical Chemistry, I fully expected to pursue a career in radiochemistry. However, I answered an advertisement in the New York Times for "A physical chemist with a sense of humor." That's how I entered the food industry, at DCA Food Industries (Doughnut Corp. of America), studying the physics and chemistry of doughnuts – by no means a trivial problem.

Early in 1961, on my lunch hour and while studying heat transfer characteristics in deep fat frying, I saw a colleague put a sandwich, on a plate, into what I thought was a 5 foot tall chrome refrigerator, but turned out to be a microwave oven – something I'd never heard of. Seeing the astonishing result, hot sandwich – cool plate, during the next 15 minutes I first heated my own sandwich, then some doughnut dough and finally a beaker of fat into which I dropped some raw dough, thereby microwave-frying it. That was the basis of my first patent and eventually led to the construction of large industrial microwave doughnut fryers. So began my lifelong passion for microwave heating. After several months of microwaving instead of performing my assigned research, I quit my job on the spot when told by the VP of Research to "stop wasting my time with microwaves" and get back to my assigned research.

There followed a year of running a radiochemical laboratory, during which time the VP of Research at DCA was fired. I was then rehired by DCA with an agreement by the company that I could spend at least 50% of my time on microwave heating applications. By the time I left DCA in 1971 to become a consultant, they were the largest manufacturer of industrial microwave systems in the world, eventually selling and installing in the U.S.A. and Europe 12 microwave doughnut fryers and 24 doughnut and sweet dough microwave proofers, all producing substantial profits for the company. However, within 2 or 3 years after I left the entire microwave program ceased and the equipment was no longer serviced or installed.

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Editor's Comment

In this issue Bob Schiffmann describes his involvement with microwave heating from the early days at DCA to the World Congress. Readers would have come across the numerous names that Bob mentions in his article in past publications in the literature on microwave heating and other topics. This adds another perspective to the intricate spider's web of personalities and firms that shaped microwave heating in the sixties and seventies.

John Bows introduces another case study using microwaves this time in the manufacture of sausage patties and describes the new integrated process that included the patty-former, microwave system, gas-fired infrared browning unit, packaging line and freezer. The average increase in yield was around 75% and the return on investment was less than six months. Coincidentally, the details for this case study were supplied by RF Schiffmann Associates.

The 10th AMPERE conference will be held at Modena, Italy, during 13-15 September 2005, preceded by a short course on 12 September. The usual mix of industrial and academic contributions are envisaged as well as thematic keynote addresses by well-known personalities in our field.

Ricky Metaxas
St John's College, Cambridge CB2 1TP, England, UK

Herein are two important lessons:

1. For any truly innovative technology to be sold or adopted by industry, it takes a "hero" or "heroes": persons with an almost monomaniacal desire to make the technology succeed and continue. That is because industry resists change, with only a few exceptions such as computers and their components.

2. Innovation that occurs too early is likely to fail.

During those exciting days of the 1960's and early 1970's I met and worked with many of the pioneers in industrial applications; persons such as Jerry White, Jim Jolly, George Badger, Cliff Warner, and Carl Olsen (all of Varian Associates), John Gerling, Sr. (Genesys Systems & Gerling Laboratories), Frank Smith (Cryodry, later Microdry), Dave Goerz (Bechtel) and many others Those were the halcyon days of great innovation in industrial applications of microwave heating, in industries as diverse as food, pharmaceuticals, automotive, wood, chemical and many more. A number of large companies were involved in the search for commercial applications: Varian, Bechtel, Raytheon, Litton and Cryodry (a division of Armour Corporation). Everyone saw a great future for industrial microwave heating – remember that consumers did not have microwave ovens in their homes, and probably had never heard of them.

