

THE PEN-BASED TECHNOLOGY TOWARDS THE LECTURE IMPROVEMENT

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Abstract

Nowadays perhaps the most widespread way of giving lectures at the universities is the slides presentation using computer and data projector. The common problems concerning this type of lecture presentation include one-way static transfer of information from teacher towards students, uncomfortable ways of active entries into the presentation, low students' engagement with no feedback, and static or no access to presentation materials. This contribution presents four years of experience in the effort to improve lectures using different presentation applications and several pen-based technologies. Currently, the Tablet PC accompanied with Enhanced Classroom Presenter tends to be one of the most suitable solutions.

Keywords: Tablet PC, interactive presentation, wireless network communication, digital ink, Classroom Presenter.

1 INTRODUCTION

Lecture presentation methods have been developed for hundreds of years. In many classrooms and auditoriums, even at modern universities, the blackboard and chalk are still available for use by teacher. Somewhere they have been replaced by whiteboard and board marker. This replacement brought cleaner dust-free environment, more colours, and easy-to-clean surface, often a bit smaller in dimensions. However, the presentation method remained more or less the same - handwritten explanations and notes. There were number of advantages concerning this presentation method. Handwriting ensures the ideal pace of presentation both for listening and for note-taking. Writing remains visible to students until the teacher runs out of place and needs to erase something. Students are forced to take notes as long as they want to benefit from the lecture. Of course the advantages can fade out in case the teacher does not follow some basic rules (illegible handwriting, talking to the blackboard, shading the current writing). To mention some of the disadvantages: when revising the knowledge the students can go back to their own notes but not to the original content, in a huge lecture hall the board handwriting can hardly be visible from any place of auditorium, and chiefly this presentation type is very demanding for teacher.

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That was probably the main reason why with the occurrence of overhead projectors and transparencies most of the teachers did not continue to use on-the-spot handwriting presentation style, although it was still possible. Instead they switched to presenting the slides prepared in advance, either printed or handwritten. There was still the possibility to annotate the slides during the lecture, although not all the teachers took the advantage of this. With traditional laptop and data projector replacing the overhead projector the comfort of spontaneous handwritten annotation was lost. The only way of attracting students attention was the laser pointer which is hardly visible in huge lecture halls.

On the other hand, the student usually get the handouts with prepared slides at they disposal (often in electronic form), to add notes to. This should be the advantage but it often turned into the disadvantage. Many students believed the slides will do for the exam and they were not interested in lectures any more. A lot of lecturers noticed the declining ability of students to follow the lectures and a lack of interest in thinking. When taking notes most of the students do it automatically without even knowing what they are writing. So there was an urgent need to make the lectures more attractive.

There are several ways how to do it including attention catching marks for emphasizing slide content, writing illustrating examples, annotating diagrams, drawings or pictures, promoting audience interaction [1]. Bringing back the possibility to annotate the presented slides using handwriting seems to be the basic precondition for these practices.

2 RELATED WORK

Almost everyone enjoys working with technology. The possibility of interaction during the lectures leads to better perception of the audience. Therefore several software and hardware solutions have been developed whose primary purpose was to create an interactive presentation system. At the beginning they permitted only to change the lecture content directly at the time of presentation.

Later, the possibilities were expanded to active interaction. By active interaction we mean, that the system gives audience the possibility to interfere directly with the presentation. Therefore, as a whole product it helps students to understand the problem by presenting the subject, discuss it and to interact with it. To give an example of interaction, we can imagine the teacher to ask a question and a student who solves it on his notebook, tablet PC, etc. and sends the solution back to the teacher, who can evaluate, correct or annotate it.

There is a number of systems, which give us the necessary functionality mentioned above [2]. Some of them are open source, freeware, shareware and some need paid license to work.

DyKnow [3] stands for Dynamic Knowledge. It was first created on DePauw University by Dr. Berque to help students to learn new things. Later it was commercialized and its functionality widely extended. It has client-server architecture and provides both wired and wireless capabilities. Nowadays it allows student authentication and has some monitoring capabilities. To get student feedback, teacher can create little tests that are sent to the client applications. The students solve them and send the solutions back to the teacher. Another interactive feature represents the possibility to grant a student control over the teacher's working space in order to fill in some information.

