Software environments for supporting End-User Development

Maria Francesca Costabile, Antonio Piccinno
Dipartimento di Informatica, Università degli Studi di Bari, via Orabona, 4,
Bari, 70125, Italy
costabile@di.uniba.it, piccinno@di.uniba.it

In the Information Society, end users keep increasing very fast in number, as well as in their demand with respect to the activities they would like to perform with computer environments, without being obliged to become computer specialists. There is a great request to provide end users with powerful and flexible environments, tailorable to the culture, skills and needs of a very diverse end user population. Moreover, the evolution in the culture of computing and the evolution of the roles of designers, programmers, and end users in the life cycle of software products lead to a new perspective in the development of software systems. Current work organizations require end users to tailor their software environments for better adapting them to their needs, and even to create or modify software artefacts. These are defined activities of End-User Development (EUD), to which a lot of attention is currently devoted by various researchers in Europe and all over in the world.

Our work in EUD has been carried out in the last few years together with Piero Mussio, of the University of Milan, also participating in EUD-Net (thematic network on EUD, funded by the UE). The work has provided various contributions to EUD, as summarized in the following.

We highlighted the needs of a community of users that is the most specific target audience for EUD, namely professionals in diverse areas outside of computer science, such as engineers, physicians, geologists and physicist, who are not professional programmers. This is described in papers that report experiences we collected by developing interactive systems used by such professional people, also called *domain experts* [1][2][3][4]. We identified two classes types of end user activities, as reported in [2][5], also mentioned by H. Lieberman, F. Paternò, M. Klann and V. Wulf in the first chapter of the Springer book "End-User Development".

We developed a participatory design methodology, called SSW (Software Shaping Workshop) methodology, aimed at designing software environments that support end users to become co-designers of their tools. The SSW methodology emerges from the experiences gained in different application domains, and stresses the need for collaboration of different stakeholders, namely software engineers, HCI experts and domain experts.

The importance of considering user diversity is also considered. End users are very diverse because of their culture, education, skill, age, and training. In many domains, there are different communities of end users that need to collaborate to reach a common goal. Members of each community should need an appropriate software environment, suitable to them to manage their own view of the activity to be performed. This environment is called Software Shaping Workshop (SSW), since it is developed by exploiting the metaphor of the artisan workshop, where an artisan finds all and only the tools necessary to carry out her/his activities and properly shapes various materials (wood, iron, etc.) into usable products. In analogy, people should find in the SSWs all and only the tools to shape software artefacts. Such tools must be perceived and must behave so as to be usable in the current situation. To this aim, in the SSW methodology, representative of end users are required to participate in the design and implementation process as co-authors. Such representatives are involved in the design of the final workshops to be used by all the end users belonging to the specific sub-community to which they belong too. In this manner users have a twofold rule: users and designers of their own software environment.

This methodology, first presented in [1], has been refined in the following years [2][3][4][7]. It is a participatory, meta-design approach [Fischer G., Giaccardi E., Ye Y., Sutcliffe A. G., Mehandjiev N., Meta-design: a manifesto for end-user development, *Communications of the ACM*, Vol. 47(9), Sept. 2004, 33-37.] in which the different stakeholders can contribute their own views on the problem

to design, development and maintenance of an application, using their own languages and notations.

Many types of hurdles are studied, which induce users to make errors and mistakes, and to break the continuity of their reasoning while carrying out a working task with the computer. As a consequence, negative emotional states, such as frustration, dissatisfaction, anxiety, may arise. The Software Shaping Workshop (SSW) methodology drives the development of interactive systems that are correctly perceived and interpreted by end users, thus becoming more acceptable and favouring positive emotional states [8].

We proposed a model of the Interaction and Co-Evolution processes (ICE model) occurring between users and system [6]. It extends the previous model of Human-Computer Interaction by considering an important phenomenon occurring during the use of interactive systems, called *co-evolution of users and systems* and based on the following two observations: 1) once people gain proficiency in system usage, they would like to use the system in different ways and need different interfaces than those they required when they were novice users (*user evolution*); 2) designers are then forced to evolve the system to meet the new users' needs (*system evolution*). The ICE model leads to re-examine the way interactive system are designed and forces a perspective of meta-design.

We consider a primary challenge for EUSE the creation of methodologies and tools which permit the creation of systems localized to end user culture and situation, so that end users may access knowledge sources, comprehend their content and perform their tasks without hurdles deriving from different cultures and traditions. These novel systems should also allow end users to tailor them at use time according to their needs and preferences. We believe that a meta-design approach must be stressed, which distinguishes two-phases: the first phase being designing the design environment that will be used by various experts (stakeholders) in the design team in order to design the specific applications; the second one being designing the applications using that design environment. The different stakeholders should be enabled to collaborate, also respecting their different viewpoints, both at design and use time.

In our view, meta-design is a process in which humans are able to act as designers of the system they use and to contribute to the co-evolution of such system. Meta-design must support humans in shaping their socio-technical environments and in adapting their tools to their needs.

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