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Extreme Programming in development of specific software

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Abstract

The paper shows experiences with using Extreme Programming (XP) for specific projects. XP practices Test-Driven Development, pair programming, short interaction, a team code ownership and acceptance tests. Author writes about possibilities of information technologies when improving communicative skills of children with specific disorders, such as autistic spectrum disorders, Down syndrome, mental retardation, etc. The development of an application stemming from the communication system PECS (The Picture Exchange Communication System) and its Czech variant VOKS is the base of this paper to show specificity of the development and verification of software for the given group of handicapped users. The paper shows suitability of using agile methods of software development for a concrete application which is designed for users with specific disorders. It tries to show advantages and disadvantages of new methodologies, particularly Extreme Programming. This agile method prefers fast reaction to a change before the plan completion, which proved to be important in the case of the developed software. There were plenty of changes and new requirements during the development, and their solution was more important for the output quality than following the time schedule of the development.

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1. Introduction

Use of information and communication technologies has reached massive expansion recently. Computer users are to be found in every social and professional group. Computers simplify a lot of work tasks, make methods of communication easier and more accessible, intermediate new information, etc. These modern technologies can play a role of important supporting and compensational means for a group of users with specific needs. It is mainly people with some mental and health problems who face difficulties with communication, and common means of communication are usually unusable for them. Computers can act as a positive agent in such cases. However, hardware and software must be adjusted to the specific needs and it is not possible to implement experience gained and applied with common groups of users.

There is a potential group of users with specific disorders who could make use of the development of communication skills. E.g. people with autistic spectrum disorders, Down syndrome, forms of mental retardation and other development defects which cause problems to learn and use spoken language, written text, and other commonly used means of communication. Various methodics bringing interesting results have been worked out to develop communication skills of people with the above mentioned disorders. For instance, such methodics is the system PECS (The Picture Exchange Communication System) and its Czech variation VOKS. The base is a use of pictures representing particular concepts, things, activities. The user gradually becomes familiar with new concepts

– pictures, which are then incorporated in their list. Choosing pictures and placing them on a sentence strip helps them learn to create even simple sentences. (5) (6)

2. Application VOKS

Based on the requirements from special school, we are developing an application which should facilitate communication with a child with specific disorders such as autism, Down syndrome, mental retardation and others. Autism is a mental handicap which demonstrates in worsened communication skills. Speech formation of people with an autistic spectrum disorder is delayed and some of them do not speak all their life or they use only limited number of words, frequently corrupted. Several methodics to improve their communication skills have been developed. The fundamental principle is an exchange of a picture representing a particular thing for a real one. Continuous practice leads the child to learn how to use concepts correctly and improve its communication skills. The whole process is emphasised by stimulation. (1)

The Czech system VOKS mainly stems from the methodics and principles of PECS. However, it brings some improvements and it tries to adjust to particularities of the Czech language. The first contains important information concerning teachers of the VOKS system and training environment. In addition, it describes preparation of individual tools for communication and the way of reward choice before the whole training of the communication begins. The second part contains educative lessons, which form the backbone of the education. The client learns to ask spontaneously for a favourite thing in exchange for a picture, to go on his own to the symbol container to get a picture and then to hand it in subsequently to the partner. They learn to ask different people about anything in an unfamiliar environment, to choose appropriate symbol from several pictures, to complete correctly a simple sentence on a sentence strip using pictures and then to ask by help of the sentence strip. Finally, they learn to react to various questions and to comment on the environment around them. The supplementary lessons then develop picture inventory and syntax. (5)

3. Development of application

When designing a new application environment, it was necessary to get rid of all control features which were not directly related to the main use of the programme, and which could lead to early closing, new configuration, initialisation of new actions, etc. A lot of children find difficult to concentrate on realizing the needed performance. They frequently unwillingly click the mouse or wander the cursor round the screen. Thus it is highly important that children could not consciously or by mistake initiate functions indirectly related to the course of the programme.