Classroom Presenter version 3 (CP3) was created by students on University of Washington [4]. It is an open source software and it has many useful functions. Its architecture is completely object oriented. Slides are divided into sheet layers. These layers are image sheet layer, text sheet layer and ink sheet layer. It supports a few commonly used stylus types as pen, highlighter, and eraser. CP3 allows the teacher to carry out short poll and also to receive students' answers for a question he gave.

Ubiquitous Presenter is an extension of CP version 2. It is being developed in University of California, San Diego [5]. The main new function which was implemented was the creation of a web based java applet, which allows the user to connect to the presentations through the Internet. Students' submissions are sent to a central server, which sends them to teacher's application. It supports ink as well as other annotation techniques.

The people behind Ubiquitous Presenter are working on a new submission style using short message service (SMS).

NetSupport School [6] is not purely an interaction presentation system. Its main purpose is class management. It can manage whole computers and their running processes. However, it has some capabilities, which allow it to present the subject and to save the presentation and solution as a Portable Document Format (PDF) journal. The students can submit their notes and students testing is available too.

The main disadvantage of this solution is the initial high cost investment not only into the application itself but also to equip the class with tablet PC or other computers. Another drawback resides in the fact that if the management is set to tight, nobody, except the teacher, can do anything but watch the display. In this case the application has the opposite effect it should originally have.

InkSurvey [7] is a completely web based, freeware application. It gives teacher the ability to prepare some questions that can then be raised during the presentation. Students can answer these questions using digital ink or just typing them in. When submitting the answer, students can choose how certain they are with the solution. There is however a restriction when using ink. It can be used only in Mozilla Firefox browser.

eBeam Projection by Luidia [8] is more a hardware (HW) solution than a software one. The HW package contains an interactive stylus that behaves like a mouse and an eBeam receiver that can be mounted on almost any surface (wall, whiteboard etc.) and turn it into an interactive whiteboard. To

annotate the prepared electronic content you will need the data projector as well. The projector then projects the computers screen onto the surface and the receiver catches the stylus position and actions and transfers it back to computer. In other words we can create a giant touch screen. eBeam Projection is accompanied with eBeam Interact software package which is free of charge but needs a HW package to work. Included in the software package there is an eBeam Scrapbook – the presentation tool with content sharing and collaboration features. All you need to share your presentation and to interact with the audience is an Internet connection.

Interactive White Boards nowadays called **Smartboards**, have been around for many years now (since 1987). These equipments are an excellent tool to help teachers provide the most compelling lessons to their students. The main part of Smartboard is based on the Touch Screen technology where it is possible to interact with the board with a pen or just a finger. Although the fundamental Smartboard's installation is not very easy next using is very simple. For annotation it is possible to use one of the 4 pens provided or to use fingers to move the annotation anywhere on the board and then to use fist to erase what is needed. Based on teacher's action the board automatically switches modes. The main problem is the high price, lack of portability and the fact that many schools cannot afford the high costs of acquiring this groundbreaking technology.

3 PREVIOUS EXPERIENCE

About four years ago we started to look for the contribution to the problem of declining involvement of students in the learning process especially at the lectures. Obviously the basic assumption to solving this problem was the lecture improvement. In general, the pen-based approaches enable to improve lecturers' presentations in the sense that the presentation can be made more attractive to students, can be created/modified interactively with students, or can even be turned into active learning.

When searching for the most suitable technology to use the university specific conditions have to be considered:

- lectures usually take place in several high capacity auditoriums,
- the auditoriums are most often opened for students also outside lecture time, therefore the expensive solutions are not appropriate,
- some lecturers have the presentation materials prepared in advance in various formats (e.g. word or pdf) and would like to use them,
- some lecturers prefer on the spot writing and expect just the comfortable blackboard replacement,
- the rest would like to combine prepared materials with on-the-spot writing.

3.1 eBeam Projection

At the beginning we started with the Interactive whiteboard by Luidia [8] accompanied by an eBeam Interact software package (See Fig. 1(a)).

