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Electronic Workplace - The Complete Laboratory Environment

Abstract:

The purpose of an electronic workplace for students and educators and the expected outcomes and benefits are described. Development of an electronic workplace as a new virtual environment where students can find the appropriate tools, i.e. data and applications that enable them to collaborate virtually to meet their educational goals is conceptualized. An experiment with the electronic workplace implemented in laboratory environment was performed. Description of the solution and results achieved are presented, and certain experiences evaluated.

Keywords:

Workplace, e-workplace, electronic workplace, digital workplace, virtual workplace, collaboration, communication, education

1. Introduction

Advanced e-learning makes possible the development of experiential knowledge through simulations, and the rapid inculcation of similar experiences by virtual teams, thereby accelerating the development of cohesiveness.

French Caldwell [2]

Hypercompetitive global market put an imperative to companies: Collaborate or Perish [10]. Today's enterprises must realize the necessary pace of products innovations and reduce production costs, so outsourcing of non-core business elements, and well organized collaboration of all business partners are an imperative. IT offers electronic workplace¹ as the concept and practice, theory and technology, expectation and salvation from ones tail position at the market.

If so in business and industry what about education? Is education the competitive environment? Isn't it necessary to implement certain e-workplace components and to promote a spirit of collaboration in a high-level education curriculum?

Dilemmas mentioned and feeling that it has to be, were a challenge for testing the electronic workplace concept implementation in an education process with two motives:

- e-workplace is a segment of improved education technology (fig. 1.);

¹ digital virtual e-workplace

- student's introduction into collaborative systems as their future workplace natural environment [13].

Teaching	→	Learning
Teacher	→	Mentor or Coach
Student	→	Learner
Synchronous	→	Asynchronous
Passive	→	Active
Linear	→	Non-linear
Scheduled	→	On-demand
Teaching material	→	Accomplishing a goal

Fig. 1. Revising our Thinking about Teaching and Learning...[9]

2. What is an Electronic Workplace?

The picture we usually have of a workplace is a room where we can find all kind of tools needed to solve certain problems. Tools for analyzing the problem, tools to repair the problem and a place where new components or items are stored. These parts e.g. are used to replace damaged parts of a machine. In this description one easily will recognise a garage. As a matter of fact the e-workplace in this contribution, has a lot of similarities with that well-known garage. The main difference is that we do not deal with real tools but with electronic tools. In this electronic environment, available via a computer, we can use specific tools that can support us to solve a certain problem. [5]



Fig. 2. An electrical engineering workplace

This is a good place to start, since many of the same features and functions of e-workplace began way back to "garage". Electronic workplace isn't a workplace saturated with electrical and electronic devices (fig. 2), neither a workplace with all electronic hardware devices (fig. 3). That's something completely different.

"... the e-workplace could be defined as a set of software to be delivered on the office desktop in as standardized a way as possible. " [4]

"... the computer desktop rearranged from the original version into one that includes a range of internal and external links representing the business at hand." [3]

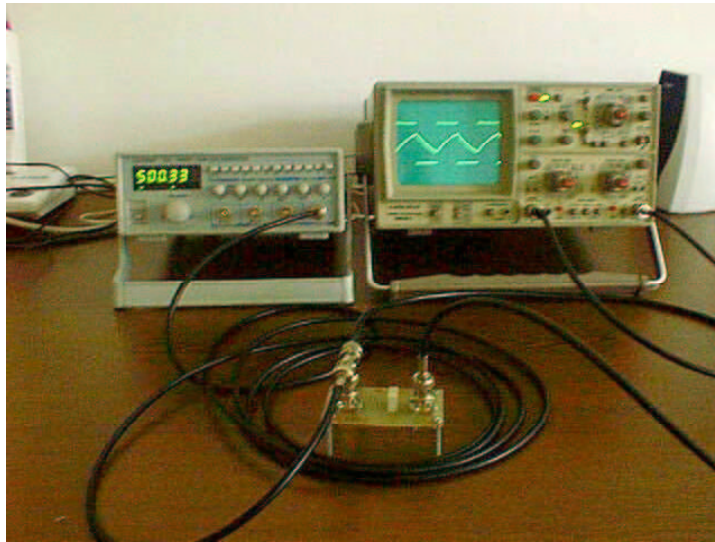


Fig. 3. Hardware electronic workplace [7]

"Everything you need to manage your business." [3]



Fig. 4. Electronic workplace environment [7]

A nice definition one can find on Citrix Systems Inc. [11] web site:

*The virtual workplace is an Internet-centric environment where people **communicate** and do **business** via a seamless web of **digital** media e-mail, voice mail, cellular telephones, laptops, **desktops**, hand-held devices, video conferencing, interactive pagers —and more.*

Keywords are business, communication, digital and desktop

The business is education, computers are desktop PCs and everything is digital. Teaching is a classic one, performed in a classroom-laboratory (fig. 4.) so the communication and collaboration among students and with educator are direct and natural, without Internet, even without LAN.

3. Why an e-workplace?

In a time limited teaching process at an undergraduate study as is at Polytechnic of Zagreb, it is important to, as much as possible, overlap certain activities, e.g. education and training. That means, during new knowledge learning, practising some routine skills previously learned and creating an introduction for the following study subjects. The primary goal of laboratory exercises in study subject Telecommunication fundamentals is better understanding of certain signal modifications in telecommunication channel and devices. The following study subjects are Telecommunication systems and Digital Signal Processing.

In the classic labs (fig. 3.) signals are generated in hardware "function generators", monitored and visualized by the oscilloscope, and measured with suitable electronic voltmeters. Exercise report is a printed form to be filled with hand-written data, pictures and comments. This is a time consuming process so the number of measurements is limited.

