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Forty years of European microwaves. What about the future?

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This paper describes some key points in the history and development of the European Microwave Conference, the European Microwave Week, and the European Microwave Association, starting from 1969. It captures the way in which the conference since the earliest days has sought to create a successful blend of scientific and industry interests and has adapted itself to and indeed shaped the many existing technical changes that have characterized and continue to be at the core of the field of microwave engineering.

Keywords: European Microwave, Conference, Exhibition, Association

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I. INTRODUCTION

This article is based on papers and presentations made at the European Microwave Conference, Rome, 2009, in a special session devoted to the 40th anniversary of the first European Microwave Conference [1–6].

The story started in London, 1969. The EuMC, then called EMC, was first established in the fall of every odd year: London 1969, Stockholm 1971, and Brussels 1973. Starting with Montreux in 1974, the EuMC became an annual event, organized with the support of a professional conference manager and combined with an exhibition of manufacturers of microwave components, systems, and test equipment [7–9]. The name EuMC was introduced by F. Gardiol in 1974 to avoid confusion with ElectroMagnetic Compatibility Symposia (EMC).

A further development in the conference came from the decision to organize a European Microwave Week, EuMW, starting in 1998 and, with this in mind, contacts were established with other technical entities [10, 11]. Simultaneously, the Management Committee (MC) of the EuMC decided in 1997 to create the European Microwave Association, Eu*M*A, as an international non-profit association under Belgian law, with a scientific, educational and technical purpose [12–14]. Five years after its establishment, the EuMW was recognized as the most important microwave event in Europe and the second in the world. European achievements and trends in the area of microwaves have been described [15, 16].

Chairmen have been involved in a huge amount of preparation work and they should be thanked for this. They are listed on the EuMA website at: http://www.eumwa.org/en/conferences/eumc/past-eumcs-and-chairs.html.

II. HOW IT ALL STARTED: LONDON 1969

After graduation, P. Clarricoats began work on microwave ferrite devices. However, there was also much interest in gaseous plasmas in the context of the re-entry of manned space vehicles, when the signal was lost during a critical period. There was a suggestion that the application of a magnetic field could, as with ferrites, change the properties of the plasma and allow the signal to propagate and communication to be restored. Because of the similarities between ferrites and plasmas, Peter studied both for a time and, with worldwide interest, he suggested to the IEE that an international conference should be held.

For the Institution of Electrical Engineers (IEE) in the swinging sixties, an international conference was a totally new idea. P. Clarricoats organized and chaired the International Conference on Ferrimagnetics and Plasmas. It was a success, attracting some of the most famous microwave names of the day from both USA and Europe.

So when, in 1967, the IEE committee came to review the concept of a second conference on Ferrimagnetics and Plasmas, Peter suggested that instead they should hold an International Microwave Conference. Another member of the committee, Eric Ash, who was then working in Industry and was very pro Europe, went the next stage and said: 'why not a European Microwave Conference?' The Committee Chairman and natural microwave leader in the UK at that time, Professor Harold Barlow, University College London, was designated as Conference Chairman. Later, Ash became co-chairman. There were two parallel sessions, and the programme was held

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simultaneously at the IEE, Savoy Place, and the IMechE, Birdcage Walk. Interesting: the Conferences fees were £15 for members of sponsoring bodies. . . ! It should also be noted that this was a five-day conference!

The members of the Organizing Committee were representing the IEE, the Institution of Electronic and Radio Engineers and the Institute of Electrical and Electronics Engineers, Region 8, as well as the Group on Microwave Theory and Techniques. They were I.B. Bott, P.J.B. Clarricoats, D.E.N. Davies, C.A.P. Foxell, W.A. Gambling, K.C. Kao, J.A. Lane, P.F Mariner, M.H.N. Potok, S.J. Robinson, C.R. Russell, and F.L. Warner.

