Biomedical Engineering, Support Model between Medicine and Technology in Panama

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ABSTRACT

This paper addresses various aspects of Biomedical Engineering career. It is focused primarily on the professional and educational aspects in Panama. It provides a snapshot about the career, the inclusion of it in the country, field of application, higher level teaching, the integration of biomedical engineer on labor, the current reality and future of Biomedical Engineering in Panama. In addtion, the results of a short survey of Panamanian Biomedical Engineers are shown with some international experiences. Remarkable programs in other coutries are identified as a way forward for the advancement of the Biomedical Engineering in Panama.

Keywords: Biomedical engineering, education, industry, medical services, technology.

1. INTRODUCTION

Health systems worldwide depend increasingly on the use of medical technologies to support the processes of diagnosis and therapy. The demand by health professionals to obtain increasingly accurate results with greater efficiency in the shortest possible time, have made the integration of emerging technologies a need to be filled. However, the complexity of health technologies that are in the market today, its rapid integration and application in medicine, have led to need a professional who understands the medical needs, knows the clinical language, and offers the best solutions that may exist. Additionally, many needs expressed by the medical staff can not be performed due to the absence of commercial devices for personal use in patients.

The new devices, machines or prototypes to improve the quality of life and independence of the people are important aspects in medicine and might be unattainable in many countries due to high costs for equipment and maintenance, as well as the socioeconomical disparities, causes a lack of health attention (Douglas, 2011).

Professionals who meet the aforementioned qualifications to understand the medical needs from a technological orientation is the Biomedical Engineer. Under the ancient Whitaker Foundation, "Biomedical engineering is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that intengrate engineering sciences with biomedical sciences and clinical practice" (The Whitaker Foundation, 2006).

This definition recognizes and emphasizes the need to adapt to the existing programs training engineers in the biomedical field in order to obtain a solid profile of engineering and also in medicine and biology. Globally, there is a rapid growth in the programs of bioengineering and biomedical engineering (Abu-Faraj, 2008). This informative article refers to some of the most significant aspects related to the inclusion and acceptance of biomedical engineering in Panama. Some considerations about the experience gained in other academic programs have yielded positive results and can be used as models to be developed in Panama.

2. INCLUSION OF BIOMEDICAL ENGINEERING IN PANAMA

In recent years, engineering has had a high impact in Panama due to the rapid modernization of the different health services. There are many positive changes and improvements experienced by the Panamanian health system with the inclusion of Biomedical Engineer within its structure. These changes occurred gradually since the first rating of these health professionals.

The figure of the Biomedical Engineer was soon recognized in both public and private sectors. It created not only jobs but also created or completed restructuring Biomedical engineering departments in hospitals. It also created approval systems, registration and control of medical equipment nationwide, among others. Private companies, biomedical equipment distribution, and also found the staff multinationally qualified, accredited and professional profile required to meet the different needs of its clientele.

Other events increased the weight of the career nationally, including the creation of Professional Chapter of IEEE Engineering in Medicine and Biology (IEEE-EMB) of Panama in 2008, the Student Branch IEEE-EMB-ULAT in 2009, the regulation formal career by the Society of Engineers and Architects (SPIA) of Panama and the formation of diverse national organization related to the career such as: Panamanian Association of Biomedical Engineering (APIB), National Association of Engineers and Technicians in Electro Medicine (ANITEM) and the Panamanian Association of Biomedical Technicians and Engineers Associations (APTIBA).

Also international achievements have been made as it was, in 2011, the official inclusion of the IEEE-EMB Professional Chapter of Panama giving the first performance of the country within the Regional Council of Biomedical Engineering for Latin America (CORAL), becoming the standard for all Biomedical Engineering professionals. This event promotes the representation of international careers and creates a springboard for cooperation and development of its members.

3. BIOMEDICAL ENGINEERING AND ITS APLICATION FIELD

Biomedical engineering is being increasingly integrated in world geography, mainly due to the need to offer better health services to society. Many of the contributions made in the medical areas in recent years, have been atributed to biomedical engineering. From the earliest electrophysiological studies conducted by the Luigy Galvani in 1780 of his studies about electric currents in the human body.

