2014 CMBEC37 Conference
Vancouver, BC
May 21 – 23, 2014

THE DEVELOPMENT OF A TEXT ON HUMAN FACTORS FOR CLINICAL ENGINEERING

Anthony Easty[1,2], PhD, PEng CCE; PatriciaTrbovich[1,2,3], PhD; Ying Ling Lin[1,2], MSc; Andrea Cassano-Piché[1], MSc; PEng
HumanEra Team[1], Centre for Global eHealth innovation, University Health Network; institute of Biomaterials & Biomedical Engineering[2], and Institute of Health Policy, Management and Evaluation[3], University of Toronto

INTRODUCTION

The American College of Clinical Engineering has the following definition of a clinical engineer, "*A Clinical Engineer is a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology*". Further, the College states that, "*Clinical Engineering education is based in classical engineering, supplemented with a combination of courses in physiology, human factors, systems analysis, medical terminology, measurement and instrumentation*" [1]. This definition hints at the breadth of knowledge that is required to perform well as a clinical engineer, and the profession tends to attract those who enjoy the complexity of this field.

Despite this definition, most clinical engineers receive little formal training on human factors methods, and the majority view human factors as a distinct discipline that requires extensive training to gain sufficient knowledge to be applicable applied to health technologies and associated processes of care. Human factors methods have played a major role in the reduction of errors in other safety-critical industries such as aviation [2]. The value that human factors methods can bring to health care safety improvement is gradually being recognized, and one indication of that is the emergence of the Human Factors and Ergonomics Society's HFES International Symposia on Human Factors and Ergonomics in Health care, which have been held annually since 2012 [3].

Given the low rate of adoption of human factors in health care in general and clinical engineering in particular, the Clinical Engineering Division (CED) of the International Federation for Medical & Biological Engineering (IFMBE) identified the need for an accessible text to guide the adoption and practice of human factors methods for the clinical engineering field. The Head of the CED, Professor Saide Calil of the State University of Campinas, Campinas, Brazil, approached the HumanEra Team at University Health Network/University of Toronto, to commission the production of this text.

THE DEVELOPMENT OF THE TEXT

The HumanEra Team was considered well-positioned to take on the development of this text for several reasons: First, its core focus is on the application of human factors methods and principles to the field of health care safety, considering the application of health care technologies, practices and environments of use. Second, its team members have academic backgrounds in clinical engineering, human factors engineering and psychology. Third, the hands on experience gained through multiple projects in a variety of clinical environments provides a core understanding of what is required of clinical engineers to start applying human factors methods and how such a program can develop over time.

The blending of two major disciplines is never an easy task, and in trying to make knowledge of one discipline accessible to another, there are a number of challenges to be overcome. Specifically, the text has to be placed in the context of what clinical engineers

know and do as core aspects of their profession. Also, human factors principles and methods need to be introduced and explained in the context of these core clinical engineering activities, but with sufficient detail and background that the depth and complexity of human factors as a discipline is not lost, while avoiding the trap of making the body of human factors knowledge so daunting that clinical engineers become overwhelmed and decide that there is too steep a learning curve for these methods to be adopted and applied. Finally, in recognition that the field of Clinical Engineering is practiced world-wide, and that human factors has an important role to play regarding the safe application of health technologies in clinical environments whether they are resource-rich or poor, the guide needs to be written in a way that is accessible to clinical engineers in different resource settings. Furthermore, care must be taken to avoid specifying resources such as state of the art usability labs, which are beyond the reach of many resource settings, and while nice to have, are not essential to the sound application of many human factors methods in health care.

Initial text development was informed in part by courses and lectures that HumanEra team members have given to a variety of clinical teams, including clinical engineers, and also drew on knowledge gained through collaborations with health care professionals in Brazil, including clinical engineers, where joint projects have been undertaken to support the incorporation of human factors methods into steps to improve the safety of health technologies there.