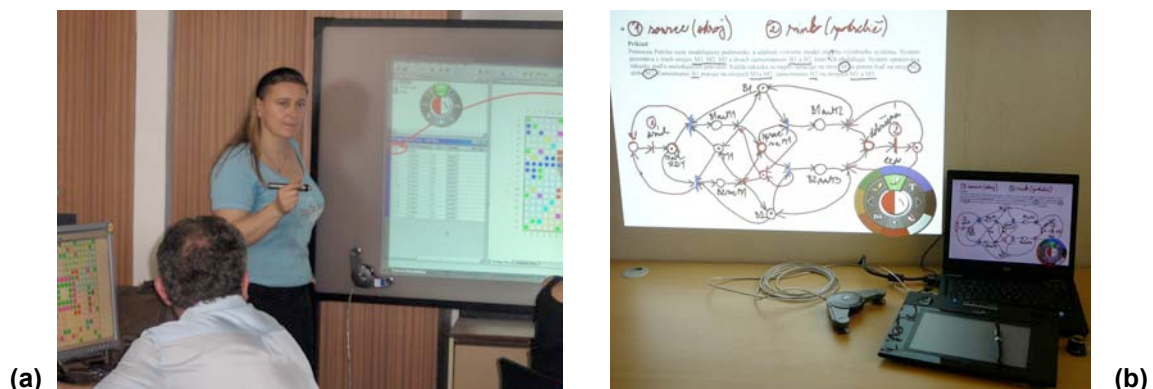


Fig. 1 Using eBeam Projection
 (a) with whiteboard and eBeam stylus (b) with external tablet.

This technology allows to navigate within, annotate on top of, and capture from any computer application using the eBeam stylus on a whiteboard. So the presentation materials prepared in any format can be reused and annotated using eBeam Interact application. The annotated screens can be automatically converted into the eBeam Scrapbook slides and stored in the form of presentation for the further reuse. We used the technology mainly with Microsoft documents materials, presented in the Full-Screen mode. An example of the usage is given in Fig. 2. The problem was that only the annotated screenshots are stored. So the teacher has to consciously annotate each screen, otherwise the presentation will not be complete and therefore not suitable for direct sharing with students.

The stored presentations can then be opened in eBeam Scrapbook (we used the version 1.2.1) – a presentation tool that supports also the content sharing and collaboration with the audience. This is much more comfortable way of presentation. However, the previously used inking of screenshots can not be deleted. Also, the quality of the stored presentation is not very high. The eBeam Scrapbook screen is shown in Fig.3. The presentation tool supports only its native format (.esb) and Whiteboard Software files (.wbd).

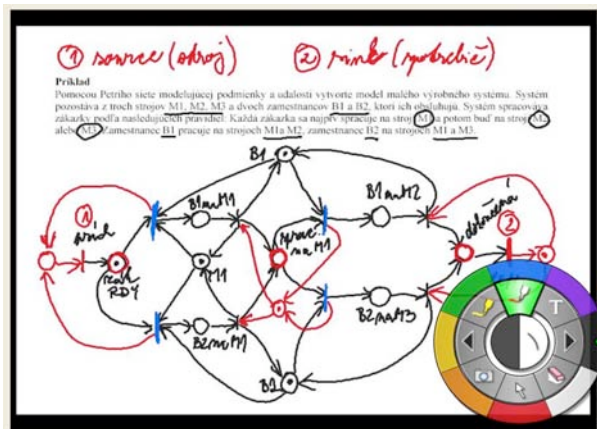


Fig. 2. Microsoft Word document annotated by eBeam Interact tool.

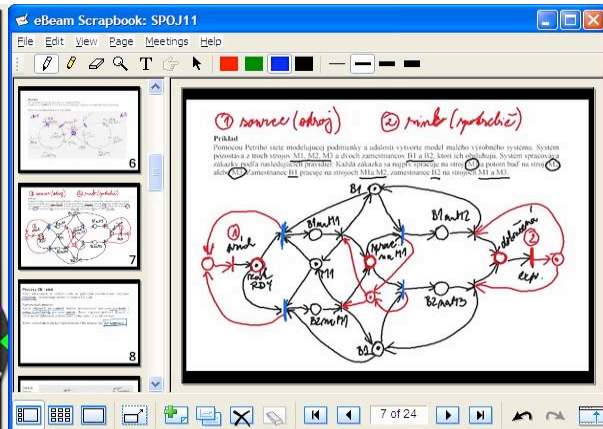


Fig. 3. The stored screenshot reopened in eBeam Scrapbook presentation tool.

