The potential of User-Centered Design (UCD) to make radical agricultural innovations

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Abstract

During the last decades, new radical agricultural technologies such as those connected with Precision Farming have been developed. These technologies, however, have not been taken into practical use efficiently enough to realize all their potential benefits. The users of technologies eventually decide if they adopt new technologies and how they do it. If technologies are not acceptable and thus not adopted, they will not be innovations.

A research funded by the OECD Co-operative Research Programme was conducted with the topic: 'Speeding up innovation in agricultural engineering'. Research question was: How could User-Centered Design (UCD) help users to adopt new efficient Precision Farming applications?

A literature review and a global Webropol® questionnaire were done in winter and spring 2012. Preliminary results of this research are presented.The results show that UCD has the potential to speed up the innovation process. If users are more involved in the design process, the products are easier to use and they fit better to their use. The R&D phase is shorter because less iteration is needed to design a product. Users also adopt the better usable products easier. Consequently, User-Centered Design is likely to enhance innovation.

In the future, research and development should be more directed towards the acceptability of new technologies, including usability and ease of use. Innovation in the applications of UCD is needed. Education topics are found in UCD methods and practices for designers. Eventually, the users should be activated to demand better products.

Key words: innovation, User-Centered Design, agricultural engineering, Precision Farming

1. Introduction

1.1. Innovation in agriculture – lack of speed

To be an innovation, a new development (product or service) needs to be widely adopted in practical life by their users and in such a way that it produces adequate benefits for them. The Oslo manual (OECD 2005) concludes that technological product and process (TPP) innovations comprise implemented products and processes. Already the original definition of innovation (Schumpeter 1934, ref. Drejer 2004) claimed that it is an essential feature of innovation that it is something that is carried into practice. It also suggests that it is the entrepreneur who leads others in the same branch to follow, i.e. the innovation is spread through imitation. In other words, the end-users have an important role in the creation of an innovation.

During the last couple of decades, researchers and designers have put a lot of effort to find solutions to global challenges in the production of food, feed, fibre and fuel. Consequently, some new agricultural technologies have been developed. The application of advanced measurement and control technologies has made it possible to achieve radical improvement of the efficiency of agricultural processes and simultaneous reduction of their environmental impact. Precision Farming is a good example of these applications. Precision Farming applies accurate control engineering to plant production. It combines biology and technology. The goal is to produce more accurately according to biological processes. (Haapala 1995)

The new technologies, however, have not been taken into wide practical use. As the adoption is not wider, the technologies do not provide all their potential benefits. Precision Farming has been only partially adopted. Some parts of it, such as guidance and yield mapping, have been adopted by larger farming units (Diekman & Batte 2010, Winstead et al. 2010). The vision of a fully integrated Precision Farming system has not, however, been realised in such a magnitude that it could be called an innovation.

1.2 Acceptability as a challenge

As stated before, if technologies are not adopted, they will not be innovations. In the case of Precision Farming the speed of innovation has been moderate.

According to recent research one important reason for the new technologies not being adopted by their potential users is that the users do not trust enough in them (Kaasinen 2005, Li et al. 2008). In order to be better adopted, the new technologies need to show strong evidence that they fulfil important needs. To be acceptable, they also need to be easy to learn, easy to use, dependable and ergonomically sound (Nielsen 1993). This applies also to agricultural technologies (Haapala & Nurkka 2006).

1.3. User-Centered Design (UCD) as a solution

There are some prerequisites for an innovation to happen. The technology must be at an appropriate level, it must be acceptable and it has to be purchased. Furthermore, the technology has to be applied and in a correct way. Eventually, the volume of application has to be wide enough. UCD can enhance the process. (Haapala 2012, Fig. 1.)