There was a rather large set of corresponding members: B. Agdur, F. Borgnis, H. Bosma, E. Dalla Volta, P.G. Debois, L. Dobner, V.M. Dmitrachenko, R.S. Engelbert, G. Epprecht, A. Grivet, R.C. Hansen, A.E. Karbowiak, W. Klei, H.L. Knudsen, R. Levy, H.G. Meinke, J. Nishizawa, B. Oguchi, S. Okwit, A.A. Oliner, G. Reiter, G. Rosenberg, J.E. Rowe, G. Sinclair, A. Smolinski, M. Tiuri, G. Toraldo di Francia, H-G. Unger, G.B. Walker, A.A.Th.M. Van Trier, A. Vander Vorst, E. Viti, T. Wessel-Berg, and L. Young. A rather impressive group of individuals!

It is worth mentioning that in those days there were two chairmen: the General Chairman and the TPC Chairman. The General Chair had to take care of everything, including receptions, general organization, hotels, etc., while the TPC Chair was in charge of the 'intellectual part': evaluating the submitting papers, selecting the accepted papers, organizing sessions, appointing session chairs, etc.

The first formal document, Advance Programme, of the first EuMC is shown in Fig. 1. It is interesting to observe that – for the first and last time – the cover page was in four languages! In alphabetical order of the languages. . .

In some papers presented at this first EuMC, one recognizes well-known names and what have been their fields of interest for quite some time:

Felsen	Ray methods for propagation and scattering in waveguides
Oxley	The design and performance of an integrated X-band receiver
Mittra, Itoh	Theory of shielded microstrip lines
Clarricoats	A multimode monopulse feed for a satellite tracking antenna
Bach Andersen	Broadband properties of dielectric antennas compared with metallic antennas
Ash	Microwave acoustics (survey)
Oliner	Microwave approaches applied to guided acoustic waves (survey)
Vander Vorst, Gardiol	Application of the variation-iteration method to inhomogeneously loaded waveguides
Bandler	Computer optimization of inhomogeneous waveguide transformers
Berceli	Optimum load tunnel-diode oscillators
Young	Microwave filters and couplers (survey)
Rhodes	Advances in microwave linear phase and elliptic function filters
deLoach	Modes of avalanche diodes and their associated circuits (survey)

Fig. 1. Advance Programme of the first EuMC, London 1969.

It was planned that the second EuMC would be held in Stockholm, 1971, with Professor Bertil Agdur as General Chair and Professor Folke E. Bolinder as TPC Chair. In Stockholm 1971, Professor Jean Van Bladel who could not attend called Professor André Vander Vorst, proposing Brussels for 1973, with them as General Chair and TPC Chair, respectively.

A meeting was held in 1973 at Brussels airport between the British company Microwave Exhibitors and Publishers Ltd (MEPL), Roger Marriott and Gordon Saville, and Professors Van Bladel and Vander Vorst, to envisage EuMC as an annual event, run by a professional manager together with an exhibition.

III. BRUSSELS 1973

From a report written by J.H. Collins in MSN, October/November 1973 [7], it appears that Brussels 1973 was quite a success: a four-day event; record attendance: 780 registrants; massive support from Britain, West Germany, France; significant support from The Netherlands, Sweden, Italy, Belgium; 'Iron Curtain countries' and US were there, each with 40 participants.

There were:

- 12 invited papers
- 215 papers presented
- 3 parallel sessions

Among the papers, one could notice the following main trends:

- Solid-state active circuits, 50 papers, including a significant paper by Peter Weissglas on the comparison of Baritt with Gunn diodes in the 5–20 GHz range
- Antennas, 22 papers, including one session on phased arrays
- Terrestrial communications: a collective presentation (COST project) from Belgium, England, France, and Germany, on a 30-GHz, 800-Mbit/sec, PCM-QPSK; all solid-state repeater from Japan; all solid-state radio relay

transmitter (Bell Telephone) from Belgium; and British Post office aimed at a full-scale field trial, spring of 1975
- Microwave acoustics, 18 papers, with a heavy bias from surface acoustics waves.