Although this is very convenient solution for small to medium classrooms, in auditoriums of 150, 300 or even more seats is not very suitable. Of course the eBeam receiver can be mounted also on the wall to turn it into a huge interactive whiteboard. However, when using the eBeam stylus the whiteboard's dimensions are still restricted by the teacher's reaching distance, let alone the discomfort of writing on the wall.

Therefore the need for other pen-based technology has arisen. Using the external tablet, wired or wireless, (e.g. eBeam Inscribe 200e) or special active display to replace the whiteboard and eBeam stylus was one of the possible solutions. We tried G-Pen M609X from Genius connected to conventional notebook with data projector. Although, one can get used to it writing blindly onto the tablet with the sight concentrated to the display or the projected screen on the wall is far from being natural for human being and therefore not the ideal solution.

Considerable advantages to this solution brought the replacement of the conventional notebook with external tablet by Tablet PC (Personal Computer). This versatile, easy to move solution is usable at any time and any place, it is much more comfortable and the projection screen is always fully visible. However, the above mentioned problems with Interact software package usage motivated us to search for / look around to find a more suitable presentation software.

3.2 Microsoft Office PowerPoint 2007

Perhaps the most widespread presentation environment is Microsoft Office PowerPoint. The version 2007 enables also the slides annotation either during the presentation or in advance. There is also a compelling feature – animation of digital ink. This is all very nice when preparing new presentation or if you have your material prepared in the form of PowerPoint or OpenDocument presentation. You would not open Microsoft Word or PDF document in a usable manner. So the only way is to transform the prepared materials into the PowerPoint presentation manually which is of course time consuming work. Also the interaction possibilities are very limited.

The inking works perfectly in normal presentation mode. If you want to use the Presenter view feature you will come into a problem. Although in Presenter view (Fig. 4(b)) you can see a nice red marker you can not use it on the slide. Touching the slide in this window will advance the slides. The only window where you can annotate the slide is the original PowerPoint window (Fig. 4(a)). The annotation will appear on the projected screen given in Fig. 4(c). The erasing feature of the other side of the TabletPC stylus is not supported and when using the menu eraser the ink from the projected screen will be erased only after selecting other tool. What is more, the slide advancement is not synchronized in these two windows so when switching the windows you have to find the correct slide manually. This makes very difficult to combine Presenter view with inking and distracts your attention from the actual content.

