Clinton Sylvester Hartmann: His Achievements and Our Unwritten Stories

Ken-ya Hashimoto (k.hashimoto@ieee.org)
Graduate School of Engineering, Chiba University, 1-33 Yayoi-cho, Inage-ku, Chiba, Chiba 263-8522, Japan

Abstract—A brilliant super-star in the surface-acoustic-wave (SAW) community, Clinton Sylvester Hartmann passed away in Dallas, TX, on February 4, 2013, at the age of 68. This article reviews Clinton’s professional career and achievements at first, and then a few stories between Clinton and me are given. The stories tell how deeply Clinton contributed to my career up and early achievements. They also show how Clinton motivated, trained, and directed one young engineer.

I. INTRODUCTION
A brilliant super-star in the surface-acoustic-wave (SAW) community, Clinton Sylvester Hartmann passed away in Dallas, TX, on February 4, 2013, at the age of 68 [1]. Clinton is internationally recognized as one of the pioneers in SAW technology. He devoted his 40+ years career developing a wide variety of SAW related technologies from wave phenomena to systems applications. His inventions and developed technologies are indispensable for current SAW devices.

Clinton Sylvester Hartmann
(December 31, 1944 – February 4, 2013)

Clinton was also an excellent mentor. “Guru” might be appropriate. A lot of major players in the SAW community have enhanced their capabilities through collaborative work with him. I am one of them, and his impact to my life is enormous in various aspects. I feel so sorry for the younger generations who did not have the chance to see him and receive his guidance.

In this article, Clinton’s professional career and achievements are reviewed at first, and then a few stories between Clinton and me are given. The stories tell how deeply Clinton contributed to my career up and early achievements including FEMSDA [2] and 42°YX-LiTaO3 (42-LT) [3]. They also show how Clinton motivated, trained, and directed one young engineer.

I trust such mentoring should be imitated by everyone leading young talents. In fact, this is the way that I intend to do when I interact with young bright engineers as well as talented students.

II. HIS ACHIEVEMENTS
Clinton always challenged and even studied new items until his final day, and did not want to spoil his time for non-technical ones including preparation of technical papers. Although Clinton published more than 100 technical papers [4]-[91] in SAW technologies, the number is still surprisingly small when we compare it with his achievements. The number of awarded patents (52 US patents) seems to be a more appropriate indicator.

Since Clinton has already been a super star when I started to work on SAW devices as an undergraduate in 1977, my knowledge of his early activities is limited and may be inaccurate. Thus some information was taken from Ref. [1].

Clinton received the BS degree from the University of Texas, Austin, and the MS degree from the Massachusetts Institute of Technology in electrical engineering with honor.

He was not a Ph-D officially. I felt quite uncomfortable on this because I have it but Clinton does not. I had told him that Japanese Universities offer Dr. degree without course requirements, to applicants with excellent achievements. He showed general interest, however, did not want to share his time even for thesis preparation. He was always too busy.

Clinton joined Texas Instruments (TI) in the Central Research Laboratories in 1968. It was the dawn of the SAW technology. In 1965, Prof. White of the University of California Berkeley proposed use of an interdigital transducer (IDT) for the SAW excitation and detection [92], and this triggered research efforts on the SAW technology for military and communication applications.

Clinton elevated the technology from the basic level to the practical one very quickly [28]. He developed key devices such as

- SAW transversal filters [10,16,17,22,23,32],
- SAW transversal filters using three-phase unidirectional transducers (UDTs)[5,15,24,25,30,33] and/or withdrawal weighting [19],
- SAW matched filters and correlators [4,6,31,34],
- Tunable SAW filters [13,18,26],
- Programmable filters using chirp-Z transform [27],
- SAW delay lines and oscillators [11], etc.

His achievements were not limited only to the device development and system applications, but also to understanding and modeling of SAW physics and their applications to device design tools;

- Impulse response model [8,20,21]
- End effects [12]
- Second order effects [14], etc.

Most of all fundamental technologies established during the period are still used today, and Clinton was always a top runner for their development.

For his work in the field of SAW devices and applications, Eta Kappa Nu, the electrical engineering honor society, named Clinton “The Outstanding Young Electrical Engineer in the United States” in 1976, and TI recognized him as a TI Fellow in 1978. In 2000, Clinton and Prof. White received the W. G. Cady award “For pioneering the early understanding of SAW devices” from the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society.

In 1979, Clinton co-founded RF Monolithics, Inc., where he developed and mass produced SAW devices and systems for consumer use such as CATV, garage opener, etc. Although he...
spent most of his time for the company management in this period, his technical achievements are also notable. Their examples are, SAW resonators [35,40] and their oscillator applications, single-phase unidirectional transducers (SPUDTs)[36-38,41], and the coupling-of-modes (COM) analysis [91]. In 1985, Clinton founded Hartmann Research Inc., an independent SAW research and consulting company. He invented the electrode-width-controlled (EWC) SPUDT [49], and applied it to the development of low loss SAW filters under a succession of programs funded by the US Army. The research effort culminated in the successful development of an EWC SPUDT channelizer for the electronic warfare receiver application [57]. Clinton consulted TI to support development of compressive receivers and pulse compression radars using slanted IDTs [46-48]. He also consulted ASCOM Microsystems (later Advanced SAW Products, or ASP, and then Micronas) for development of radio frequency (RF) SAW devices for communications [54-55,58-73]. Some stories in this period are given in the next section.