In 1968 I attended my first IMPI Symposium in Boston. (IMPI – The International Microwave Power Institute, was founded in 1966 as a Canadian corporation, and for many years remained the leading worldwide scientific society in this field.) Joel Elman, a vice president at Litton, gave a talk about microwave ovens and their future, and he predicted they would become major consumer cooking appliances. We industrialists listened in total disbelief – how could a cooking appliance that would not brown, toast or crisp, and would probably sell for $250 - $500, ever be successful? Just how wrong we were is shown by the fact that in the USA we sell about 11 million microwave ovens annually, or about 1.5 billion dollars in sales, while, the entire annual worldwide market for industrial microwave equipment does not exceed 100 million dollars! As Bernie Krieger often says, convenience is important to consumers; it doesn't mean much in industry.

However, my introduction to IMPI was exciting and I joined its Board of Governors, serving for 20 years, during which time I was secretary for 3 years, president for 10 years and chairman for 2 years.

During this period I was fortunate to work closely with such well known persons as Wayne Tinga, Geoffrey Voss (both at U. Alberta), Bill Brown (Raytheon), Bernie Krieger (Cober Electronics, and a dear friend and trout fishing partner), George Freedman (Raytheon), Verle Blaha (Litton and Holaday), Nicolas Meisel (LMI – France), Stan and Maria Stuchly and many more. (Bill Brown and Jim Jolly were my professional mentors and focused my career in a more serious direction.) For many years, through 1979, IMPI rotated its annual symposium between Canada, the United States and Europe. Canada was a major center for microwave heating research particularly at the Universities of Alberta (Voss and Tinga), Manitoba (Hamid and both Stuchlys) and Ottawa (Stan Stuchly). The National Research Council of Canada (NRC) also did a great deal of groundbreaking work, including early animal exposure studies, primarily with dogs and birds. Some of the important researchers I met included Roy Van Koughnett (NRC), Mike Hamid (U of Manitoba), Walter Wyslouzil (NRC); S.C. Kashyap (NRC), all of who were active in IMPI. Kashyap and Stan Stuchly individually served as editors of the Journal of Microwave Power (JMP).

A brief word about JMP: published 4 times a year, it is now in its 38th volume and has published many of the earliest papers in areas such as industrial heating, microwave ovens and magnetrons, biological effects, microwave hyperthermia applications for cancer treatment, and microwave power from space.

IMPI's four European Symposia were held at The Hague, The Netherlands (1970); University of Loughborough in UK (1973); University of Leuven in Belgium (1976) and in Monaco (1979). Each of these was personally notable for different reasons. In 1970 I sat at an outdoor café having a beer with the famous Herbert Püschner (Peter's father), having just presented my first ever microwave paper on our various microwave doughnut-processing systems. He was appalled by my ignorance of microwave applicator theory and left in disgust having finished only half of his beer. This was also the Symposium at which I met the physicist Maria Rzepecka who, rather than returning to her native Poland, went to the University of Manitoba where she married Stan Stuchly and later became an eminent government expert on the biological effects of non-ionizing radiation. Stan, Maria, my wife Marilyn and I skied together several times in the Gatineau outside Ottawa, or rather Stan and Maria skied – Marilyn and I mostly fell down, with Stan characteristically urging us to "press on". This first European Symposium was also notable because IMPI's treasury was depleted to $13 by that meeting and the Institute was near financial ruin.

The 1973 Symposium at the Loughborough University of Technology was organized by a committee including Percy Giles (Mullard Research and later Apollo UK), Roy Smith (U. Bradford) and Harry Barber (U. Loughborough), with Bob Peterson (Raytheon) as Technical Program Chair. Especially interesting is that one of the final papers was co-authored by Ricky Metaxas, with whom I formed a lifelong friendship. Among the other authors I met for the first time were Nils Bengtsson (SIK), Thomas Ohlsson (SIK) and Per Risman (Husqvarna), Renato Bosisio (Ecole Polytechnique, Montreal) and Ted Grant (Queen Elizabeth College).