The development of medical devices such as electrocardiographs, modern X-ray equipment, computed tomography magnetic resonance imaging, automated equipment for clinical laboratory tests and the inclusion of robot-assisted surgery in the operating rooms are some of the examples where biomedical engineering could improve knowledge and practice in modern medicine from the scientific perspective and technology (Nebeker, 2002).

Is enriched with different areas of human knowledge such as, mathematics, physics, chemistry, biology, anatomy, physiology, among others. Using them in conjunction with an engineering knowledge to try to find optimal solutions to various problems in the health field. Some of the main areas of application of biomedical engineering, are found, but not limited the diagram shown in Figure 1.

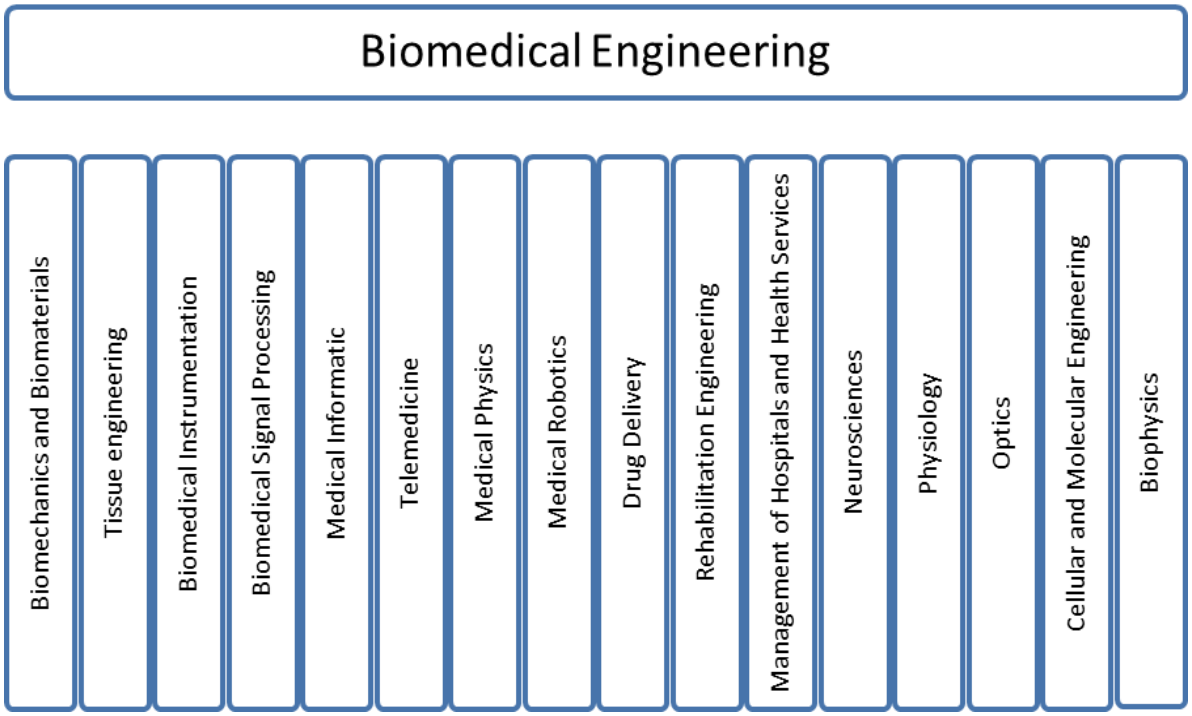

Figure 1: Some of the main areas of application of biomedical engineering.

4. HIGHER EDUCATION IN PANAMA

Biomedical engineering in Panama is at least a decade old at the university level. Actually, there are two universities, the Universidad Especializada de las Américas (UDELAS) and Universidad Latina de Panamá (ULAT), a state and a private respectively, offered in their undergraduate curricula in Biomedical Engineering with different professional orientations.