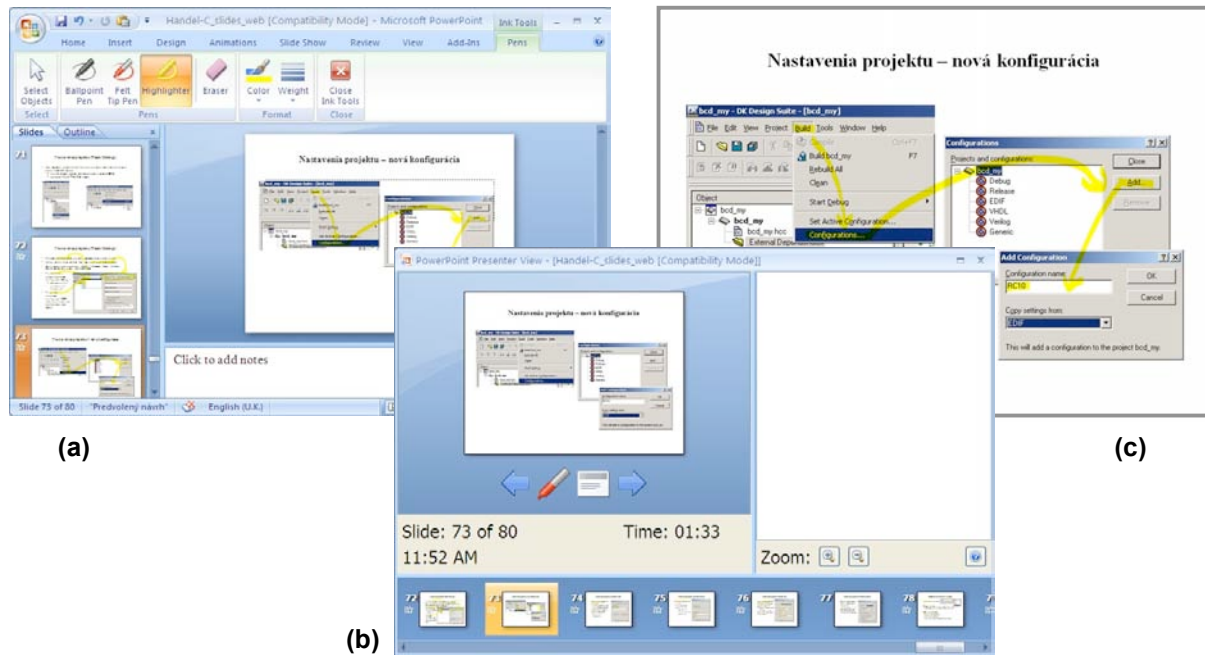


Fig. 4 Microsoft Office PowerPoint

a) Main window, b) Presenter view window, c) data projector

3.3 Classroom Presenter

As it was mentioned above, the presentation tool Classroom Presenter 3 (CP3) was developed at the University of Washington, Department of Computer Science and Engineering [4]. It supports dual monitor output and on line interaction with students. Primarily it is devoted to presenting and annotating the presentations prepared in advance in Microsoft Office PowerPoint. Therefore the presentation editing capabilities of CP3 are very poor compared to other reviewed environments. It does not even support the basic editing features like slide movement or copying which one would say are indispensable when reviewing the old presentation. Also except for PowerPoint presentations there are no import possibilities. So the materials prepared in other formats can not be reused with Classroom Presenter.

On the other hand, CP3 supports easy to use on line presentation sharing and direct interaction with students in the form of pull or short anonymous tests. What is more it is open source software and therefore can be further enhanced according to our needs. Some extensions were designed and implemented into the CP3 to meet our basic import/export and presentation editing requirements and will be described in the following section.

4 ENHANCED CLASSROOM PRESENTER

After experiencing several interactive presentation applications we found out that none of them satisfies our expectations without reservation. All the tested applications can be characterized by poor import possibilities. If ever a tool supported other than its own natural format then the only one was PowerPoint presentations. Since we believe this is an important restriction we decided to concentrate

on this issue. There were two possibilities: to design and implement a completely new interactive The presentation application or to improve one of the existing ones. University of Washington's Classroom Presenter 3.1 (CP3) was chosen for this purpose [4] simply because it is the only open source software. Based on the CP3 license it can be extended and redistributed by anyone providing that the license conditions will be met. We also realized the potential of this application consisting mainly in its quality interaction support. On the other hand, the documentation to CP3 is far from perfect. Therefore, if someone wants to make some changes, it is necessary to go through the whole code and find out what one wants to.

4.1 Original Features

Classroom Presenter is role based choosing system. It supports two different role types. The first one is standalone, the second one is networked. In the standalone style you can choose to work only as an instructor. In the networked style, there are 3 roles.

The first one is a **student role**. As the role implies it is designed to be for students connecting to the presentation. After a successful connection they can download the presentation and they are able to browse it. If allowed, they can send their slides to teacher and answer the quick polls. The second role is an **instructor role**. This role is identical to the standalone instructor role. The only difference is that it creates a TCP based server, where students can connect to. The last role is called **public display**. This role was created to give the teacher a possibility not to be connected directly to the projector. Another computer can be used which is connected to the projector with CP3 application set to public display. It is used as middle man to show the teachers slides while the teacher himself can roam freely in a classroom.

Another interesting feature of CP3 is the use of pen stylus and highlighter stylus. If the computer's technology supports it, then it recognizes the stylus pressure too, so there is no need to change the stylus width manually very often. The same applies to highlighter. Colour can of course be changed too.