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A notable presentation was that of Bill Brown (Raytheon) regarding high power microwave transmission from free space. Following the Symposium I traveled by automobile with Nicolas Meisel to his extraordinary home in France. We were harassed by Customs after we crossed the Channel, because of all the microwave equipment Nicolas had in the boot of his car.

The 1976 IMPI Symposium in Leuven was co-chaired by Peter Luypaert and A. Van de Cappelle both from the University. Several sessions were devoted to biological effects, dosimetry and medical applications, chaired by such eminent researchers as Ted Grant, Sol Michaelson, P. Czerski, Tom Rozzell, John Gallagher and John Osepchuk (Raytheon). But there are three things I most remember about this Symposium: first, Thelma Pressman, an independent home economist from the United States, asked me, as IMPI's president, to form a special section of IMPI devoted to microwave ovens, packaging, foods, etc. which I pursued and that led to the formation of IMPI's Cooking Appliance Section (CAS), first chaired by Gertrude Armbruster (Cornell University). Second, was the disappearance of Wayne Tinga's pajama bottoms and their reappearance on top of a statue in the town square. Finally, there was a wonderful dinner, at a tiny outdoor restaurant in the old part of Brussels, attended by Ricky and Margaret Metaxas, Stan and Maria Stuchly, Wayne Tinga, Zjelko Plavcic (Zagreb Airport) and myself. I remember the look of horror on Ricky's face as we ordered snails, which he and Margaret came to love.

IMPI's 14th and last European conference was in Monaco, in 1979, and sponsored by Comité Francais d'Electrothermie. There I met or renewed friendship with many more wonderful colleagues: Serge Lefeuvre, Fred Gardiol (Ecole Polytechnique – Lausanne), Glen Fanslow, Georges Roussy, Walter Van Loock and many others (At this point, I must apologize to any colleagues and friends I may miss – it is not done deliberately. There are so many wonderful people I have known all these years – forgive me – put it down to a "senior (senility) moment"). Two events stand out for me: first, Bernie Krieger drying his laundry on the balcony of the Loew's hotel in the direct line of sight of the royal palace; second, a marvelous afternoon in which I hired a car and traveled to St. Tropez with Percy Giles, Ken Eke (both of Apollo UK) and Wayne Tinga. The four of us sat on the beach trying to eat our sausages, cheese, and baguettes, and drink wine, during a sand storm. I believe I laughed more that afternoon than any other afternoon of my life.

Your news and views are always welcome

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IMPI grew substantially in membership due to the CAS, but it also suffered from internal and fiscal problems. The cessation of its European conferences was partly the reason for the founding of AMPERE. Eventually, in the late 1990's a group of members from the Industrial, Scientific and Medical Instrumentation Sections (ISMI), including myself, resigned our positions in IMPI and turned our attention to the Microwave Working Group (MWG), a small group of individuals led by Bernie Krieger and Will Sutton (United Technologies) whose purpose was to continue the microwave conference efforts of groups such as IMPI, the American Ceramics Society (AcerS), the Material Research Society (MRS) and American Chemical Society – Polymer Division (ACS) by holding a single World Congress in microwave and radio frequency processing and applications, rather than many conflicting annual symposia.

Following a successful First World Congress (1WC) in Orlando, Florida, this small group – less than a dozen members, has organized two more Congresses: 2WC in Orlando (2000) and 3WC in Sydney, Australia (2002). The Fourth World Congress (4WC) is being organized, in conjunction with the Annual Fall Meeting of the American Institute of Chemical Engineers (AIChE) in Austin, Texas, November 2004, and will be chaired by yours truly. The MWG has as its motto "Bridging Science, Technology and Applications" and has formed a harmonious working relationship with AMPERE, planning its Congresses in alternate years so as to create an information continuum with the AMPERE meetings. Through the MWG I worked with such wonderful persons as Jon Binner (Loughborough University), David Lewis (formerly at IBM now at SOLA in Australia), David Clark and Diane Folz (Virginia Polytechnic Institute), John Booske (University of Wisconsin – Madison), John Gerling, Jr. (Gerling Applied Engineering).