The organization of futures conferences was planned: to form a Board of Directors, including one member from each of 'the 11 European nations' (!), hold a Convention with both Conference and Exhibition in Montreux 1974 and cooperate with a professional organizer, MEPL, represented by Roger Marriott.

IV. MONTREUX 1974

In 1972 came an unexpected announcement: a microwave trade exhibition would take place in 1973 in Brighton, England, organized by MEPL, and this exhibition, called Microwave' 73, would be accompanied by a small Conference. This event would take place on a yearly basis, which meant direct competition for future EuMC's. Some microwave people started to worry: was the European microwave market large enough to support two major microwave events?

At that time, the little town of Montreux hosted a very successful Television Symposium every year. It was suggested that this would be a good place to organize a joint microwave event, in 1974 or 1975. This is why F. Gardiol, who had recently started a new Microwave Laboratory at the 'École Polytechnique Fédérale' of Lausanne, received in 1973 a phone call from Professor J. Van Bladel, inviting him to organize a future EuMC in Montreux. A longstanding collaboration was established with MEPL, which implied a need for a governing body to formally represent the Conference. The Management Committee was created, with F. Gardiol as first chairman, for three years. A balanced representation of entire Europe was worked out: H. Barlow, J. Van Bladel, E.A. Ash, P. de Santis, A. Smolinski, T. Berceli, J.O. Scanlan, H.J. Schmitt, J. Deutsch, H. Steyskal, M.T. Vlaardingerbroek, J. Le Mezec, and B.V. Arkinson, Secretary of the Committee.

About the technical programme, one can for instance notice the invited papers:

W. Klein	Microwaves for Communications (Opening Address)
H.W. Thim (Austria)	Active Semiconductor Devices
W.A. Geoffrey Voss (Canada)	Industrial Applications
E.A. Ash (UK)	Microwave Acoustics (survey)
G. Scafé (Italy)	ESM Receiving Systems
P.J.B. Clarricoats (UK)	Improved Feed Systems
B.I. Ryabov *et al.* (USSR)	Dielectric waveguides
H. Howe (USA)	The Impact of Microwave CAD
C. Lewis Cuccia (USA)	Digital Satellite Communications
R. Voles (UK)	Radar, Present and Future

A closed circuit TV proved most valuable to inform participants: it showed which papers were in progress in the two lecture halls – one could then 'hop' from one session to the other. The TV circuit also circulated messages in an unobtrusive manner.

The collaboration with MEPL had worked out without a hitch: the Chair did not have to worry about administrative and financial aspects; he did not notice any interference between the exhibition organizers and the technical program; and he greatly thanked Messrs Marriott and Saville, who took great care to ensure the success of both the conference and the exhibition (Fig. 2). The MC was also quite happy to receive royalties, and these were used to set up a European Microwave Prize to reward the best technical presentation in future conferences, for the first time in 1977.

V. THE FIRST PROFESSIONAL ORGANIZER: MEPL

Professor Vander Vorst contacted Roger Marriott and a meeting arranged at Brussels airport to discuss the possibility of future cooperation, together with Professor Van Bladel and Gordon Saville. As a result of this meeting, it was agreed to propose to merge both interests: the MC to organize the Conference Programme, while MEPL would undertake full financial and management responsibility for organizing a combined Conference and Exhibition.

There are many anecdotes R. Marriott could mention, covering the 20-year period. Here are only a few.

During the '76 Rome Event, under the Chair of Professor P. de Santis, there was a bomb scare in the Exhibition hall. The police were called and the Conference and Exhibition areas were cleared of all personnel. Apparently a briefcase was left unattended on the Marconi stand, which was ticking. Bomb disposal experts expertly slashed the briefcase open only to reveal a Philips tape recorder that had been inadvertently activated.