THE STRUCTURE OF THE DOCUMENT

The full development of the text was undertaken by one of the authors (ACP), when it was realized that a project on this scale cannot easily be completed if the primary author is concurrently engaged in other work. This is an intense activity that requires focus and dedication, and it proceeds more slowly, or fails altogether, if regular interruptions to the work occur.

The text has been developed in English, since this is the first language of the authors, and the language in which other IFMBE texts are developed. However, it is recognized that many clinical engineers practice in other languages, and so funding has been set aside in future CED budgets to enable the translation of the text. The decision on which languages to translate to will rest with IFMBE and CED. Translation will need to be overseen by experts in the field for whom the target language of translation is their native tongue, to ensure that the true meaning of the text is accurately conveyed in the translated version.

Given the challenges discussed in the previous section, the decision was made to adopt the following structural approach to the document, with the text broken into three main parts:

Part I: The Need For Human Factors in Clinical Engineering provides a brief background on the disciplines of clinical engineering and human factors engineering, and the need for these disciplines to come together to improve health technology safety. In this section, topics that are key aspects of the clinical engineer's role are identified:

- Participating in the planning process and in the assessment of new technology.
- Assuring regulatory compliance in the medical technology management area.
- Investigating incidents involving the use of medical technology.
- Actively participating in training and education of technical and medical personnel.
- Overseeing Biomedical Equipment Technicians (or Technologists), who are responsible for the support, service and repair of medical technology.
- Creating systems to manage medical technology inventory.

Combined with this is a brief overview of the general discipline of human factors, its application in other fields, and its gradual incorporation into health care.

Part II: Applying Human Factors to Clinical Engineering Tasks describes how human factors methods can be incorporated into clinical engineering tasks and uses case studies and examples to illustrate the output of each step. In this major section, three main topics are covered:

- Procurement Support.
- Identifying Issues and Investigating Incidents.
- Training and Education.

To some degree, this may be considered the heart of the text, since it aims to provide clinical engineers with practical examples of the application of a selection of human factors methods to key tasks in clinical engineering and the health care environment. This "how to" guide is meant to enable clinical engineers to understand the potential that human factors methods can offer to the field of clinical engineering, and to explain in an accessible manner how this can be achieved.

Part III: Human Factors Methods provides a detailed description of how to conduct each of the human factors methods referenced in Part II. The human factors methods are described according to best practices for formally applying these methods, but the available resources to formally apply a particular human factors method may not be feasible in certain situations. In these circumstances it is recommended that the human factors methods approaches be adapted to suit the available resources rather than not applied at all. In an effort to make the methods presented in this book accessible to the global community, consideration has been given to minimizing the need for any specialized or costly equipment and descriptions of abridged approaches to employing some of the methods are provided.

FINAL STEPS AND CONCLUSION

At the time of writing, the text is being finalized. The next step will be an internal editing process, followed by internal and external expert review, to ensure that the goals have been met and the content is as accessible and applicable as possible. The text will then be modified in light of reviewers' comments and will be published as an Adobe Acrobat document on the CED website, in freely downloadable form.

The authors hope to make this a living document and so encourage feedback from users regarding their experiences interacting with the text. This feedback will help to inform revisions to the text over time, as more experience is gained in the field.

Finally, it is hoped that this text will stimulate clinical engineers in diverse work environments to take their first steps toward the adoption of human factors methods in their work practices, and that this in turn will help to facilitate improvements in the safe and effective use of health care technologies.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support of the Clinical Engineering Division of the International Federation for Medical & Biological Engineering to assist the preparation of the text, and particularly the visionary leadership and encouragement of Professor Saide Calil, who has done much to champion the introduction of human factors methods into the field of Clinical Engineering.

REFERENCES

[1] http://www.accenet.org/default.asp?page=about&section=definition
[2] Wiener EL, Nagel DC: Human factors in aviation: Access Online via Elsevier; 1988.
[3] http://www.hfes.org/web/hfesmeetings/2014healthcaresymposium.