As it was mentioned above, CP3 has a completely object based architecture. Object slide consists of multiple sheet layers. These layers are objects too and there are three of them:

- Image sheet layer – holds an image, which can be resized and moved. Resizing keeps the aspect ratio; therefore we cannot change only one of its dimensions (height or width). It is the bottommost layers.
- Text sheet layer – gives us the opportunity to insert normal text into the presentation. Font, size and colour can be changed to fit our needs.
- Ink sheet layer – stores all the strokes we draw. It is the topmost layer. Therefore it is always redrawn as the last one and we can always see it.

Further there is a possibility to switch between a whiteboard and the current presentation. The whiteboard creates a new presentation with empty slides, so if needed we can use it as a scrap paper. However, there is also the possibility to insert new empty slide into the current presentation.

The zoom out feature opens up other sorts of possibilities. By zooming out, the slide size is scaled down and the space for additional notes is enlarged. This feature showed up useful for instance when solving a problem based on the assignment, After going through the assignment it can be zoomed out to free up place for the solution. Also it can solve the problem of running into a margin while writing when the instructor suddenly needs more place than he/she expected.

Concerning the import and export possibilities of CP3, it is able to open its native format and Microsoft Power Point presentations and to export slides as images (PNG files) and as Hypertext Markup Language (HTML).

4.2 New Features

While using the CP3 during lectures preparation and presentation several issues occurred that could or even should be solved to improve the comfort and the efficiency of the Presenter. Some of the new features that were implemented in the frame of diploma thesis [9, 10] will be summarised in this section.

4.2.1 Import and Export Possibilities

Perhaps the most important drawback that was identified in CP3 was its poor import support. Besides the native format only the Microsoft Power Point presentations could be imported and turned into the CP3 presentations. We implemented the possibility to open PDF and export to PDF documents. To export to PDF document we take the advantage of CP3 to export slides as images. We then take these images and create a PDF document from them. Just before the creation, we can add some metadata information like author, title, etc. We can change dots per inch (DPI) of the images we are using. The solution to manually create a PDF structure from a slide would be too difficult.

Another document format the enhanced CP3 can open is the Word document. The supported file formats are .doc, .docx and .rtf. To open these types of documents we need to have Microsoft Word installed. The supported versions are Word 2003, Word 2007 and Word 2010 Beta edition. In addition, the user can choose how the document should be opened. The open dialog window is illustrated in Fig. 5. There are three options:

- 1:1 style – this opens the document in CP3 as one to one copy that means one page on one slide. This style does not allow the slides' text to be edited afterwards but of course the slides can be annotated. This type of import is useful when correcting for example a thesis, paper etc.
- PPT style – this style is very similar to Power Point presentation. The Word document is resized, rescaled and then used to create the CP3 slides. The text in the created slides cannot be edited either.
- Editable text style – the last style can be used to open the Word document as editable text. This style uses the PPT style format, but the content is then parsed into the CP3. For each document page we parse its text and create a text sheet layer, for each picture in this page we create an image sheet layer and for each table we create additional text sheet layer.

The enhanced import support will enable the massive material reuse. Almost all the materials prepared in Windows environment can now be turned into the CP3 presentations. We believe this will encourage more instructors to use Classroom Presenter for their lecture presentations.

4.2.2 Presentation Publishing

Another feature that was added is the presentation publishing. To accomplish that, we export the current presentation to PDF format. Then we fill in the server URL address and publish the document. However, to publish the document, we need to create a central server first. The server application allows teacher to divide students into classes and to sort the published materials for example according to the courses. Connection to the server needs authorization which recognizes the privilege level of the logging person. The path to documents are not absolute but are computed using MD5 hash algorithm.

4.2.3 Editing Features Enhancement

The original CP3 does not support slide position change or slide duplication. Therefore, the default mouse behaviour when entering the slide miniature was changed. Previously, to see the slide preview it was necessary to hold down a mouse button and move it over the slide miniature. We believe the behaviour is now more intuitive. When entering the slide miniature the preview is shown immediately. After 5 seconds of staying still, the preview closes automatically. When pressing and holding down the left mouse button over a slide miniature, the respective **slide can be moved** to the different position of the presentation. Simply move the mouse up or down while holding down the left mouse button and release the mouse button on the desired position. The slide will be moved to that position. To localize the position where the slide will be moved, a graphic marker will be displayed showing the current position.