Similarly, my attendance at nearly all the AMPERE conferences has let me maintain my friendships with many of my colleagues named above as well as introducing me to such fine and fun people as Monika Willert-Porada (U of Bayreuth and my dancing partner at the 2001 AMPERE-Bayreuth conference, John Bows (Unilever), Nguyen Tran (RMIT) In Australia), Inc.), Jean Paul Bernard (Sairem), and so many others.

From 1971 to the present I have been an independent consultant. In the early years, microwave consulting was only a small part of my business, but, starting in 1978, it has been nearly my exclusive occupation, going back and forth between industrial microwave systems and microwave ovens. In the industrial microwave applications area I have developed systems to: destroy pathogens in packaged nasal spray and tampons; dry airplane parts; cook and dry muesli (running successfully in South Africa); continuously process sausages; fry coated fish products; sterilize medical devices; vacuum dry blood oxygenators for open heart surgery; convert hematite to magnetite, and much, much more. As to microwave ovens, I and my laboratory have developed numerous microwavable consumer food products ranging from pop-corn through main meal entrees; performance tested many different food products, packaging systems, cookware, and

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Case Study 4: Sausage patty producer achieved a return on investment (ROI) within 6 months with microwave installation

The most important requirement for the adoption of any new microwave process is return on investment (ROI). This is, essentially, a measure of the profit potential of the new system. It must take into account the capital cost, amortization, required labour, floor space, cost of materials, etc. Usual industrial pay back times are two to four years, sometimes more. The microwave sausage cooking system, described below, was extraordinary in having the shortest pay back time ever encountered by RF Schiffmann Associates, producing a superior product that permitted the manufacturer to dominate the market for many years, and had manufacturing benefits that provided an extraordinary fast and clean operation.

Owens Country Sausage was a medium sized family owned business in the pork sausage manufacturing business, producing a variety of sausage products largely for food service sales. The management had identified a major new market potential – a frozen, microwavable sausage patty in a biscuit, a breakfast product very popular in the southern United States – that could be sold at retail, primarily through supermarkets and convenience stores.

The Old Process

At that time (early 1980's) Owens manufactured sausage patties using a conveyorized double sided gas-fired grill. However, there were many manufacturing and product problems.

Since pork sausage meat contained a large amount of fat which was rendered during the cooking and dripped onto the flame, fires occurred several times a day.

These required the production line to shut down, the charred meat to be scraped from the grill plates, requiring one or two workers 20 to 30 minutes to complete to the get the line operational. At the end of the production day, a cleaning crew took 16 work hours to clean the grill prior to the next day's operation.

The finished cooked patties, which were frozen after cooking, had a yield of approximately 65%. Further, their shape was thin and slightly cupped – distorted by the somewhat uneven heat transfer from the top and bottom grill plates.

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ovens; solved such problems as the spontaneous fracture of glass jars in microwave ovens; and more. I have often served in the role of a "linker" – a person who, by speaking both languages, serves as an intermediary between the microwave equipment manufacturer and the user.

Of late, I have served as an expert witness in numerous lawsuits involving microwave systems, ovens or products and covering areas such as patent litigation, microwave-induced fires, personal injury, and even felony murder. I have also continued my teaching of courses on industrial microwave and RF technology (John Zimmerly and Ben Wilson handling the RF sections) and microwave oven technology. In the last few years I've had an exciting time working with Ken Eke, one of the most original and innovative thinkers I have ever known, on some new non-food applications of his unique match plate launch systems.

It has been a fabulous time to be working with microwave heating, almost from the start of the field. I have been involved in so much and have worked with and known so many marvelous people, and there has been an enormous amount of innovation and good research.

But the field is changing, mostly for the good. The day of generalists and metal benders is slowly disappearing, to be replaced by modeling and far more academic and theoretical work. I worry that the "linker" may disappear and make industrial applications more difficult to achieve.