In 2000, Clinton founded his third company, RF SAW Inc., where he focused all his efforts to the development of SAW RF identification (RFID)[79,82,87,89]. Clinton invented new modulation scheme enhancing the data capacity [79]. In 2006, NASA selected RF SAW's RFID technology to test aboard the International Space Station as a possible method to modulation scheme enhancing the data capacity [79].

In 1993, Clinton asked me to assist ASCOM Microsystems with him. The company was developing SAW devices for mobile phones, using leaky SAWs on highly piezoelectric substrates. I accepted this proposal with pleasure, and visited Bevaix, Switzerland. In the company, there were so many talented researchers such as Victor Plessky, Dongpei Chen, Thor Thorvaldsson, Sergei Kondratiev, and Ivan Avramov. Every afternoon, we gathered at a conference room and discussed various topics deeply. Since each person has different speciality, discussions always heated up, and various new ideas came out. We were very stimulated by each other. One day, I showed my calculation of the SAW dispersion on 36°YX-LiTaO₃ without electrode mass loading at the meeting. The substrate was widely used for SAW devices, and the rotation angle was believed to possess minimum leaky loss. Clinton said, “Look! The leaky loss changes with the frequency, and does not take a minimum at the resonance. Loss minimization is always crucial!” Since I knew that the leaky loss can be theoretically zero when the cut angle is properly chosen [96], I proposed to Clinton that we try to find the best angle experimentally. He was interested in this topic, however, I did not receive a response on this from the company. A few year later, I proposed the same idea to Fujitsu, which succeeded in finding the optimal orientation (42-LT) [3] and got certain profit. I also started to develop a program to calculate the SAW dispersion with taking the mass loading into account. It was inspired by Clinton’s suggestion, “Industries need fast and accurate simulation tools for the SAW device design. Such work is what industries demand to academia!” There was a strong contrast with a chat given by a Japanese engineer, “All necessary design parameters can be estimated by series of experiments, and thus accurate simulators are not necessary.” Anyway, the CEO accepted my proposal and promised to support our lab financially through its parent company. After one and half years, we developed the program called FEMSDA [2]. We demonstrated its operation when Clinton came to Japan, and he was so surprised at its accuracy.
I proudly presented the usefulness of the software in ASP. When I showed a calculated SAW dispersion curve where the influence of the Bragg reflection was artificially removed, Clinton said, “Look! The SAW velocity decreases locally near the Bragg frequency. It is a phenomenon we only know of empirically” [66]." I thought the local velocity decrease was only a numerical artifact until his comment. Next I needed to (a) find the physical mechanism causing this phenomenon, and (b) include its model in the COM theory. I still remember how happy I was to hear his report on this topic [97].

Of course, the software was intended for the internal use in ASCOM (ASP). However, its parent company has never transferred money to us, and finally the CEO left the company.

Ben Abbott heard the FEMSDA from Clinton, and asked me to share it. I did not have obligation to ASP any more, and believed all SAW engineers and researchers want to use the software. So I decided to offer the software in free of charge under request [98].

IV. CONCLUSIONS

The above stories reveal how strongly Clinton influenced my early career. Although his name does not appear in my paper list, his indirect contribution to my work was enormous in various aspects. I might be an unknown researcher if I had not received Clinton’s guidance. At least, I would have left the SAW field.

His followers say that he could be a wonderful professor if he had wanted to. I 100% agree. As one of the gifted persons who could know Clinton deeply, I have a duty to dedicate the benefits given to me by Clinton to younger generations.

Finally, I add a last message with my wife Kaoru and daughter Hirono. We all love you, and you will keep on staying in our hearts forever. Have a good rest!

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APPENDIX

When I sent a draft of this article, Ben gave me the following interesting comments on Clinton’s mentoring.

Clinton was a great mentor to me as well. Reading this article, it is interesting that Clinton mentored us in very different ways. I recall Clinton’s commenting that Thor was a walking encyclopedia for SAW. After that I noticed it was common for Clinton to ask Thor where a particular publication could be found before starting to look for it himself (Thor was always happy to help and found it faster than any other people). It was clear from this that he had integrated into the minds of people (not just technology) and was happy to encourage them to do what they were good at.

Clinton recognized my strength was in simulation. He often asked me to answer simulation questions, which I wouldn’t dared to ask myself. Once Clinton asked the questions, the answers would seem to magically come to me. I’m still impressed that he knew the answers were in me, and grateful that he lit the spark that enabled me to find them within myself.

REFERENCES


pp. 293-296.