The **slide duplication** was implemented, too. As it is widely used, the support of common shortcuts CTRL+C and CTRL+V was also implemented. We need to distinguish between copying the whole slide and copying only the sheet. In case the pen or highlighter stylus is selected, pressing the copy shortcut (CTRL+C) will put the whole slide into the clipboard. If the add text stylus was selected before copying the topmost text sheet layer is placed into the clipboard. Finally, pressing the shortcuts CTRL+C while add image stylus is selected the topmost image sheet layer will be copied into the clipboard. The paste functionality is made more versatile.

The corresponding slide or sheet will be pasted into the presentation according to the clipboard content. The original CP3 enabled to add picture saved in a file into the current slide. Since the

process of saving the copied picture into the file and then reopening it again is time consuming and therefore almost unusable during the lecture presentation **pasting pictures** directly from the clipboard, using CTRL+V shortcut, was also implemented. In that case new image sheet layer is added into the current slide.

4.2.4 Other Features

Some enhancement has been done also in the **role selection wizard**. This wizard simplifies the way how we choose our role through a step by step user interface (Fig.6). The original login window was not very practical on monitors with low resolution. It caused the login window to be shown outside of the working area. This wizard corrects the issue. It allows teacher to simply create a TCP session and to start the presentation. The students can join the started session simply by selecting the session name and confirming it.

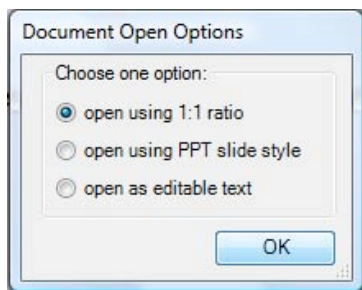


Fig. 5 Word document open dialog.

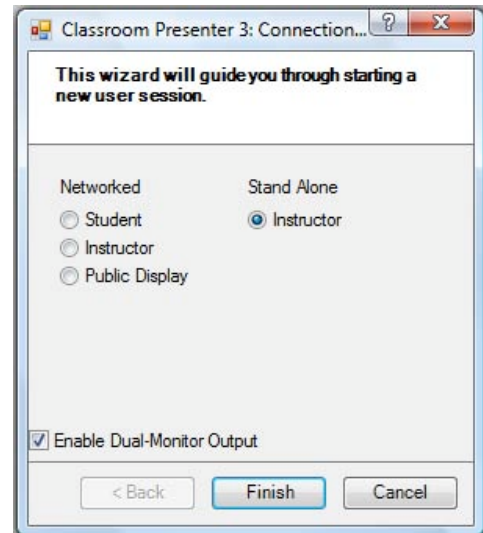


Fig. 6 Role selection

The next feature that was added is the possibility to **zoom in**. This feature gives us the opportunity to show students some details in the presentation. It is especially useful when for example large picture should be included into the presentation and the small details are not perfectly visible.

The last new feature is the **reflector stylus**. The reflector tool will create a grey, half transparent layer on the top of the slide. Using the mouse or stylus the teacher can then select the region that should be revealed. In other words, a window is created through which the selected part is visible and therefore highlighted. Two reflector styles are supported: the rectangle and custom shape style. When rectangle style is selected, the hand-drawn selection is reshaped to a rectangle. This rectangle is then removed from the layer. In case of custom shape style the selection will be transformed in a closed curve. The inside of the curve is then removed. This allows teacher to show students only a part of the slide or to focus on a specific problem. Fig. 8 shows the examples of reflector usage.

Two new tools were appended the original Toolbar – Reflector and Zoom in and the icon of the former Zoom out tool was modified. The differences are illustrated in Fig. 7.

