Chapter 14

Humans and Complex Systems: Sustainable Information Societies

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1 Introduction

1.1 Background

Emerging information systems, e.g., the Embedded Internet, where people and smart equipment are connected in a global web of networks, are an example of the most complex man made-systems so far. The complexity of this type of systems is mainly due to the emergent and unforeseen interactions between system components: hardware, software, and people. In fact, a new term, Universal Information Ecosystem (UIE), has been coined by the European Commission (EC)\(^1\) to capture the nature of this particular type of information system.

From a systems analysis perspective, UIE’s confront us with both promises and challenges. Firstly, UIE’s will clearly play a role in creating a sustainable (natural) ecosystem in the sense indicated by Costanza et al. (2001) in their *Institutions, Ecosystems, and Sustainability*, that is, UIE’s can be seen as a kind of “information glue” between natural ecological systems and humans and their institutions to support the sustainability of natural ecosystems (cf. Figure 14.1). This role of UIE’s is an important and complex matter in itself and of particular interest in the context of the present book. Secondly, UIE’s are themselves first-class citizens of complex systems that call for new approaches to system engineering. This fact has been recognized by the EC efforts in the area of UIE’s, and it is also exemplified by Nardi and O’Day (1999) in their *Information Ecologies*. Information ecologies involves a holistic view of information systems, that is, taking account of technologies supporting people in their work practices while respecting norms and values. An information ecology also has a physical location. However, in order to engineer and maintain these information systems so that they can fully meet the new challenges, we need to assess and extend our engineering models and practices by use of ideas put forward in efforts to promote UIE’s and information ecologies.

\(^1\) http://www.cordis.lu/ist/fetuie.htm#objectives (link last verified 2002-03-11)
The remaining part of the introduction in this chapter is focused on the appropriateness and applicability of the concept information societies, from the perspective of aspects emphasized in approaches such as uie’s and information ecologies. This is followed by a research agenda and introduction to the main topics of the remaining parts of the chapter. In Section 2 we introduce the concepts and ideas of sustainable information societies, specifically the importance of a sustainability invariant. Section 3 addresses some basic methodological issues and also gives a short account of the orientation of our research group Societies of Computation (SoC) at Blekinge Institute of Technology. The chapter ends with some concluding remarks.

1.2 Institutions, Ecosystems, Information Networks, and Sustainability

The discussion in this section is based on ideas put forward in Institutions, Ecosystems, and Sustainability (Costanza et al., 2001). We are going to use the arguments put forward in that book as the basic requirements for support of information infrastructures and, consequently, to derive requirements similar to those advocated elsewhere by proponents of uie’s and information ecologies.

A key point put forward by Costanza and his colleagues (2001) is that, in order to understand sustainability, we have to study human and natural systems together in a common analytical framework and language. The major use of such an analytical framework includes:

1. Providing a common language acceptable across disciplines for developing theories and models.
2. Guiding the construction of models of linked ecological and human systems.
3. Organizing, synthesizing, and interpreting empirical data.
4. Linking empirical data to policy processes.

The term sustainable system is defined as follows: A sustainable system is a renewable system that survives for some specified (non-infinite) time. Consequently, it is of particular importance to address hierarchy and scale problems in the interactions between human and ecological systems. In principle, the right information should match the right hierarchical level. Fortunately, most ecosystems can be seen as systems that it is possible to partition, i.e., as connected subsystems. Given this feature, and the hierarchical structure of human institutions, we can therefore hope to achieve a proper mapping between ecological (sub-)systems and human institutions in the form of interconnected networks of the Embedded Internet type to support sustainability. Figure 14.1 captures the framework put forward by Costanza and his colleagues.

From Figure 14.1 it follows that the quality of the human ecosystem depends on the quality of the mediating information systems. That is, how well the information system captures ecosystem characteristics, manages the interaction characteristics and supports human system characteristics.

Traditional computer-supported systems in the area are mainly of the off-line simulators type. They are of course important executable models of some characteristics, but they still only capture some aspects of the system under study. Advances in sensor