Chapter 57
A Formal Representation System for Modelling Assistive Technology Systems

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ABSTRACT

This chapter describes a formal representation scheme which can be used to model Assistive Technology (AT) Systems. At the heart of any system is a conceptual model of domain of application. Where AT is involved, the conceptual model must embrace all the elements of AT systems which are defined as "consisting of an AT device, a human operator who has a disability and an environment in which the functional activity is to be carried out" (Cook and Hussey, 1995, 2002, 2007). In order to explore the interaction between the components of AT systems in dynamic simulations of AT deployment, there is a need for a suitable representation of the underlying concepts. While the representation scheme presented here is generally applicable, examples and issues to do with representing AT systems for those with motor limitations, in particular are considered. The proposed representation scheme uses Coloured Petri-Nets (CP-Nets) and is based on the WHO International Classification of Functioning (ICF). This chapter looks at how CP-Nets may be used to represent the elements of AT systems as described by Cook and Hussey. These are Person, Activity, AT and Context. Both informal and formal representations using CP-Nets are considered. The ICF is at the heart of the proposed formal representation scheme. Its effectiveness for this purpose is analysed. Enhancements and innovative approaches are offered where there are challenges presented in using the ICF.

INTRODUCTION

This chapter presents a formal representation scheme for Assistive Technology (AT) systems based on the International Classification of Functioning. This scheme is based on a standard system modelling scheme from computer science/software engineering which has been adapted to incorporate the International Classification of Functioning. The primary aim of this representation scheme is to provide a conceptual basis for developing information systems within the

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domain of AT. These systems include systems which provide information on AT including Web based AT systems, systems which consider people who have a disability such as computer games and product design systems and systems which consider the interaction between different components of AT systems.

In order to be useful, any AT information system must be founded on a strong conceptual model which should adequately represent the constructs of AT systems (i.e. the elements of Person, Activity, Environment, and AT). The representation system uses the International Classification of Functioning (ICF), (WHO, 2002) as its basis. The ICF appears to offer many benefits. It is a tool endorsed across the international community, signed into being by 191 countries and belonging to the WHO family of international classifications. It seems to describe the key components of AT systems. It is a comprehensive multifaceted classification which has components relating to the Person (Body Structures and Body Functions), Activity and Environmental Factors. In a way this reflects the PEO (Person Environment Occupation) models of occupational therapy. (Reed & Sanderson, 1983; Hagedorn,1992; Kielhofner,2008).

The key terms and concepts of the ICF are described in a variety of languages including English, French, Spanish, Russian, Chinese and Arabic and therefore people from a range of non-English speaking backgrounds can use the key aspects of the system in their own language without ambiguity, thereby removing a significant barrier to the international understanding of the system (WHO, 2002b).

Many of the benefits of using the ICF are articulated in major reports and protocols such as the UN Convention on the Rights of Persons with disability (UNCRPD, 2008). In establishing evidence based practice for classification in the Paralympics, Tweedy describes the advantages the ICF brings (Tweedy, 2009). These are:

- The concepts of functioning and disability are contemporary and internationally accepted.
- The definitions for key terms are clear, unambiguous and internationally accepted.

There are many reasons why it is necessary to model AT systems in a formal way. Any activity places demands on the person executing it. The person must have the necessary motor and process skills to initiate, execute, monitor and complete the tasks involved. They must have required capacities to interact with the objects involved; for example, to lift and manipulate these objects. These activities take place in a range of environments, which may either facilitate or hinder the execution of the activity. This issue, of activity and environmental demands versus personal capacity, is central to many ICT initiatives in AT service provision, including AT information Systems and the Raising the Floor (RTF, 2009) and Global Public Inclusive Infrastructure (GPII, 2011) projects. They require a strong, formal, scheme to represent the underlying AT system.

The motivation behind this work has its origins in a number of distinct and independent sources, namely:

- The importance of information provision in helping people to gain access to AT (Davis, 1990; MacKeogh & Stankovic, 2003; Craddock, 2005). Information systems around AT need a strong representation scheme which articulates the complex domain of AT provision.
- The need to provide a framework to explore the relationship between a person's capabilities and the demands placed on them by a desire to participate in meaningful activities.
- A feasibility study on the establishment of an electronic repository of individual AT plans (Gilligan and Smith, 2003).