The application control must not be demanding, unclear, or complicated at all. Generally common activities (such as double-click on a mouse) are almost impossible for numerous users with specific disorders. The control features of the programme must be conveniently large and their start-up and control as easy as possible. An ideal case would be if the application, having been opened, took up the whole screen of the desktop, being maximized all the time with no possibility of any change. The use of the mentioned software counts with the use of special hardware to control the computer. The main advantages are larger control features and more robust construction. On the other hand, the disadvantage is usually the price which exceeds several times the price of commonly used hardware. Purchase of such special devices can become unaffordable for many families with handicapped children. The user can control the applications directly on the touch screen, which seems to be more convenient especially for children with specific disorders than using mouse or other positioning devices. Some children have motor problems when using mouse, moreover they have problems with moving the mouse while concentrating on another place - on the screen. Nevertheless, despite all of the above mentioned special hardware tools, it is convenient to create the developed software in a way to be usable even on common desktops, or notebooks with their usual peripherals.

3.1. Extreme Programming

Initial efforts in the development stemming from the waterfall model have proved unusable. The customer (health staff of special school) did not have a clear idea about all functionalities and qualities of the developed

communication software. Lots of the requirements had to be corrected, specified, and re-defined. Thus we proceeded to change the strategy and the software was developed according to an agile methodology. Elements and processes of Extreme Programming were taken as the basis. The basis of the whole XP software development is code-writing and testing. XP methodology is primarily designed for smaller teams with two to ten members, who work on frequently or less known assignments. Projects which take long or have difficulties in getting feedback (e.g. from technological point of view) are not suitable for this methodology. Automatic testing or version assembly is necessary for its implementation. XP is a flexible agile methodology emphasising interconnection of the proposal and implementation stages. (3)

Basic activities are

1. Planning and Managing
2. Designing
3. Coding
4. Testing

XP has the following characteristic qualities:

- Continuous revision of the program code – frequent use of pair programming, when a pair of programmers works together on one code. Application of the principle led to removal of previously occurring problems in the code of the developed application.
- Testing – apart from unit tests, continuous testing by the customer was also successful. In our case, it was primarily health staff, but also children with specific disorders. Only the health staff from special school could define whether the application was suitable.
- Short iterations – classic methodologies usually transit the application to the customer after a long period, usually at the end of the development. This approach in the development of the educational application did not prove to be suitable. When an agile development methodology started to be used, we tried to make the shortest and most frequent iterations. They were given by time possibilities of the participants and we can see from the acquired experience that it would be convenient to make iterations more often than have been made so far.

Extreme Programming consists in five values:

- *Communication* – a large number of development problems lie in incorrect communication, not only among the team members, but with the customer as well. If XP is used, large teams assign a special role, so-called coach, who detects communication failures and secures correct communication. However, small teams should not underestimate good, continuous communication. Frequent communication is important not only among the developers, but with the customer as well. Two coders create all code together at a single computer - *pair programming*.
- *Simplicity* – the methodology tries to develop software as easy as possible, not to deal with functionalities that are not currently important and that might be used in future. XP methodology says we should not create a more robust architecture than necessary for the moment. It also proved crucial in the development of the PECS application. With respect to frequently unclear customer's requirements, it was the most effective to solve the application for future needs. The development required more time and energy and certain functionalities frequently proved to be unnecessary or unusable for a specific group of users.
- *Feedback* – is very important for correct development. It runs at several levels. One of them is testing, which should be performed at all development stages and not after the implementation stage. When developing program PECS, it proved necessary to test it continuously by its users. The main reason was the need of the developers to become familiar with possibilities of users with specific disorders. Many of commonly used approaches (particularly in the area of program control) are not usable for this group of users. Thus it was necessary to test more frequently and in all stages of the development what suits the users or what does not. The second target group of users was the health staff of special school that had to define and set up in the configuration part of the program an individual educational program for individuals. The configuration program requires simple control, still it offers a wide range of possibilities of individual setting according to specific requirement of the tutored child.
- *Courage* – A very important value of XP is courage to correct and remove errors at all costs. It even means removing a great part of the code or fundamental re-doing of the so-far architecture design. According to experience with the practical use of XP in companies, it seems that this requirement is difficult to be applied (more difficult in Europe than in the USA). The developers feel that removal of a great part of the code signs their failure and they are less likely to try further. (4) In the case of the VOKS application development, it was necessary to remove a part of already created code several times because the corresponding application

functionality proved to be unsuitable for a user with specific disorders. Despite those fundamental changes, it appears that the process helps to achieve the objective better than traditional methods.

- *Respect* – The team members should be interested in their colleagues' work. In case individuals work alone, with no close relations to others, XP will be unusable. This XP value closely corresponds to the emphasis on communication.

Why is agile methodology suitable for developing educational and communication software for users with specific disorders?

