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A brief history of the term Micro Electro Mechanical Systems (MEMS)

The term Micro Electro Mechanical Systems (MEMS) was used as the title to a proposal to the U.S. Defense Advanced Research Project Agency (DARPA), authored by Stephen C. Jacobsen and John E. Wood, dated 15 July 1986. This may be the first documented instance of the use of the term “MEMS”. The proposal was funded, to the University of Utah (UU; DARPA Contract No. F33615-87-C-5287; UU account 5-28064, S.C. Jacobsen, PI; J.E. Wood, Co-PI), Center for Engineering Design (CED), in June of 1987 (through 1992; reference to this project was made in the Institute for Defense Analyses (IDA) Paper P-2374, pg. VIII-5, footnote 39, August 1990). This funding followed, contiguously, DARPA funding to the University of Utah, CED (UU account 5-28098, S.C. Jacobsen, PI; J.E. Wood, Co-PI), for a project known as the “Microfield Project”, which had three phases of funding, from February 1983 to June 1987, under DARPA Program Manager Dr. Robert L. Rosenfeld. It should be noted that this string of “MEMS” funding (to CED) by DARPA preceded the larger “MEMS” program (Microsystems Technology Office, or MTO silo) launched by DARPA in the Fall of 1992, under the direction of Dr. K.J. Gabriel.

The UU MEMS proposal posited a variety of actuators, sensors, motors and gyroscopic devices operating at small scales. Although the use of semiconductor manufacturing methods, to get large numbers of small electro-mechanical elements, was presaged in the UU DARPA proposal, it was not imperative that such methods be used to qualify a machine as a MEMS device.

Drs. K.J. Gabriel and Wm.S.N. Trimmer, both of AT&T Bell labs, as conference Co-Chairs, put together the *IEEE Micro Robots and Teleoperators Workshop*, Hyannis, Cape Cod, MA, 9-11 November 1987 [IEEE Proceedings 87TH0204-8]. Therein, R.T. Howe and J.E. Wood were Session Chairmen for the conference, and in particular, J.E. Wood was the Chairman for Session III, 10 November, titled “Micro Electro Mechanical Systems: Design, Performance and Fabrication”, wherein S.C. Jacobsen gave a talk on “Micro Electro Mechanical Systems (MEMS)” [no final manuscript was produced for that talk, however].

By 1989, the *IEEE Micro Robots and Teleoperators Workshop* had been renamed going forward, with the agreement of Drs. Gabriel and Trimmer and IEEE, to the “IEEE Micro Electro Mechanical Systems Workshop”. The Hyannis workshop was thus counted as the first of what was to become a long-standing series of MEMS

workshops and conferences. The “second” IEEE MEMS workshop was held in Salt Lake City, 20-22 February 1989, with General Co-Chairs S.C. Jacobsen and K.E. Peterson [IEEE Proceedings 89TH0249-3]. The third IEEE MEMS workshop was held in Napa Valley, California, 11-14 February 1990, with General Co-Chairs J.E. Wood and R.T. Howe [IEEE Proceedings 90CH2832-4]. From there, the conference series continued to Asian [Nara, Japan, 1991], European [Travemunde, Germany, 1992] and American [Ft. Lauderdale, Florida, 1993] venues, on a rotating basis.

The flyer for the third IEEE Workshop on MEMS (1990, Napa Valley, CA) had a statement of scope, “The IEEE Micro Electro Mechanical Systems (MEMS-90) Workshop embraces the design, fabrication, operation and application of devices, machines and systems constructed of millimeter-scale or smaller electromechanical elements. Within MEMS, electromagnetic fields can be generated or detected, and mechanical elements can be displaced or distorted in order to execute desired functions. Applications of MEMS are emerging in optics, fluids, chemical and biological processes, measurement and instrumentation, and robotics. Recent fabrication advances (such as micromachining sensor and actuator systems on silicon substrates) offer a myriad of new system possibilities”. Certainly, the notions of “bio MEMS”, “photonic MEMS” and “micro fluidics” were anticipated by practitioners of that era. To understand the micro fabrication technologies and micro devices that predated the introduction of the term MEMS (1986), and the developments shortly thereafter, the interested reader should review the compilation by Wm. Trimmer, titled “Micromechanics and MEMS: Classical and Seminal papers to 1990”, by IEEE Press, New York [1997; ISBN 0-7803-1085-3]. Clearly, there were functional micro devices prior to 1986 that could be considered “MEMS” by virtue of their combination of moving mechanical elements or fluids, electrical elements, and controllers. So, MEMS as a term came after the existence of these early devices. Arguably, MEMS research blossomed in 1987, with commercial fruits appearing by 1990 (such as the piezoelectric pressure sensor, followed by ink jet nozzles and accelerometers). Today (2016), MEMS devices permeate our lives, inside of automobiles, cameras, gaming consoles, ink-jet printers, smart phones and tablets, diagnostic instruments, light projectors and sporting equipment, to name a few commercial applications.

The MEMS field, after mid-1989, saw a proliferation of relevant journals, such as the Micromechanics section of the Journal of Sensors and Actuators (S. Middelhoek was the Editor-in-Chief; Wm. Trimmer was the first Coordinating Editor for the Micromechanics section, starting with Vol. 20, Nos. 1&2, November 1989, based on the 1989 IEEE MEMS Workshop (Salt Lake City) with S. Jacobsen serving as the Micromechanics Section Editor for Microelectromechanical Systems, 1989-1991; J. Wood was the Coordinating Editor for the Micromechanics section, from 1991 to 2013), the Journal of Micromechanics and Microengineering (Vol. 1, No. 1, March 1991), the joint IEEE/ASME Journal of Microelectromechanical Systems (Vol. 1, No. 1, March 1992; Wm. Trimmer was Editor-in-Chief, from 1992 to 1997; S. Jacobsen was an Editor-at-Large, 1992 to circa 1996), and other “micro/nano” journals that followed.

The National Science Foundation (NSF), in the midst of the above period, sponsored a series of three workshops under the guidance of Dr. George A. Hazelrigg, in order to characterize and promote the fledgling field of “microdynamics” (a term adopted by UC-Berkeley researchers). These workshops were held in Salt Lake City, UT (July 27, 1987), Hyannis, MA (November 12, 1987) and Princeton, NJ (January 28-29, 1988). The output of these workshops, attended by 3 NSF managers, 3 editors and 15 panel members, was a booklet titled “Small Machines, Large Opportunities: A report on the Emerging Field of Microdynamics”, subtitled “Report of the NSF Workshop on Microelectromechanical Systems Research” (this report was republished in the 1997 compilation by Trimmer, pg. 117, *ibid.*). It was during these meetings that the term “MEMS” was adopted for the IEEE workshop/conference series and the field.