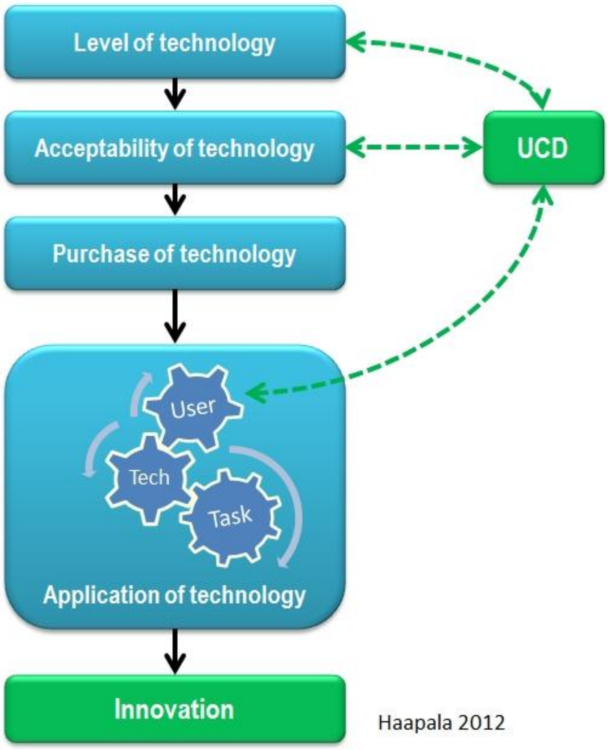

FIGURE 1. User-Centered Design (UCD) as a tool to enhance innovation (Haapala 2012).

The goal of the research is to combine two items: User-Centered Design and Precision Farming. UCD could help us to design better tools for Precision Farming so that it could be better adopted and utilized by the end users of these technologies (Haapala 2011). End users of technologies have a central role in Living Lab methodologies. In agricultural engineering Living Labs have been used for User-Centered RDI but also for education (Haapala & Pasila 2008, 2009, Wolfert et al. 2010).

Consequently, the goal of the study was to find answers to the following research question: *How could UCD help users to adopt new efficient Precision Farming applications?*

2. Material and methods

The research included a literature review, an internet-based Webropol® questionnaire for experts and interviews of selected experts. Preliminary results of the Webropol questionnaire are reported here. The questionnaire had four parts: the level of PF technology, the application rate of PF technology, the acceptability as a challenge in PF (and new agricultural technologies in general) and the applicability of UCD to agricultural engineering. The experts also gave their opinions and visions of the most important research and development topics of UCD in Agricultural Engineering. They also rated the importance and urgency of UCD and PF related actions in research policy. Those results are reported later.

There were 41 respondents for the questionnaire for experts by April 24th 2012. To get more responses, the questionnaire will be open for the summer 2012. The respondents' competence profile was variable.They were strong in engineering, research and practical use of technologies at the farm level. Weeknessess were found in marketing and sales. Living Labs were not familiar for the respondents. Furthermore, they were not very familiar with teaching of design.

3. Results

3.1 Level of technology

For expert evaluations, the technologies were split into sixteen areas of PF. The areas were related to field operations, planning and control and quality aspects The experts (n=39) evaluated that the desired situation was in every case at a higher level than the actual. The difference in expectations was higher currently than in the future. The result indicates that the experts had expected the current level of technology to be better than it is. They were somewhat disappointed on the past development. In future, they expected the difference will be less alarming. This means that the experts believe in future development that would narrow the development gap. They are optimistic about the future. In individual technologies the gap was expected to be different. Some technologies have almost reached their summit so that they, such as the measurement of weather parameters or yield quantity, are not expected to develop much until 2020. Most potential development is expected to be in the planning algorithms. (Fig. 2)

3.2. The application rate of PF technology

The application rate of PF technologies was evaluated equally. The desired situation was in every case at a higher level than the actual. The result reveals that the experts (n=39) were not satisfied with the current application rate of PF technologies. They believe that the future development will somewhat narrow the development gap which, however, still stay quite high. In other words, the experts do not believe that the application rate of PF technologies will meet the expectations as well as the foreseen development of the level of technologies would suggest.In applications of individual technologies the gap was expected to be different. The application rate of some technologies, such as the measurement of weather parameters or yield quantity, are not expected to develop much until 2020. Most potential development in the application rate is expected to be in the measurement of plant parameters and in the development of Farm Management Information Systems (FMIS). (Fig. 3)