During the '80 Warsaw Meeting there was a large explosion in the Down Town District of Warsaw, which happily turned out to be only a gas explosion. However, one of the EuMC speakers happened to be in the area and started taking photographs of the police and other officials gathering at the scene. He was immediately arrested and questioned by the authorities for several hours, but he was released in time to give his presentation.

During the planning stages of the '86 EuMC in Dublin, a serious problem was encountered. The only facility that could ideally stage the Event was the National Concert Hall, which unfortunately had already been booked by the Irish State Radio and Television Authorities (RTE), for a whole

Fig. 2. Professor Fred Gardiol, between two specialists of the English Electric Valve Company Ltd, examines a microwave power tube, while Roger Marriott, at right, looks thoughtful (courtesy EEV).

month for orchestral rehearsals. Undaunted and unfazed the Conference Chairman Professor S. Scanlan contacted the Director General of RTE, who just happened to be a personal friend, requesting that RTE release the dates which we required in order to hold the EuMC Conference. To our amazement, the Director General readily agreed to this request – a classic example of how the Inner Circle in Ireland quickly solved problems – however, one word of caution: 'You have to be a member of the 'Inner Circle' to make things happen in this way.'

At the '87 Rome Meeting under the Chairmanship of Professor F. Fedi, we came across another unexpected problem – the World Games were being held at the same time as the EuMC Convention. Roads were closed or being diverted – indeed Members of the TPC experienced difficulties in getting to their annual dinner due to the closures and diversions, etc. To cap it all, on the last day of the event the Official Parking Area for the event logistic lorries was completely sealed off. With the event about to close, we finally managed to get the lorries out by cutting the padlocks with bolt cutters kindly loaned to us by one of the drivers!

VI. THE DEVELOPMENT OF THE EuMC

Andrew Wilson attended the EuMC, Stockholm 1988, delegated by the IEE. He was appointed as Honorary Secretary and is still in position.

The task in Stockholm, and the next few years, was twofold – to maintain order over the MC's decision-making process and record keeping, and to understand and improve the dynamics of an intriguing and unique body: the MC was characterized by a number of features that made it very much a moving target. Firstly, the conference traveled each year to a different city in a different country. Secondly, the conference chairman and the TPC changed each year. Thirdly, the MC chairman and one third of the committee members changed each year. This rapid turnover meant that maintaining order was essential.

EuMC defined its European character in two ways: firstly as a peripatetic event that visited many European countries, Secondly by comprising its MC of engineers from more than a dozen different European countries. EuMC extended its conception of Europe's boundaries ahead of political developments. Significantly a EuMC was held in Poland in 1980 and in Hungary in 1990. The conference drew on a burgeoning European microwave fraternity and, in turn, helped to engender that fraternity.

Because of the annual change of chairman, the functions of the MC obtained continuity from the Honorary Secretary, A. Wilson, and also from the Honorary Treasurer, F. Gardiol, who took a long-term role in managing the EuMC's funds. This proved vital in the mid-1990s when the series of conferences was seen to falter.

During the EuMC 1995 in Bologna, the members of the MC took a bold step to redefine EuMC dramatically, believing that it could be recreated in a more vibrant, relevant and successful form. An ad-hoc committee (F. Landstorfer, A. Madjar, A. Räisänen, and A. Vander Vorst) was appointed by the MC to revisit the operation and scope of the EuMC. The key decisions were then taken in a series of meetings in Prague. Implementation started in Jerusalem in 1997 and the transformation was completed in Amsterdam in 1998.

Following the suggestions of the ad-hoc committee, firstly, the decision was taken to create a Steering Committee (StC) 'with the task of working on long planning, finance, future venues, exhibitions, industry participation, publications, liaison with the organizer, on behalf of the MC, and taking urgent decisions when necessary.' The StC comprised '6 members, 5 elected by the MC amongst those who have been exceptionally active in international activities furthering the well-being of the microwave community. The 6th member shall be appointed by the IEEE MTT-Society.' 'The Chairman of the StC will also serve as Chairman of the MC.'