And that leads me to a final comment directed primarily at the young people entering this area – before you run off and start working on what you believe to be a new idea, look back thoroughly in the literature. I do not mean to simply do an Internet search, but an in-depth search of the literature and patents, going back to at least the 1950's. You would be amazed at how much has already been done, some of which can be improved upon, but some was awfully good. On the other hand, I am sure you do not want to be in the position of the UK government researcher who, in my presence, offered his technology for license, a process I had patented several years before.

So, after 42 years, I am still microwaving and going strong, and I am still as filled with wonder every time I see a microwave oven operate, or run a microwave heating experiment: "What's really going on?"

Bob Schiffmann
RF Schiffmann Associates, New York, USA

Case Study 4

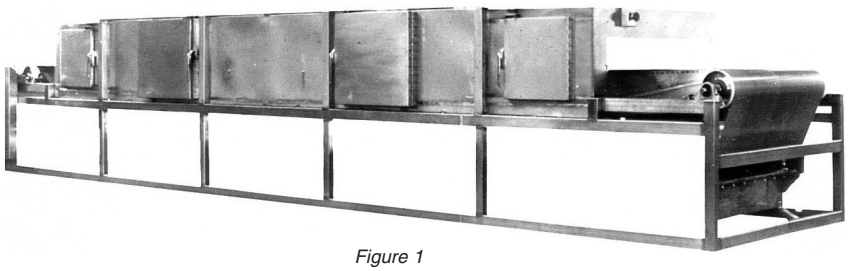

Figure 1

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The New Process

RF Schiffmann Associates were asked to evaluate the feasibility of using microwaves to cook the sausage patties. First, an economic study of the impact of equipment on manufacturing costs and profitability showed that forming and cooking the patties from chilled, not frozen, was essential. Fortunately, the first refrigerated patty-former had just entered the market and Owens became an early purchaser.

A laboratory research microwave system (0-2kW, 2450 MHz), variable velocity hot air up to approximately 350˚C), and an electrically heated ceramic plate infrared heater were used to conduct the proof-of-principle trials. Early tests attempted to reproduce the methods of a microwave beef patty cooking system operating in Sweden, the Inpro process. Here, the surface of the meat is first seared reduce liquid loss, followed by microwave cooking. However, this limited the yield to a maximum of 78%, much better than the existing Owens yield of 65%.

To further improve yield, mechanisms for liquid loss were studied. Shrinkage, not evaporation, resulting from heat denaturation and coagulation of the meat protein generated excess liquid loss. Searing the surface caused too much liquid loss, so the process was reversed: first microwaving and then browning the surface with infrared. Yield increased to 83% and the finished patties had nearly twice the height of the current product, were perfectly formed and of excellent eating quality.

Owens then ran pilot scale tests and leased appropriate microwave and infrared equipment. After producing approximately 23 tonnes of 28g patties and consumer testing the sausage in biscuit product, Owens ordered a complete processing system to be built and installed.

The Microwave Processing System

The new system included the patty-former, microwave system, gas-fired infrared browning unit; packaging line and freezer. Biscuits were to be provided by a large local bakery. The microwave cooker, shown in Figure 1, was built by Cober Electronics and consisted of six 6kW generators coupled to a stainless steel multimode applicator with a conveyorized PTFE coated fiberglass mesh belt. The belt was 91cm meters wide and 9m meters long. The production rates were based upon 30,000 one-ounce (28g) patties per hour, around 840kg per hour. Other size patties could also be cooked in this system. The microwave generators were located remotely, in a physically separate room, in order to protect them from the large volumes of hot water and steam used for cleaning and sanitation in meat processing operations.