The offer provided in the academy must be kept under continuous actualization and meet the highest standards in education. The commitment of higher education within society demands the improvement of the curricula constantly. In this case, Panama is in a University accreditation process to maintain the highest standards and provide the best professionals to society.

Within the complex processes of upgrading and accreditation of curricula, we can mention the accreditation process exercised by the Accreditation Board of Engineering and Technology (ABET). It was voluntarily submitted to many engineering schools in the United States in order to improve and systematize the biomedical engineering plans, to promote best practices in education within the highest standards of quality (Harris et al., 2002). It is a fact that the accreditation of curricula is a reality, because they constantly need to review the criteria and content required by both students and academic institutions and their faculty.

According to Nagel, the process of accreditation of biomedical engineering plans is important because it reinforces the minimum requirements of the different programs, improve its contents, credits, and quality without losing the essence of these and individuality that characterizes them and other programs (Nagel, 2001) .

5. INTEGRATION WITH THE PROFESSIONAL FIELD

This knowledge can not be given in a classroom or laboratory. It is necessary to apply the knowledge learned from the environment that future graduates will face, so that they can strengthen their theoretical knowledge to use them in the analysis and resolution problems in the real world.

This requires rotations in hospitals of different levels of complexity, so that students can learn about the various problems they will face in a hospital setting. Likewise, other students will be excited to tour the facilities of companies providing a private service and representing major brands of medical equipment and interacting with other professionals. On the other hand, another group of students will be encouraged to continue an academic career where stronger research and innovation to solve problems. The result will be the improvement of the knowledge in an area of interest.

Early exposure to a work environment is a stimulus in the training of students in biomedical engineering. Getting to perform practices "in situ" allows a better understanding of the demands of the profession and skills to be acquired during the undergraduate years through different courses. Such experiences have been put into practice.

An interesting example is the implementation of a bioengineering course given at the University of Pennsylvania in the United States whose goal is to immerse the students a few weeks in a course which will have the experience of interacting with various specialists that will be exposed to activities to bioengineering (Davies and Litt, 2006). Another model of teaching is the highlight of the programs offered by ESTEEM REDEEM projects and Tohoku University, dictated primarily by doctors and clinics where they have classes and laboratory experiences so that engineers can reflect and better understand how medical language (Matsuki et al., 2009).

5.1 BIOMEDICAL ENGINEERING PANORAMA IN PANAMA

The three main areas that are integrating biomedical engineers in Panama are (Figure 2):

• Healthcare Facilities (hospitals and clinics, public and /or private), exerting different tasks wich include technical support, implementation and administration of the vast technological infrastructure of these entities.

• Distribution companies and service provider specializing in medical equipment, chiefly in the commercial area, consulting, technical support, administration and management of technological projects.

• Governmental groups oriented to the approval, regulation, registration and control of technology applied to the field of health. (Social Security Fund of Panama (CSS), Ministry of Health of Panama (MINSA)).

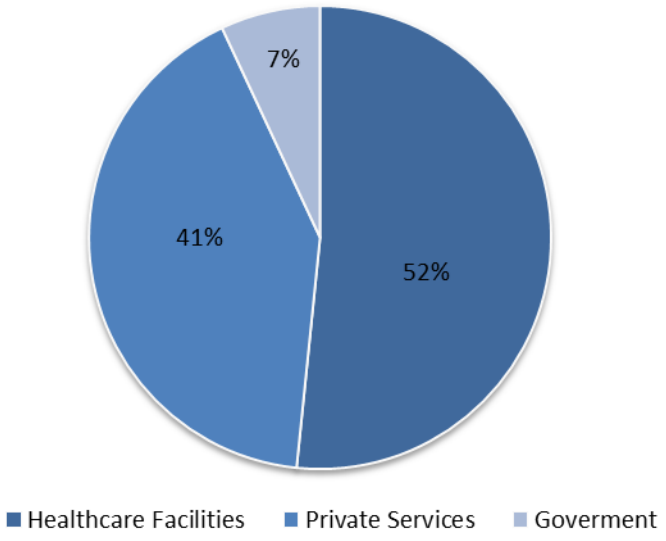

Figure 2: Proportion of biomedical engineering activities in Panama up to 2012. Source: (CSS, 2012) and (MINSA, 2012).

