31st Annual International Conference of the IEEE EMBS
Minneapolis, Minnesota, USA, September 2-6, 2009

The Natural History of the Engineering in Medicine and Biology Society from a Modern Perspective

Jesús Requena-Carrión and Ron S. Leder

Abstract— **The history of the IEEE EMBS runs hand in hand with the history of Biomedical Engineering both as a scientific discipline and as a profession. The conferences and publications led by IEEE EMBS, amongst other activities were a mirror of the evolution of Biomedical Engineering over the years and they equally contributed to shape Biomedical Engineering as we view it today. The IEEE EMBS provides a testimony of how a broad and diverse scientific community that comes from many diverse areas such as medicine, engineering, physics and chemistry and shares common purposes and interests can successfully work under the same designation of biomedical engineers. This account is a review of the history of Biomedical Engineering and the development of the IEEE EMBS since the inception of its predecessors, the AIEE Committee on Electrical Techniques in Medicine and Biology and the IRE Professional Group in Medical Electronics.**

I. Introduction

The IEEE Engineering in Medicine and Biology Society (EMBS) is the largest international member-based society of biomedical engineers, having more than 8000 members from around 70 countries in the world [1]. Incidentally, the IEEE EMBS was as well one of the first Biomedical Engineering societies to be formed more than half a century ago, when the idea of Biomedical Engineering as a scientific discipline and as a profession was still incipient.

Over the years since its inception, the IEEE EMBS has contributed to shape Biomedical Engineering as we see it today. Therefore, understanding Biomedical Engineering nowadays would be incomplete without considering the history of IEEE EMBS. The present paper is a summary of the more exhaustive account that Frederik Nebeker presented on the occasion of the 50th anniversary of the IEEE EMBS [2]. We intend to provide with a glimpse of the exciting course followed by the IEEE EMBS over the years of development of Biomedical Engineering. For the interested reader we suggest to further learn from the stimulating account written by Frederik Nebeker.

II. The Birth of IEEE EMBS

The origins of the IEEE EMBS can be traced back more than 50 years to the predecessors of the IEEE, namely the Institute of Radio Engineers (IRE) and the American Institute of Electrical Engineers (AIEE). Back in the late 1940s, the World War II had given a boost to scientific and technological production and as a consequence, many fields of science and technology experienced a rapid diversification. Electronics was one of the fields that advanced the most, and both the IRE and the AIEE readily adapted to the new scenario by creating special committees devoted to specific areas of electronics. One of the main areas of electronics was concerned with problems in biology and medicine. In order to promote this area, the AIEE formed a Committee on Electrical Techniques in Medicine and Biology in 1948, and the IRE formed the Professional Group on Medical Electronics in 1952.

The IRE Professional Group on Biomedical Engineering and the AIEE Committee on Electrical Techniques in Medicine and Biology favored many forms of collaborations between them. Along with the Instrument Society of America (ISA) they formed the Joint Executive Committee on Medicine and Biology. The Joint Executive Comittee assumed, among other activities, the task of organizing the annual Conference on Medical Electronics inaugurated in 1948 by the AIEE. The intense collaboration between the IRE Professional Group on Biomedical Engineering and the AIEE Committee on Electrical Techniques in Medicine and Biology was one of the leading factors that contributed to form the IEEE from the fusion between the AIEE and the IRE in 1963. From its birth, the IEEE adopted the IRE system of professional groups and as a result the IEEE Professional Technical Group on Bio-Medical Engineering was born, which was later to become the IEEE Engineering in Medicine and Biology Society.

III. The Development of Biomedical Engineering and The IEEE EMBS

Biomedical Engineering is nowadays regarded as a broad and diverse scientific discipline and the IEEE EMBS reflects this feature [1]. Around 87% of its members hold a diversity of engineering degrees -most notably electronic, computer, industrial, biomedical and communications- and the remaining 13% hold degrees in life sciences -biology, chemistry and medical- and physics. Additionally, IEEE EMBS includes 13 Technical Committees that cover specific areas within Biomedical Engineering, such as microtechnology, signal processing, image processing and information technology.

The current picture of Biomedical Engineering differs from the early physics and engineering approaches to solve problems in biological and medical research. Part of the explanation for this discrepancy is the rapid evolution of science and technology during the second half of the 20th century. It was this feature of science and technology that stimulated the development of new techniques and methods which would have never been foreseen in earlier decades.

J. Requena-Carrión is with Department of Signal Theory and Communications, Universidad Rey Juan Carlos, Spain jesus@tsc.uc3m.es
R. S. Leder is with Universidad Nacional Autónoma de México, México rleder@ieee.org

It can be safely argued that the origins of Biomedical Engineering can be found in the earliest experiences with bioelectromagnetic phenomena. Already in the 18th century, electricity was used for therapeutic purposes, although in a rather crude manner. It was especially through instrumentation that engineering entered biological and medical research. In 1888 August Waller recorded heart voltages from the body surface using a capillary electrometer. In 1903 the string galvanometer invented by Willen Einthoven made possible two important medical instruments, the electrocardiograph and the electroencephalograph. Other advances in electronics, such as electron tubes and the differential amplifier, contributed to the advancement of medical instrumentation. X-ray imaging, invented by Wilhelm Röntgen in 1895, was the other technology that had a big impact on medical practice.