Secondly, the EuMC would restrict its peripatetic travels to five countries: France, Germany, Italy, The Netherlands and the United Kingdom. Thirdly, EuMC would become the center-piece of a newly created European Microwave Week (EuMW), which would involve other events of interest to the microwave community. An important principle was to reinvigorate the relationship with the exhibition.

A contract from 1998 through 2002 with Miller Freeman, later CMP, led to a massive expansion of the Exhibition, which was critical to the success of the first EuMW. Since 2003, with Horizon House Ltd, UK, as professional organizer, the Exhibition has been stabilized and is steadily growing.

At the same time Eu*MA* has stayed true to its principles – its European focus, the peer review, investing surpluses in the EuMW, and creating the best possible events for the European microwave community.

VII. THE 1ST EUROPEAN MICROWAVE WEEK, AMSTERDAM 1998

The five members of the StC were elected during the 1996 TPC meeting, Prague: L. Ligthart, A. Madjar, H. Meinel, F. Meyers, and R. Sorrentino. At the first StC meeting, in London, R. Sorrentino was elected Chairman, and the EuMW idea was adopted, with L. Ligthart as first chairman for 1998. R. Jansen was then appointed by IEEE-MTT-S as the 6th StC member.

The major StC tasks were to investigate the conditions for a successful EuMW, by organizing simultaneously several microwave-related top conferences and a major European Microwave exhibition. The programme should cover components, devices, systems and networks, in scientific, technology, and application-oriented sense. It should also be profitable. A link between Microwaves and Wireless was planned. The EuMW programme should reflect: three conferences with breakthrough presentations (invited, focused, industrial, joint, and regular papers); a European R&D platform; presentations on major developments outside Europe; tutorial and workshops; the most important microwave exhibition outside USA; awards, and grants for NIS researchers.

The Eu*MA* was created with the 1998 StC members (L. Ligthart, A. Madjar, H. Meinel, S. Nightingale, R. Sorrentino, and A. Vander Vorst) as founding members.

The General Chairman and Secretary of the EuMW 1998 were L. Ligthart (TUD) and D. Vanhoenacker-Janvier (UCL), respectively. The EuMW included three conferences: the 28th EuMC (L. Ligthart, D. Vanhoenacker-Janvier); GAAS®98 (G. Gatti, ESA-ESTEC); and MTT-S European Wireless 98 (R. Jansen, RWTH-Aachen).

The Call for Papers was widely distributed, resulting in a huge increase in the number of received abstracts. The abstracts handling (D. Vanhoenacker-Janvier + UCL team) necessitated a professional approach: increase the number of reviewers; design a system for separating distributing abstracts per conference; inform reviewers, committees, and organizer; and prepare three separate TPC meetings, linked together.

Here are some statistics about the Conferences:

EuMC 228 regular accepted papers

12 invited papers
52 special papers (focused, industrial, etc.)
55 workshop papers

EuMW 488 accepted regular + invited papers

62 workshop papers

Registrations EuMC 660

GAAs: 319
Wireless 223
Workshops 282

Exhibition: net space 1557 m² (more than 3000 m² gross)

There were many combined registrations illustrating the success of an event with several conferences within one week, with well-attended joint sessions. The social program was successful: a boat trip and welcome reception offered by the Major and aldermen of the Amsterdam city council; invitation for all EuMW attendees to a cocktail sponsored by industry; and a well-closing closing ceremony (Fig. 3).

Fig. 3. The EuMW 1998 team with some Eu*MA* officers after the closing ceremony.

VIII. FORTY YEARS OF EuMC AND BEYOND

Figure 4 shows the evolution of EuMC in terms of number of papers presented: after the initial growth of the first three editions and the 1974 drop when the conference became annual, the size remained approximately the same for several years with around 120 papers: the MC considered that accepting 120 papers was about the right number and this was enforced for about 15 years. Hence, this does not necessary reflect the true size of the conference, nor the number of papers submitted, since the acceptance rate has varied along the years. For example, the acceptance rate at EuMC 1987 in Rome was only 36%, with a submission of 416 papers. From 1987 onwards, the conference size increased up to 289 papers (Budapest 1990) and again underwent two years of decrease.