- The submitter does not have a clear idea about functionality of the application. Because there is a lack of experience with similar software, the development is frequently changed or corrected.
- A closely specialised group of future users requires frequent communication with submitters as well as continuous testing on by the developers and future users.
- The number of developed similar applications is very small, therefore there is a lack of experience with similar projects. Traditional development processes cannot be used in many aspects, particularly in the area of program control.
- The developers must get thoroughly acquainted with the environment and users, with whom they do not often get in touch and thus they do not know their abilities and requirements.

The used methodology has its disadvantages and risks. The requirement on frequent iterations proved to be hardly realisable. With respect to the nature of the solved project, direct communication of the developing team and the staff of the special school was necessary. It was quite a difficult task to secure this way of communication (taking into consideration time possibilities and distances between the participants). In order to achieve faster advance in the development of educational software, it would be necessary to communicate in shorter intervals, which was not possible to carry out successfully. (2)

4. Testing of VOKS application

4.1. Unit tests

Test-Driven Development is development technique exploited in Extreme Programming. Unit tests are very important for Extreme Programming. (10) Developers create automatic unit tests before or after the code. Tests guard functionality and validity of code. Unfortunately when we create unit test, we must write more code (30%).

Example of unit test code from MS Visual Studio: (9)

```
namespace VOKS
{
    public partial class WinUceniTest
    {
        [TestMethod]
        [PexGeneratedBy(typeof(WinUceniTest))]
        [PexRaisedException(typeof(InvalidOperationException))]
        public void ConstructorThrowsInvalidOperationException348()
        {
            WinUceni winUceni;
            winUceni = this.Constructor();
        }
    }
}
```

4.2. Usability testing

Hand in hand with an increase in requirements and properties of software tools, there is a need of appropriate and profound testing. Despite the fact that the above described programme does not include any complicated functional structures or algorithms, and work of complicated and expensive devices is independent of its activity, it is necessary to secure its high reliability. Children suffering from e.g. autism find difficult to get used to a new environment and unfamiliar things. The time needed for the child to accept the programme and learn to work with it is usually very long. In case of serious disorders, there is a danger that the child will decline it or refuse to work with it. During testing of an application by children, there should not be any fundamental adjustments of the graphical

interface and its control. Apart from classical procedures of testing of the programme functionality, it is important to observe how the child masters the application. It is not enough to use only usual static and dynamic testing means, analysis of the source code, monitoring by testing programme, special tests on memory usage or load, etc.

Thus the application incorporates internal mechanisms which monitor user's activities. Monitoring data about manipulation with programme objects are stored in XML files. The application contains an interface designed purely for parents and health workers which enables to evaluate both child's skills to work with the programme and its functionality. The output data then acts as a feedback for the creators of the programme as well as for parents and health workers, who can adjust the process of education more effectively. Another way to verify the programme functionality is methods used in quality oriented pedagogical research. It primarily concerns the method of observation. The children use the application together with the parents or health workers. The adults act both as a pedagogue, who teaches the child to use and communicate with the programme, and an observer, who check for reactions and skills of the child. The observation results are very important not only for the educational process, but also for the development of the programme.

Unlike commonly used software, there are specific problems when testing:

- The target group of users is not large enough.
- The target group of users is very diverse and the level of the disorder considerably influences ability to work with the programme. It is necessary to take into consideration individual needs of the users and to enable more possibilities of setting and adjustment.
- The phase of learning how to use the programme is very time consuming. This results in longer period of testing than with usual applications. Children with higher level of disorder can take months to pass from one phase of the programme to another.

It is important to largely cooperate with parents and health workers because the children find difficult to get used to changes in environment and unknown people.

5. Conclusion

Extreme Programming and other agile development methods have been implemented more and more in the past decade. It does not concern methodologies that would be suitable for all projects, they find their place in smaller developing teams. They can be used in projects with no clear initial definition, where the customers do not have a clear idea about the output product. Extreme Programming does not emphasise documentation of the development and its strict control. The basic element is a high level of communication among all team members and customers as well as frequent iterations. An advantage of this methodology was its possibility to react fast on customer's changes in requirements and possibility to adapt the program to users with specific disorders, even at the cost of removal of a great part of already written code. The methodology prefers fast reaction to a change before the plan completion, which proved to be important in the case of the developed software. There were plenty of changes and new requirements during the development, and their solution was more important for the output quality than following the time schedule of the development.

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