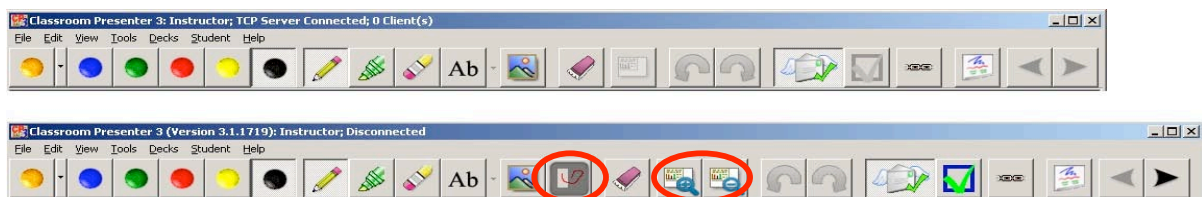


Fig. 7 Toolbar extension in enhanced Classroom Presenter.

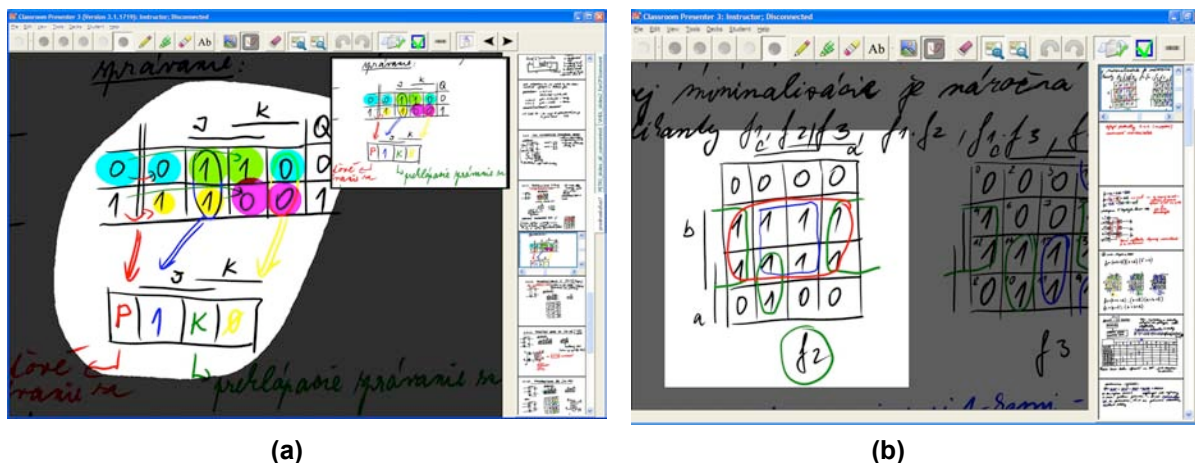


Fig. 8 Reflector usage

(a) custom shape reflector and (b) rectangle reflector on zoomed in slide.

5 CONCLUSION

Attracting students' attention during a lecture presentation is a common issue. An approach to its solution using pen-based technologies has been presented in this paper. The presented results show that nowadays Tablet PC proved to be the most suitable technology for this purpose. We have reviewed several presentation tools and all of them were the most comfortable to use with Tablet PC. All the tested applications can be characterized by poor import possibilities, making thus the previously prepared materials, other than PowerPoint presentations useless. To overcome this deficiency several improvements have been designed and implemented into one of the existing presentation tools – Classroom Presenter 3.

We used this existing system to expand its functionalities to meet our teachers' needs. We added the support to open PDF and Word documents, supporting versions of Word 2003, Word 2007 and Word 2010 Beta and Word document formats .doc, .docx and .rtf. A Word document can be opened in three modes increasing thus the import flexibility. We implemented the possibility to publish the presentation as a PDF onto a central server. Exporting presentation as PDF was added too. We simplified the role selection by replacing it with a step by step role selection wizard. Besides we created a zoom in button to magnify the current slide. Another added feature is reflector. Reflector creates a grey half transparent layer on the top of current slide. Then by using mouse we select a region we want to see normally. This gives us the opportunity to focus on a specific problem. Next implemented feature enables to move slide in presentation. Also the possibility to copy a whole slide or just an image or text sheet layer was added. In pasting we support adding slides to presentation, sheet layers into currently selected slide or images.

The practice indicates that the interactive presentations made the explanation of study material in the course much easier and illustrative, at the same time increasing the course attractiveness and students' involvement in learning process. For teacher it is a big motivation to give lectures to students that are interested in the presented material. On the other hand, the students can easily get the presentations, e.g. modified directly during the lecture and store them for further reading.

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