Many of the technical topics in the first conference programme have remained of durable significance until the present day, although technology, design and realization capabilities have in many cases been transformed beyond recognition.

Just a few papers on microwave power transistors were presented at the 1969 conference. For example, Hughes et al. [17] described Si NPN transistor amplifiers in which a single unit produced 1.5 W at 2 GHz, with an f_T of only 1.7 GHz.

In contrast with other microwave symposia, antennas have always been an important part of EuMC. Reconfigurable and scanning antennas have for instance constituted an important

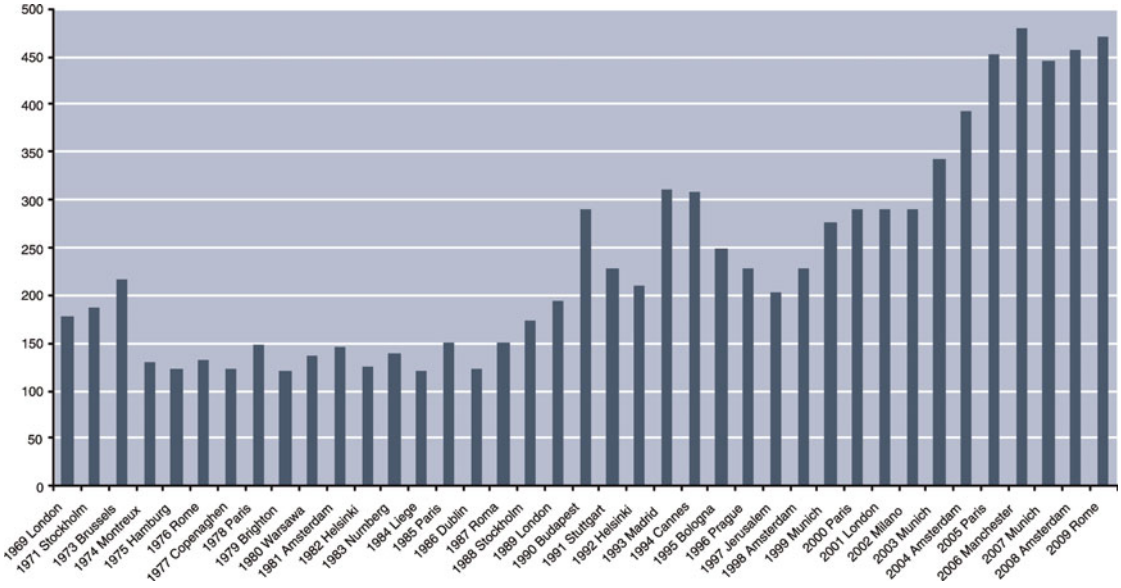

Fig. 4. Number of papers presented at the EuMC since its inception.

application area since 1969. Electronic beam steering was already developed in 1969 using Butler matrix [18] or frequency scanning [19]. Numerous achievements have then been presented over the years, including reconfigurable reflector [20] and multi-beam antennas [21] up to the most recent advances employing RF MEMS technology to achieve full electronic reconfigurability [22].

Microwave filtering is another key area both in 1969 as well as today. The realization technologies, however, have evolved from more conventional (cavity and comb-line filters) [23] to MIC [24] and, more recently, to many novel technologies such as LTCC and micromachining [25, 26]. On the other hand, the design techniques have progressed and become more dependent on CAD methods, see e.g. [27–29]. The evolution of the microwave system realization from basic single-function hybrid integrated circuits into modern complex multifunction MMICS has been a continuing dominant theme that links the earliest conferences with the present day. Over the years, several papers have been presented at EuMC showcasing the state-of-the-art in this key technology [30, 31]. As mentioned earlier, microwave CAD was at a very early stage in 1969. The first conference had a paper by E. Whitehead, 'The role of the digital computer in microwave engineering', which argued that microwave design challenges were well suited to the capabilities of this powerful new tool. Over the years, many key papers have been presented at EuMC in the areas of electromagnetic modeling and simulation of passive microwave circuits as well as modeling and simulation at the device, circuit, and system levels [32–34]. For example, the original presentation of the widely used 'Root-model' approach to large-signal device modeling was made at EuMC 1991 [35]. This is one of the most heavily cited papers from the conference's history.