Following the initial microwave cook, whose purpose was to gently internally cook the patties without causing the yield-reducing shrinkage, a covered conveyor transported the patties through the infrared broiler for surface browning. The final internal meat temperature was approximately 74˚C. The patties were cooled, placed between the biscuit halves, packaged and frozen. The entire microwave cook and infrared browning operation took 5 minutes.

The benefits of the installation were:

- increase in yield from 65% to 83%,
- elimination of fires and line shutdowns several times a day, enabling continuous running,
- reduction of cleanup time from 16 work hours to 30 work minutes per day
- pay back time (ROI) of all equipment (from patty-former to freezer) less than 6 months

The result of all this was the production of a superior and successful product. Owens “Sausage ‘n Biscuit” dominated this market for the entire life of the microwave process – approximately ten years. The line ran virtually trouble-free and was only shut down when Owens was sold and became part of a much larger company and had to adopt that company’s sausage cooking system. However, to this day, the retired vice-president of engineering refers to the microwave system as the finest processing system he ever saw. It is surprising that this process was never adopted by another user.

Thanks are due to Bob Schiffmann (RF Schiffmann Associates, USA) for providing the details of this case study.

John Bows
Unilever R&D Colworth, UK

News & Events

Seminar on Validation of Computational Electromagnetics

The UK's IEE Electromagnetics Professional Network is pleased to announce a Seminar on Validation of Computational Electromagnetics supported by BAE Systems Ltd and held at their premises at Farnborough, UK on Monday 29 March 2004.

Organised by the IEE Electromagnetics Professional Network.

See ***www.iee.org/events/validation.cfm*** for details

7th International Workshop on FINITE ELEMENTS FOR MICROWAVE ENGINEERING Antennas Circuits and Devices

May 20-21, 2004, Madrid, Spain
www.fem2004.etsit.upm.es

Topics include computational electromagnetics, emc and industrial applications.

Organized by the Polytechnic University of Madrid (Spain) and the University of Florence (Italy).

Sponsored by: Escuela Técnica Superior de Ingenieros de Telecomunicación (Universidad Politécnica de Madrid), IEEE Spain Section, IEEE Region 8, IEEE AP-S, IEEE MTT-S, RYMSA

38th IMPI Symposium

The next IMPI Symposium will be held at the The Marriott Bloor Yorkville Hotel Toronto, Ontario, Canada during July 13-16, 2004.

For further details visit
http://www.impi.org/Meetings/index.html

International Symposium on Microwave Science and its Application to Related Fields

July 28-30, 2004, Sunport Takamatsu International Convention Hall, Takamatsu, Japan

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3rd International Workshop of Biological Effects of EMFs

For the list of topics and other organizational details of the 3rd International Workshop of Biological Effects of EMFs to be held in the Aegean Island of Kos in October 2004,visit the following web site:

http://imm.demokritos.gr/bioeffects/

The abstracts submission deadline is April 17th 2004

AMPERE 2005 10th International Conference on Microwave and High Frequency Heating and short course

12-15 September 2005, Universita' degli Studi di Modena e Reggio Emilia, Modena, Italy

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www.mag.unimo.it

George Freedman et al still invent!

Bob Schiffmann mentioned in his article that early on in his career he met George Freedman then at Raytheon's New Products Centre, USA. Interestingly, an article appeared in the IEEE's SPECTRUM September 2003 issue entitled "Invention on Demand", which describes a partnership of four entrepreneurs who meet every Tuesday in a rented conference room at Lexington Mass, to brainstorm and spice up new but mundane products. The four are A Ze'ev Hed (Haifa physicist and cryogenics expert), Richard Pavelle (University of London mathematician and consumer products expert), Sol Alsenberg (MIT physicist and medical technology expert), and George Freedman (MIT engineer).

These four 60-something men have to their names more than 300 products, 130 issued or pending patents and 50 licensing arrangements. The article describes George Freedman as the group's pacifier and pragmatist. They trade under the name Invent Resources Inc.

(see ***http://www.weinvent.com/newsletter-sep2002.html*** for further details)

The Editor