Keynote Lecture

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Microscale Bioengineering Inspired by Nature: From Widgets to Cell Biology

David J. Beebe

Biomedical Engineering, University of Wisconsin – Madison, USA.

Thursday, August 23, 10:00 – 10:45, Amphitheatre

Nature has accomplished impressive functionality through evolution that far surpasses our ability to recreate similar functionality through engineered systems. While nature is limited to leveraging and adapting the physics of the natural world, engineers are free to imagine. With notable exceptions such as digital computing, the freedom to imagine has often led to "over engineered" solutions rather than the simple solutions nature often achieves. At the micro scale the dominate physical phenomena is often different than at the macro scale. For example, diffusive transport becomes increasingly important and surface tension can dominate over gravitational forces. The scaling of these natural phenomena lead to a very different physical world than the one we live in and presents opportunities for elegant harnessing of these forces in useful and interesting ways. Microscale forces can be leveraged to realize a variety of functions ranging from sensing and control to manipulation and processing to creating systems aimed at recapitulating in vivo cellular structure and function. The presentation will include a microscale tutorial, examples of bioinspired micro/cellular scale engineering and a discussion of the promise and challenges in mimicking cellular microenvironments in vivo.

David J. Beebe is a Professor in the Department of Biomedical Engineering at the University of Wisconsin-Madison. He is also a member of the UW Comprehensive Cancer Center, Stem Cell Program, Materials Science Program, Biotechnology Training Program, and Genomic and Sciences Training Program. From 1996 to 1999, he was an Assistant Professor at the University of Illinois at Urbana- Champaign. From 1994 to 1996, David was an Assistant Professor at Louisiana Tech University. He received the B.S. (1987), M.S. (1990) and Ph.D. (1994) in Electrical Engineering from the University of Wisconsin-Madison. He is the recipient of the IEEE EMBS Early Career Achievement Award, the Romnes Award at UW-Madison and Lab on a Chip, Royal Society of Chemistry and Corning, Pioneers of Miniaturization Prize. He has also served as an Associate Editor for Journal of MicroeElectroMechanical Systems, the Journal of Biomechanical Engineering and is currently on the editorial board of Lab on a Chip.

He has published over 100 peer reviewed articles in leading journals including Science, Nature and the Proceedings of the National Academy of Sciences. Prof. Beebe is a co-founder of Vitae LLC, Salus LLC and Ratio Inc. Past research topics have included development of non-traditional autonomous micro fluidic devices and systems, and the study of cell and embryo development in microenvironments. David's current interests center around understanding the role stem/progenitor cells play in the development of the mammary gland. David is currently in the midst of a retraining effort in cancer biology via a 5 year NIH K25 award.

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What is the Added Value of Biomedical Engineering Technologies?

Jean-Claude Healy

European Commission Brussels, Senior Advisor United Nations GAID New York, former WHO Director Geneva

Thursday, August 23, 10:45 – 11:30, Amphitheatre

All the Nations are convinced the Research and Development (RD)in general and in the Biomedical Engineering (BME) area in particular, will save the present growing problems of the planet and accordingly, try to convince the tax payers to invest money and human resources for a better future quality of life.

Of course this assumption is valid but, learnt from the last 3 century history of BME, must be documented. The first naïve approach is to be convinced a magic unknown new technology will solve tomorrow the present global health and medical problems. The second approach highlights the economical impact including employment in the relevant industry. Many others approaches focuses on the progress of knowledge and sciences, on the global competition and others completive advantages.

But two main lessons are learnt from the past:

- The first lesson is: the impact of technologies are peanuts without an ad hoc implementation systems, or, in others words, the long term impacts of new technologies are not related to the direct today performance of the techniques, but to the long term ability of the technique to induce the reengineering of the overall system. At the end of the XIX century, the drugs redesigned completely the treatment procedures, during the XX century the medical imaging solutions redesigned the diagnostic procedures and now the information and communication technologies are fostering a complete revision of the traditional of the various healthcare delivery systems. The reengineering of the system is the final goal of the techniques and the technical solutions are not a treatment for curing the present diseases of healthcare system. But towards which system? A technical or economical driven systems? No
- The second lesson is: The present "patient and disease centered Healthcare delivery systems" are the common paradigms for reasoning and are based on the assumption "sciences will save me". Due to different reasons (economy, acceptance, accessibility, sustainability etc) this paradigm is outdated and a new one, more "citizen and Health centered paradigm" must be urgently designed. This new paradigm suppose a continuous personal long life commitment and is now largely facilitated by the progress of the personal predictive medicine and communication technologies. In addition this paradigm is not limited to the rich countries (25% of population) but equally valid for low income countries and 100% of the population of the world.

These lessons induce substantial operational consequences: the power and the efficiency of RD are not just limited to the performance of the new products, so good they are, but to the capability to induce changes in the overall system towards an acceptable one. On the reverse, with the technologies of the moment, substantial productivity gains and better results can be expected from RD focused not on techniques but on the systems themselves.

As a whole, the medical system is extremely conservative and in average,17 years, (half generation…), are needed for a full approval of qualified techniques. Each component of the value chain is concerned: HC professionals, final users, decision makers, financial authorities, politicians, etc. This is unacceptable.

The Biomedical Engineers have the intellectual capability to develop the due systemic approaches of the problems and to propose solutions, but the fragmentation of the research and disciplines, the competition, and the lack of top level responsibility don't facilitate robust sustainable implementation plans.

Accordingly, in addition to RD activities, we need new vision, new long term vision, new global vision, new integrated vision for boosting the new "citizen centered Health delivery systems". Here is the value of the technique.

Prof Jean-Claude Healy, PhD MD (Paris University), was for 30 years Professor of Biophysics and Medical informatics in a range of leading French Universities and Hospitals. He joined the EU DG INFSO in 1995 as Head of Unit "Telematics Applications for Health" (1995-2004), "IST Applications relating to Health", eHealth. He is presently Senior Advisor to the UN GAID (Global Alliance for ICT and Development) in New York and has been recently appointed by the French Minister of health as a Member of the High Level Public Health Council. He has published more than 250 scientific publications and additional administrative documents for the eHealth Resolution (WHA 58 28) , WHO eHealth action Plan, the EU-WHO eHealth report for the World Summit on Information Society etc.