Given the importance of electronic instrumentation in the early years of Biomedical Engineering, it is not surprising that the AIEE and the IRE promoted the establishment of technical committees concerned with medicine and biology. In the 1940s both the AIEE and the IRE had expanded from their respective fields to include almost all areas of electronics and therefore, anyone interested in solving problems in biology and medicine by using electronic engineering principles might have belonged to either the AIEE, the IRE or both. The terminology used at the time shows how central electronics was for Biomedical Engineering. The main technical committees concerned with Biomedical Engineering contained either of the terms *electrical* or *electronics*, and so did the main conference in the field. Along that same line, the first regular journal of the IRE Professional Group was the *IRE Transactions on Medical Electronics*.

The 1950s saw the first serious attempts to consolidate Biomedical Engineering as a discipline. This decade was one of economic growth and enormous advances in electronic technology following to the invention of the transistor, which improved electronic amplification. Biomedical research, notably cardiopulmonary research, benefited from these advances, and devices such as the cardiac pacemaker, the external defibrillator and the heart-lung machine were developed. X-ray technology continued improving with the introduction of fluoroscopic image intensifiers. The electronic digital computer was another device that quickly found its place in biomedical research, notably for electrophysiological data processing. The role of computers became so prominent that in the 1960s the journals *Computers in Medicine and Biology* and *Computers and Biomedical Research* were established.

Through the 1960s more and more noneletronic engineering techniques and methods for medicine and biology were developed. This change was reflected on the adoption of new terms for the emergent field that had been known either as *medical electronics* or *engineering in medicine and biology*. Some committees promoted the term *bioengineering*, whereas other promoted *biomedical engineering*. The IEEE technical committee devoted to engineering in medicine and biology was named *IEEE Professional Group on Bio-Medical Engineering*, and published the *Transactions on Bio-Medical Engineering*. In 1968 the Biomedical Engineering Society was formed from a group of leaders of the IEEE Professional Group on Bio-Medical Engineering that sought to achieve more autonomy within the IEEE.

The 1970s was the decade of medical imaging techniques. Computerized tomography, nuclear magnetic resonance and positron emission tomography were all developed in this decade. As a result of the interest elicited by medical imaging techniques, the *IEEE Transactions on Medical Imaging* began publication in 1982. Digital technologies takeover became a reality in the 1970s and instruments started incorporating microprocessor, which made possible to create automatic medical devices. Cardiopulmonary research benefited also from the advances in engineering, with outstanding inventions such as the implantable defibrillator and the artificial heart. Twenty years after the establishment of the first societies devoted to Biomedical Engineering, this field had become a significant sector of the economy: only in the United States, 5000 companies offered products with a total annual sales of $1.5 billion.

Advances in electronics and computing further stimulated the improvement and diversification of biomedical solutions and devices during the 1980s and simultaneously, the IEEE EMBS broadened its scope. It was in 1982 that the magazine of the Society made its debut with the purpose of reaching an increasingly diverse audience. Cardiopulmonary research and medical imaging remained active areas in biomedical research in the 1980s. Specifically, the FDA approval to four companies to manufacture magnetic resonance imaging machines in 1984 was one of the milestones of this decade. Medical practice benefited greatly from the introduction of other new techniques based on engineering principles, such as balloon angioplasty, endoscopy and laser surgery. This tendency towards more diversification continued in the 1990s, in which the human genome project and medical robotics stood out as the most exciting areas in Biomedical Engineering. During the last decade of the 20th century, the biomedical sector expanded to be the fastest growing economic sector in the United States. In the meantime, the membership of IEEE EMBS reached at peak of 9,426 in 1993, gradually declining thereafter until the current total of some 8000. Membership composition reflected an increased internationalization which culminated when in 1992, the EMBS held its annual conference in Paris.

IV. The EMBC

The U.S. Conference on Medical Electronics held by the AIEE Committee on Electrical Techniques in Medicine and Biology in 1948 is considered to be the first ever on the subject. Shortly thereafter, the Joint Executive Committee on Medicine and Biology -which was formed by the AIEE, IRE and ISA in 1954- assumed the task of organizing the annual conference which was named Conference on Electrical Techniques in Medicine and Biology. When the decade was over, the conference had reached 500 attendees and 60 to 70 papers were presented.

In the 1960s the newly formed Alliance for Engineering in Medicine and Biology assumed the task of organizing the Annual Conference of Engineering in Medicine and Biology. In the late 1970s the IEEE EMBS decided to hold its own annual conference. As a results, between 1979 and 1985 the IEEE EMBS participated in both its Annual Conference and the conference organized by the Alliance, that would take place in the same city and one after another. Nevertheless, after 1986 IEEE EMBS started holding its annual conference separately, which resulted in the later demise of the AEMB conference.

V. Conclusions

The EMBC motto for this year is *Engineering the Future of Biomedicine*. Through this motto the IEEE EMBS recognizes its central role in determining the Biomedical Engineering of the future. History shows us that since its inception the IEEE EMBS has contributed to shape Biomedical Engineering as it stands today. We believe that understanding the history of Biomedical Engineering will help us both understanding Biomedical Engineering today and making the Biomedical Engineering of tomorrow.

References

[1] *www.embs.org*.

[2] F. Nebeker, "Golden accomplishments in biomedical engineering", *IEEE Engineering in Medicine and Biology Magazine*, vol. 21, 2002, pp 17-47.