5.2 COOPERATION BETWEEN UNIVERSITY, PRIVATE ENTERPRISE AND STATE AGENCIES

It is expected that the interaction of universities, private companies and government to create new fields of work in the area of research and development, including:

• Research, analyze and develop new technological solutions aimed at the solution or improvement of various problems affecting the welfare and health of people.

• Business incubation, where the potential advantage of the engineers to create new products and services aimed at the constant improvement of resources and quality of specific areas of the health sector.

Focusing on this year 2012, there is cautious optimism that the economy and the labor market continue to improve. According to the Office of Labor Statistics of the United States (BLS, Bureau of Labor Statistics, Charting the Projections: 2008-2018), biomedical engineering is one of the fastest growing occupations, with a projected increase of 72% employment during the period 2008-2018 (Figure 3).

This information gives us a notion of projection and the growing importance and will race in the near future, which is why the training of these professionals should be focused on meeting the needs of current and future markets in order to achieve professional excellence (U.S. Bureau of Labor Statistics, 2009).

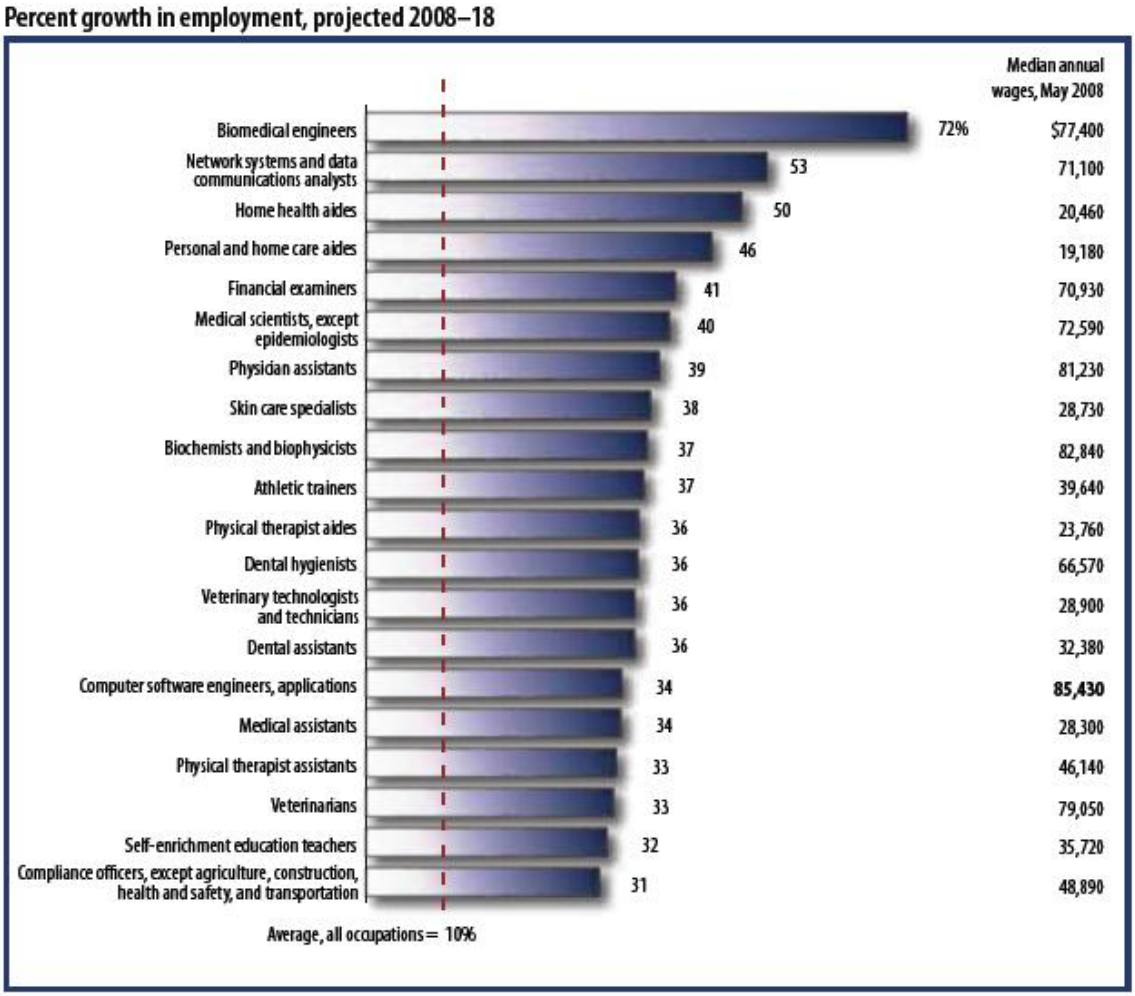

Figure 3: It shows the projected job growth for the period 2008-2018, which shows that the biomedical engineer is the career with the greatest growth in that period. Source: Graph taken from paper (U.S. Bureau of Labor Statistics, 2009).

6. SKILL ACQUISITION

In a real world, teamwork is essential to solve multidisciplinary problems and bring to fruition the project development. Exposure and understanding of ideas within a team of engineers and health professionals for its academic nature, who speak different technical languages, is a challenge to overcome. Complicated concepts must be easily communicated within a multidisciplinary team in order to culminate a successful project.

Therefore it is necessary for students to acquire a number of learning-based skills focused on case studies, problems and projects in order to approach more and more everyday situations. One should look for solutions or different alterantives to a problem through a process of reflection that involves a recognition and understanding of the problem itself (Harris et al., 2002). This will help students deal with real problems, where classes implement the knowledge acquired in order to deal with real situations(Shuman et al., 2005).

