Technology and Tools Appropriation in Medical Practices

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INTRODUCTION

The design and use of technological artifacts in medical practices involve the participation of several experts communities including engineers, scientists, and medical doctors. Thus, to delve into what happens to artifacts (designed by engineers) when they enter into medical practices implies not only to uncover what engineering and medical practices entail, but also to address how both agendas could converge or incorporate common goals. Regarding the engineering as a discipline, the National Research Council (NRC) (2009) pointed out its problem solving approach to design and create human-made products under certain conditions or constraints. Some of those constraints involve taking into account principles that encompass science and scientific laws, budget restrictions, available materials, sustainability, ergonomics, and ethical issues.

Progress in science and engineering goes hand in hand, science advances often depend on tools developed by engineers and reciprocally scientific knowledge guides and permeates engineering designs. Nowadays, it is not unusual to find engineers working with medical doctors and researchers in the design of artifacts that aim to improve human health.

Engineering design is a purposeful activity bound by specifications and constraints and an eminently collaborative enterprise. It involves an interactive process in which the design is tested and modified and it often offers several solutions to a particular problem (NRC, 2009). In general, the design and the construction of artifacts are tasks that require an expertise in science of materials, control, ergonomics and biomedicine. And there is set of standards that any medical artifact needs to fulfill in order to be used within the medical community. However, as Béguin (2003) pointed out the design of artifacts does not finish when the tool or object fulfills material and technical requirements; it should include how users transform the artifact into an instrument. Then, how does the medical community develop the needed expertise to use those artifacts efficiently in medical practice? This question becomes important to identify and delve into a research area that examines ways in which medical doctors transform and artifact (physical devise) into an instrument to solve problems. Then, what information and actions are important to characterize the process to transform an artifact into an instrument? Hadolt, Hörbst & Müller- Rockstroh (2012) cited a four-phase model (Hahn, 2004) that includes appropriation, objectification, incorporation, and conversion activities. The authors stress that the incorporation of artifacts into practices depends on social, cultural, and economic conditions.

It is important to analyze the extent to which medical doctors construct cognitive schemata that explain what we called their appropriation process of an artifact. In this process, it is recognized that tools shape and are shaped by the users' actions. Trouche (2004) pointed out the importance of considering the instrument as an extension of the body that becomes an organ formed by the artifact itself and by a psychological part that helps the user to mobilize the artifact to carry out activities and solve problems. Béguin (2003) emphasizes the difference between an artifact and an instrument or a problem- solving tool. The latter is made up by the artifact and the user' social and private cognitive schemata.

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The artifact characteristics that include ergonomics and constraints and the cognitive schemata developed by the user during the activities are important for the transformation of the artifact into a problem-solving tool or instrument to solve problems.

Artigue (2002) pointed out that users need to get involved in an appropriation process to transform an artifact or physical devise into an instrument for specific use. This process leads users to gradually construct personal schemata or to appropriate pre-existing social schemata to appreciate its potentialities and use them in problem solving situations. Thus, relations between users and objects are shaped by ways in which a community of practice acts in problem solving environments. Trouche (2004) also mentioned that the development of the user's psychological component could be categorized in terms of three related functions: A *pragmatic* function where the subject achieves a particular goal, a *heuristic* function in which the subject visualizes and pursues an action plan; and an *epistemic* function where the subject comprehends and makes sense of what is being achieved.

BACKGROUND AND RATIONALE

Delving into the ways that medical doctors develop an expertise in the use of artifacts in their practice implies examining not only what activities they engaged in order to develop such expertise; but also reflecting on common issues that permeate or characterize two fields: the engineering design and medical practice. In this context, we stress the interdependence between scientific principles that support the design of tools and those activities involved in using those tools in problem solving environments.

Throughout the article, it is recognized that performances and advances of humankind go hand in hand with developments and use of technology. Thus, the use of tools not only influence cultural and science developments (Trouche, 2004); but also some tools facilitate the maintenance of physical wellness and humans comfort. Koszalka et al. (2014) pointed out that the use of technology goes beyond developing an expertise in its practice, it also includes that subjects develop a set of abilities for accessing relevant medical information, constructing an effective communication among colleagues and patients, and supporting the subjects participation in virtual practices environments. Thus, the use of tools has been shaping the developments and practices in medicine and in all disciplines. As a consequence, tasks in the design field and ways in which users appropriate the tools become relevant not only to incorporate the tools in different practicing domains, but also to provide feedback to improve the tools design.

Are there common principles that characterize the design and development of particular tools? How do engineers design artifacts? How are designed technologies or tools used in medical practices? To what extent does the design process influence or shape ways in which medical doctors use the tool in their practices? The discussion of these questions provides basis to comprehend and frame ways in which medical doctors develop an expertise in the use of the tools. In a broader context, the relation between science and technology is a theme that should be examined from diverse angles or perspectives. In terms of goals and methods, engineering design, as an area of study, can be compared with processes involved in scientific developments, both processes rely on or are conceptualized as problem solving approaches (Santos-Trigo, 2010).

Trouche (2004) pointed out there are cultural biases or differences between Western and Eastern cultures regarding the value of physical and manual work vs. cognitive or intellectual work. While Eastern cultures recognize a dialectic interaction between mind and body, the West tends to privilege intellectual or mind activities over physical or manual activities. Recently, science and technology communities recognize that scientific inquiry or science development, technology, engineering, and mathematics are fields in constant interaction and play an important role in society developments. Trouche cites a Francis Bacon' passage that seems to recognize the importance of both intellectual and manual activities: "Human hand and intelligence, alone, are powerless: what gives them power are tools and assistants provided by culture" (p. 283). That is, both science and engineering or technology activities are fields that depend on each other and as a consequence, multidisciplinary approaches that incorporate principles and methods from several realms seem essential to identify, frame, and solve society problems. In particular, information regarding how scientific and technology developments influence not only the building of disciplinary knowledge or practices; but also the users' appropriation process of those developments becomes an important component of the academic