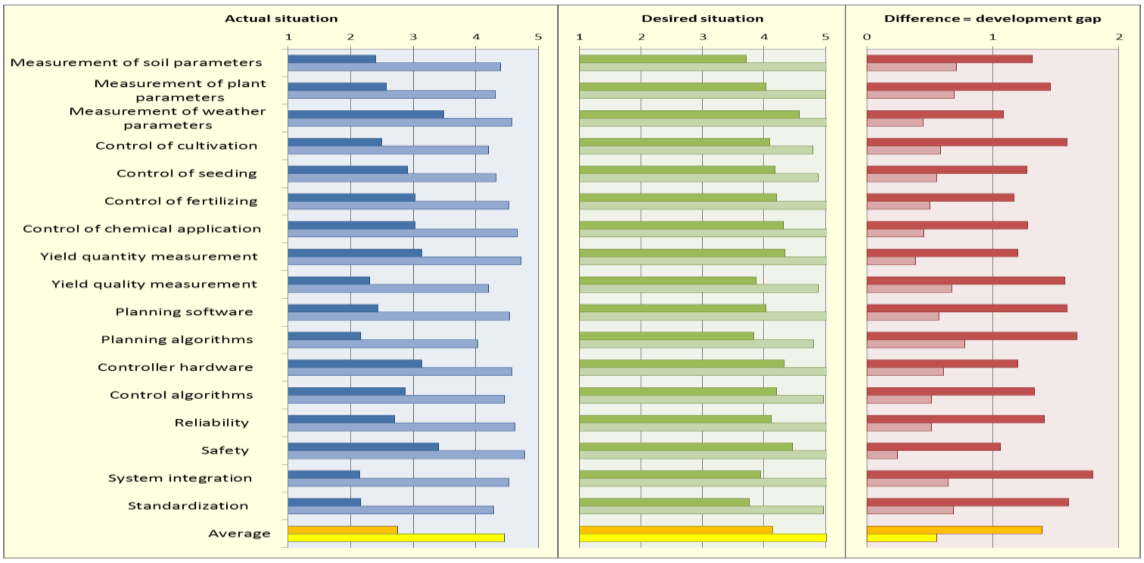

FIGURE 2. The level of PF technology (scale 1-5). Dark bar = ‘now’, light bar = ‘in 2020’.

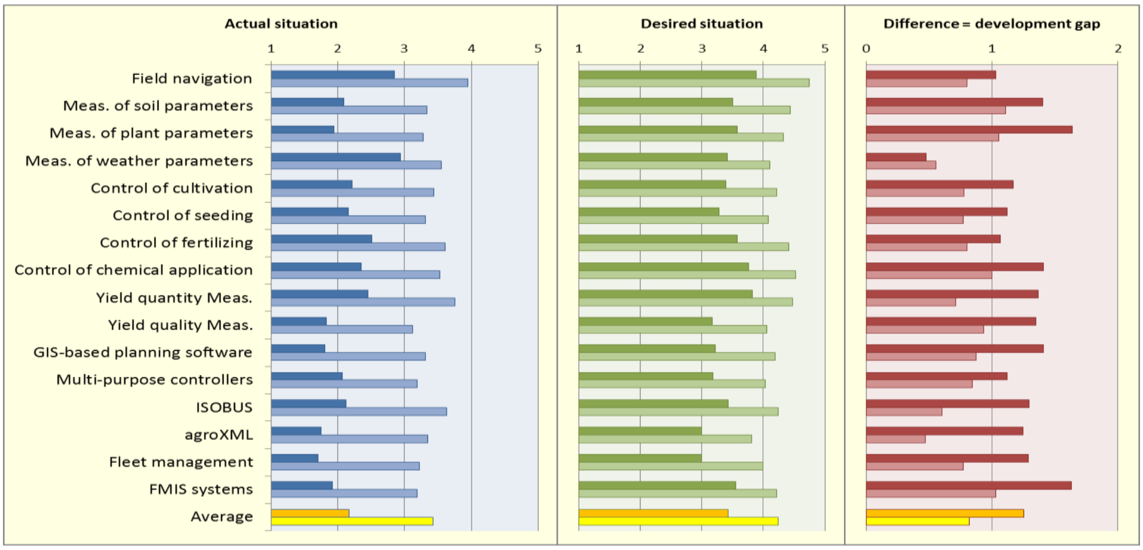

FIGURE 3. The application rate of PF technologies (scale 1-5). Dark bar = ‘now’, light bar = ‘in 2020’.

