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collaboration

Biomedical engineering is a discipline that advances knowledge in engineering, biology, and medicine; improves human health; and enhances human lives through cross-disciplinary activities that integrate engineering with the biomedical sciences and clinical medicine. A unique feature of biomedical engineering is its close integration of engineering with biomedicine. On the one hand, it is an engineering discipline, so engineering innovations lead to advances in the field. On the other hand, the unique features of biological systems and medical needs drive the development of new theory, methods, devices, and materials.

The interdisciplinary nature of biomedical engineering represents an exciting opportunity to address the mystery of biological systems. However, the fact that so much knowledge and skill is required to make a contribution to this interdisciplinary field is a major challenge. Despite the debate concerning what would be the optimal education model to train the next generation of biomedical engineers, those who are actively engaging in R&D in biomedical engineering face the necessity of having expertise in multiple fields required for much of the biomedical engineering's research and development. This may explain the length of training a biomedical engineer needs and may also partially explain the increased average age of academic investigators who receive the National Institutes of Health (NIH) RO1 grants (regular research project grants) in the United States.

A possible solution to this problem is through collaborations. Significant accomplishments are increasingly made through collaboration between or among

researchers who have expertise in related areas. This is especially true for biomedical engineering, as engineers or physical scientists often collaborate with biologists or clinical scientists to discover new mechanisms; invent new techniques; and develop new devices, algorithms, and materials. More than half a century ago, Earl Bakken, an electrical engineer, collaborated with C. Walton Lillehei, a heart surgeon at the University of Minnesota, which led to the invention of a battery-powered cardiac pacemaker. This

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collaboration between engineering and medicine has been fruitful, leading to establishment of a medical device industry and having saved numerous lives.

Collaboration is important in biomedical engineering, not only between engineering and biomedicine but also between academia and industry. Academic exploration of fundamental research is critically important for academic investigators. Such investigator-initiated exploration is the foundation of basic research. At the

same time, translational research that can transform research findings into clinical applications, in order for the larger society to benefit from research, is growing more important. Academia–industry collaboration stimulates academic researchers to look for real problems in clinical medicine. Although caution is needed to ensure academic freedom in scientific exploration, such exposure or stimulation from collaboration with industry benefits academic investigators in reshaping their research strategy and identifying significant problems in biomedicine that society needs us to address.

Academia–industry collaborations are not only beneficial to academics but also to industrial colleagues. With the vast expertise represented by the academic community, such collaboration would provide an opportunity for industry to have access to unique expertise without the need to establish in-house expertise in all areas that might become important for a company in the future.

As with any collaboration between disciplines, or between sectors, there are barriers that must be overcome to achieve successful collaborations. The first step shall be to get together and discuss what would be of interest for both academia and industry. Scientific conferences shall serve this purpose to facilitate the exchange of ideas and foster cross-discipline and cross-sector collaborations. We have made efforts in encouraging enhanced participation from the medical device and health-care industry in the IEEE Engineering in Medicine and Biology Conference 2009 (EMBC 2009) held in Minneapolis and hope that industry representation will be further enhanced in future conferences.