Numerical techniques for the CAD of microwave passive circuits have evolved substantially in these 40 years and this is of course reflected in EuMC Proceedings. The most direct numerical approach, which has been in use since the early times, is the Finite-Difference method, originally applied only in the frequency domain. In the first EuMC, Beaubien and Wexler presented some of the first contributions to this area [36], as well as Pontoppidan [37]. At the same time, 1969 and the early 1970s, the first seminal papers appeared on the Spectral Domain Approach [38, 39], and the first applications of the mode matching technique to inhomogeneous lossy structures [24]. However, computational capabilities were still rather limited so that one had to resort to practical formulae based on accurate computer analyses and semi-empirical considerations. This has been the basis of one of the most popular models for the design of microstrip circuits due to Hammerstad [40]. The years that followed saw a large variety of numerical methods, developed both in frequency and time domains. A number of review papers have been presented during EuMC, marking the pace of development of such a key discipline [41–44].

Reflecting the dynamism and continuing innovation in microwave engineering, major new themes in the contemporary EuMC were quite unknown or only dimly perceived when the conference began in 1969. Examples include RF MEMS, RF CMOS, and GaN-based devices, LTCC modules, RFIDs, metamaterials, nonlinear measurement-based modeling, UWB, MIMO, etc. There has been an increased emphasis on the realization of complete microwave systems in the more recent papers. Another more recent trend is a blurring of the traditional boundaries between analogue and digital design at microwave frequencies. The capabilities of A/D and D/A conversion are constantly improving and bringing the digital world ever closer to the antenna. At the same time, digital techniques can be used in a powerful way within microwave systems to overcome some of their limitations, for example using digital predistortion within power amplifiers. Older areas continue to reappear, perhaps re-invigorated by new technological possibilities: the now popular Doherty power amplifier concept originates from the 1930s, while parametric amplifiers are currently undergoing some renewed interest for mm-wave CMOS implementation.

What does the future hold? Could the inspired enthusiasts who launched the first EuMC in 1969 have predicted much of what is now commonplace in microwave engineering today? Probably not! Hence, we hesitate to offer firm predictions about what topics will dominate the conference in the decades to come. We can, however, be confident that the insatiable demand for ever greater bandwidth with the personal convenience that only wireless and microwave-based systems can offer, will continue unabated. Highly reconfigurable multi-band and multi-mode terminals will exploit the spectrum in an intensive and innovative way, creating new business opportunities around the spectrum itself. The historical trend of microwave engineering to exploit higher frequencies will surely continue and the vast Terahertz band, still relatively underutilized, is just beginning to be used now. All of this will require ever more sophisticated electronic components, both active and passive. Highly integrated complex multi-function systems will be developed with more and more digital functionality realized in low-cost MOS-based circuits. It is likely that energy sources and efficiency will play an even greater role in design, with more interest in 'scavenging' energy from the environment.

IX. CONCLUSIONS

The European Microwave Conference has had a sustained and distinguished development since its first meeting in 1969. It has become one of the two premier conferences in its field in the world and has re-invited itself successfully in the past decade to create a secure foundation for a long and equally successful evolution into the future. This paper has tried to capture the way in which the conference since the earliest days has sought to create a successful blend of scientific and industry interests and has adapted itself to and indeed shaped the many existing technical changes that have characterized and continue to be at the core of the field of microwave engineering.

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