3.3. Acceptability of PF technology

Acceptability was evaluated in modified categories of Nielsen (1993) where more detailed features of economy, benefits and technical compatibility and reliability were added. The concept of trust was also added. The experts think the main topics of usefulness, utility and usability are important areas of acceptability. More accurately, efficiency of use is the most important component. Economic aspects including awareness of the costs and benefits are significant. Reliability and trust building are also ranking high. (Fig. 4)

3.4. UCD and the innovation process

The fourth chapter in the questionnaire focused on the use of User-Centered Design (UCD) in the innovation process. The experts answered to some arguments concerning the innovation process and the potential effect of UCD on it. The arguments reveal that there is an agreement that the current innovation process is not perfect. The users are not in the centre of development and the designers do not understand them well enough. User-Centered Design could bring more speed into the innovation process but methods are not familiar to the designers. The experts clearly agree that UCD and related methods would yield to better products that would help the users to better adopt new technologies. Trust would be built with the use of UCD. Poor trust is identified as being an important explanation for the slow market uptake of PF technologies. (Fig. 5)

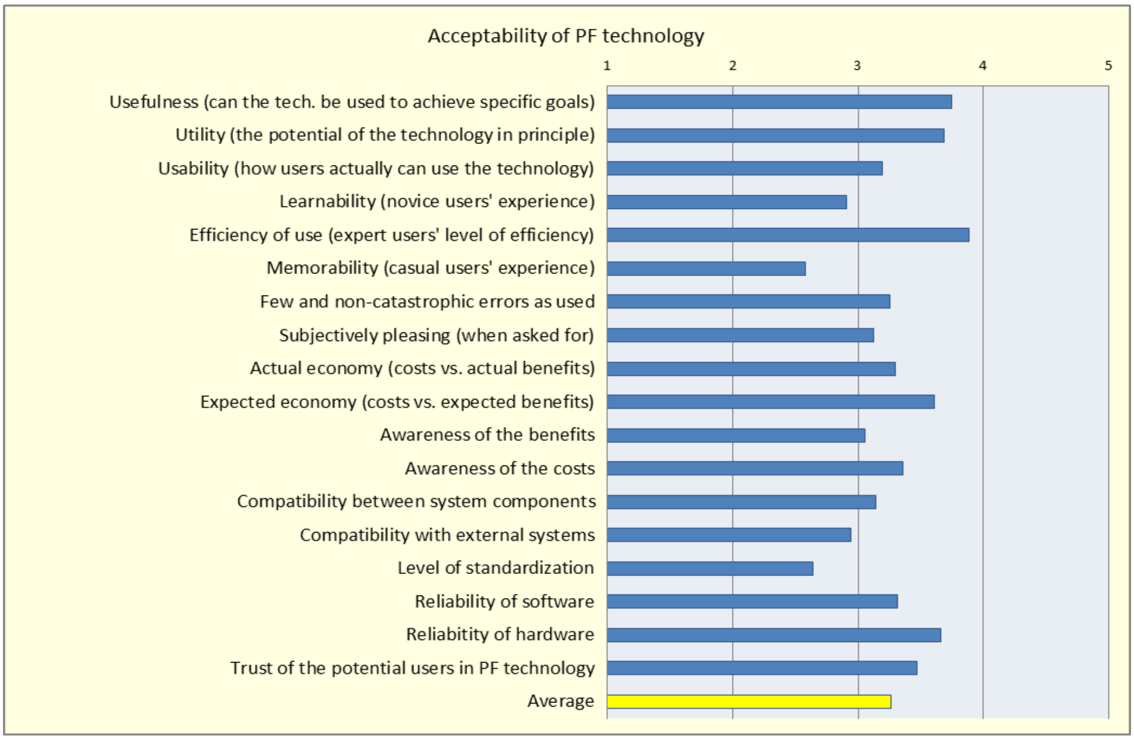

FIGURE 4. Acceptability of PF technology (scale 1-5). Modified classes of Nielsen (1993).