For example, if you want to solve a real problem in biomedicine, it will require the use of different strategies, which can lead to use software (MATLAB, MATHEMATICA) to better understand a given phenomenon and in turn several limitations, or perform an experiment using virtual instrumentation (LABVIEW) that allow them to develop a prototype, which will enable students to discuss the best way to write a program, to know the level of complexity that is needed to make a prototype to solve a biomedical engineering problem (Enderle et al., 2002).

On the other hand, part of the knowledge is acquired through practice and experience. Often we find limitations in the use of facilities, equipment, human resources or time. Different alternatives can be applied to reduce these impediments. An interesting alternative is used to teach and reinforce concepts in courses in anatomy, physiology or biomedical instrumentation where it makes use of clinical simulation, through the manipulation of mannequins. Allowing biomedical engineering students to understand those aspects that are often discussed in a textbook or simply when they are faced in the workplace (Figure 4).

As a particular example, in a scenario where a student must properly position leads to take an electrocardiogram, with the dummy can be carried out with this practice. Plus an instructor can guide you to know what would be observed in vital signs monitor if you make a wrong connection, and induces some type of arrhythmia that students could easily recognize.

Figure 4: Students using a mannequin for medical simulation. Source: Courtesy of de Clinic-Hospital of Simulation. Universidad Latina de Panamá, Medical and Health Science College.

Such practices will help the student in their future careers as you can respond appropriately in a compromising situation, where appropriate decision making from a technical point of view, reduces the risk of an unexpected situation (Gordon et al., 2001). An observed advantage is the flexibility of schedule and time to perform this type of experience and use of corpse in a morgue is a priority for students of medical sciences entails a much larger number of steps for those who are not medical students.

7. POST-GRAD AND RESEARCH ACTIVITIES

It is necessary to carry out research activities that meet at multidisciplinary academic institutions, hospitals, research centers and government.

To meet current market demands and promote research, Europe has been building initiatives and the enforcement of a curricula, which will combine mobile students and professional-level improvements in continuing education. Concepts and related accreditation field of biomedical engineering with the implementation of the Meleti project, and the Chaert Tempus project will bring together a large number of countries in Europe as the final goal (Magjarevic et al., 2010).