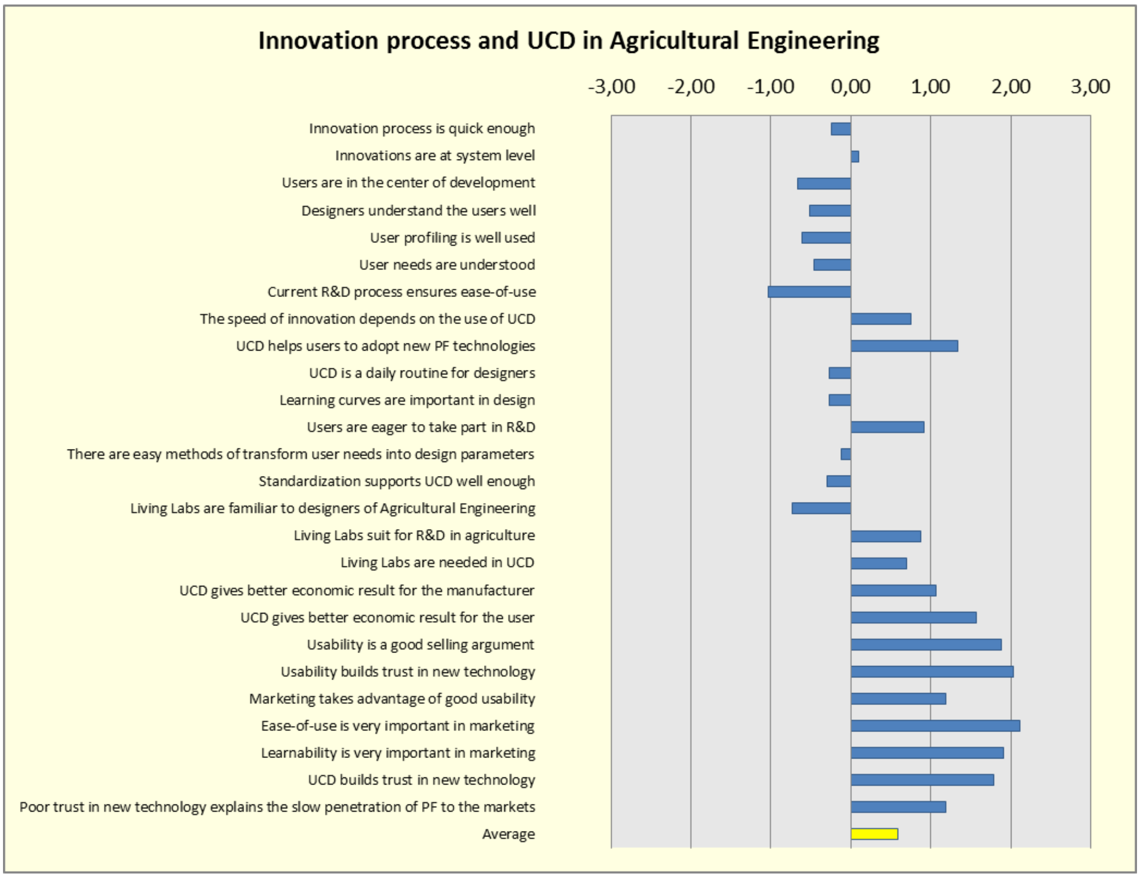

FIGURE 5. Innovation process and UCD in Agricultural Engineering. Arguments (-3=argee, 0= neutral, 3=agree).

4. Conclusions

The results show that User-Centered Design (UCD) could speed up the innovation process. If users are more involved in the design process, the products are easier to use and they fit better to their use. The design phase would be shorter because less iteration is needed to design a product. Users also adopt the better usable products easier. Consequently, User-Centered Design is likely to enhance innovation.

In the future, research and development should be more directed towards the acceptability of new technologies, including usability and ease of use. Innovation in the applications of UCD is needed. Education topics are found in UCD methods and practices for designers. Eventually, the users should be activated to demand for better products.

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