Neighboring countries are trying to strengthen curricula in biomedical engineering. Such is the case of Brazil, to meet their needs they are seeking ways to improve their undergraduate programs and higher education as well as industrial development (Gehlot, 2009). Such activities are achievable in Panama if several universities and hospitals create collaborative groups with support from governmental or private enterprises to promote research grants. Additionally, a possibility is the creation of postgraduate programs between two universities or center of investigation, where each university issued those courses for a better learning experience.

8. CONTINUING EDUCATION

In Panama, they are investing millions of dollar in the health sector. Hospitals possess state-of-the-art technologies, which will require the support of biomedical engineers, specializing in the hospitality sector. One of the specialties that exist in this area is that of clinical engineering. According to the American College of Clinical Engineering, "A Clinical Engineer is a professional who supports and assists in patient care by applying engineering and management skills to health technologies" (ACCE, 2011). The expertise of a Clinical Engineer can solve problems related to health technologies.

This will ensure the integrity of the infrastructure, hospital equipment and working with health staff to solve technical problems that might affect your practice everyday. Such specialization can be carried out in the form of internships (Krishnan, 2010), graduate, professional certifications. In adittion, agencies outside the country can provide initial recommendations for adequate preparation in clinical engineering.

9. BIOMEDICAL ENGINEERING PERSPECTIVES

Based on a survey (consisted of 9 open and close questions) on a sample of 50 biomedical engineers (graduates at ULAT and UDELAS, selected at random and with different levels of experience), the final results are:

• High theoretical knowledge: focused on performance, size, control, security, administration and management of medical technology.

• High technical skills: especially in the areas of maintenance. electronics, electrical and computer.

• High rational and analysis: fast ability to identify problems (and future) seeking the most efficient and effective solutions.

96% of respondents agree that the current situation in Panama Biomedical engineering is focused on the areas of management, sales, and technical support of medical equipment. Overall the survey reveals that the vast majority of engineering graduates have been placed in the area of product support medical equipment. This trend is unacceptable for two reasons: First, by The scarcity of Biomedical Engineers in Panama and the growing

importance of their role in recent years. The second reason is the character of Panama as a country of service, while the research and development needs improvement.

The area of biomedical research is a field that opens doors each year in global landscape, the impact of universities and their importance is measured especially in research, publications and development of solutions to specific problems. Another interesting result that was presented in the survey is that 99.5% of respondents think that specialization (graduate, masters, doctorates, for example) is important for their professional growth, the remaining 0.5% did not know or had no opinion about it.

10. CONCLUSIONS

While Biomedical engineering is relatively new in Panama, it has a positive impact in solving health problems. The Biomedical Engineer in Panama serves both public and private institutions. It provides new ideas and works closely with staff from different medical areas. For greater understanding of the clinical aspect, which must be one of the pillars of the Biomedical Engineer. It should emphasized in those key courses for obtaining clinical knowledge, such as courses in Human Anatomy and Physiology that may spark an interest in combining medicine with the technology applied to health (Carmichael and Robb, 2008). Multiple problems affecting our societies, one of particular interest is the aging population, which will require promoting new policies in education and make more and better use of health technologies, where qualified engineers in the field of biomedical are required.

According with the World Health Organization, in Panama, the population aged 60 years and over is expected to rise from 10-19 per cent in 2012 to about 20-24 per cent by 2050 (WHO, 2012). These figures indicate that it is necessary to implement new policies which allow Biomedical Engineers to integrate earlier in society. Its work can bridge the gap between medical technology and people, therefore, it supports the development of more user-friendly technology, specially for elderly. It is important to make progress on significant issues such as molecular engineering, cell engineering, tissue engineering, BioMEMS, microfluidics, nanoinstrumentación, virtual surgery, medical imaging and bioinformatics, to name a few (Griffith and Grodzinsky, 2001). However, it is necessary to improve conditions for research allowed in hospitals, technology companies, universities and other centers of academic excellence.

In conlusion, Biomedical Engineering is beneficial for the country as a whole, and in the health field in particular. The evidence is in the information provided throughout the article. This step has been initiated to develop a career aimed at improving the quality of life for human beings through technology.

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