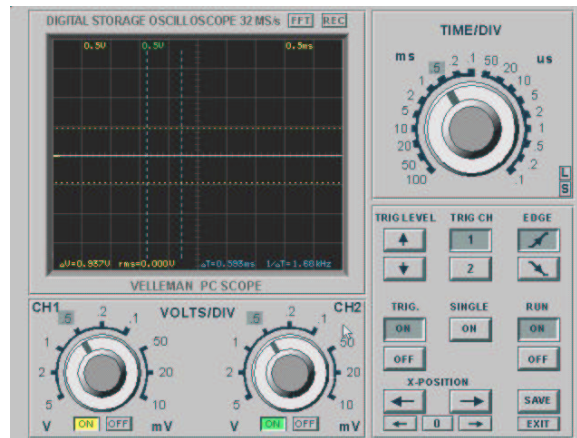


Fig. 5. Emulated digital oscilloscope² PCS-32[®]

E-workplace based labs on the same topic are performed on PCs. Signal generators, device under test (DUT) and measuring instruments are simulated on the computer. It is customary to emulate hardware instruments front plates and controls, so the impression of reality (virtual) is present (fig. 5.). Measurements are fast and easy "click the button",

² Velleman

parameters changes can be numerous and frequent, and learning is supported with experience from examples performed.

The third possible approach is with automatic computer based measurement system and real, hardware instruments and test device. Instruments are to be computer controllable (HPIB, GPIB, IEEE-488...). The additional skill needed is instruments programming, so the additional training is needed. Automated measurement systems are efficient in mass production lines, but for education applications are totally unacceptable due to programmable instruments enormous price.

The compromise³ among three previous configurations is an e-workplace with computer generated or captured real signals, simulated or real DUT and measurement system performed by PC equipped with A/D converter system (sound card or multi-channel A/D card) and appropriate software. Reports are electronic forms (MS Word *.doc) with instruction embedded - editing it is already well known process. By the optimal choice of measurement parameters, hardware and software, it is possible to reduce additional cost and training to acceptable value.

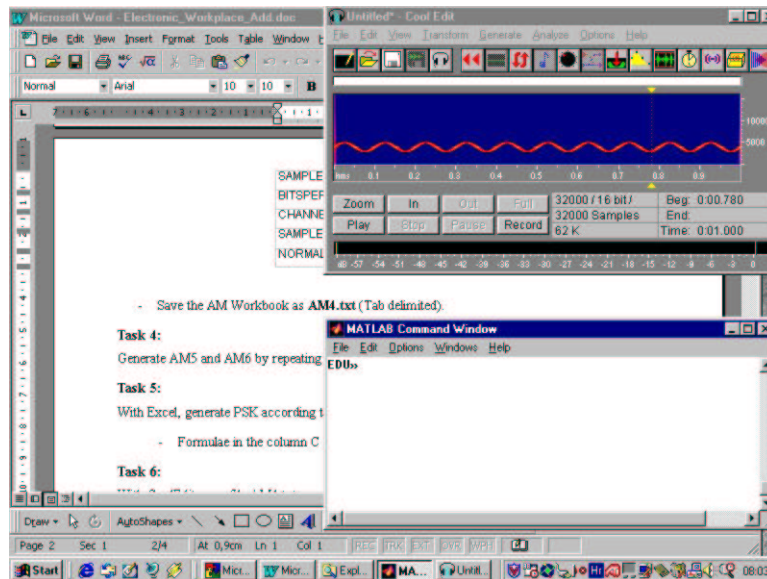


Fig. 6. Electronic workplace multiple windows desktop

Electronic workplace is a template for:

1. Data collecting or creating (input)
2. Data editing or modifying (processing)
3. Report generating and editing (output)

The whole workplace is performed on a single PC. Tools for signal generating, processing and analyzing are placed in different windows (fig. 6.) and by jumping from one window to another different tasks are performed.

Instead of instruction and forms written on paper, the same texts are in original, MS Word *.doc format installed on the PC and available for editing. This, so called "leading document" is essential for the electronic workplace. At the beginning of an exercise, the leading document (fig. 7.) is the set of tasks and instructions to be performed step-by-step.

Task 1:

With CoolEdit generate 2s (64000 samples) of **sine** modulation signals, according to Table 1...

Task 3:

With CoolEdit, generate 2s of AM signal, according to Table 3:

- Start program: Excel
- Open file S5.txt file in the Workbook 1.
- Open file MS1.txt file in the Workbook 2.
- Open a new Workbook for signal generating, name it AM.

Fig. 7. The e-workplace leading document: Tasks and instructions

Additional, less important instructions are "hidden" in comments, highlighted with yellow (fig. 8).




The screenshot shows a document with a yellow-highlighted comment box. The comment text reads: "TSM: o File, New, o New Waveform: o Sample rate = 32000 Hz o Mono / Stereo = Mono o Resolution = 16 bit o View: o Waveform View o Display Time Format: o Samples o Vertical Scale Format o Sample Values o Generate: o Tones: o Base Frequency (Table 1) o Modulate By (Table 1) o Frequency Components (1st at 100%, the other at 0%) o dB Volume (Table 1) o Presets - nothing o Start Phase 0° o Flavor - Sine o Duration - 2 - seconds". Below the comment box, the text "With CoolEdit generate 2s (64000 samples) of sine modulation signals," is visible.

Fig. 8. Comment - additional instructions

Outcome of the task or instruction done is to be included in the leading document. Measured or calculated values, pictures, graphs or samples of the signal generated or

processed are inserted as objects. Initially text-like leading document becomes a multimedia report (fig. 9.). An audible sample of the signal generated or processed is presented with a loudspeaker icon.

Table 2, FM signals generated by CoolEdit:

$f_0 = 5kHz$ $A_0 = -6dB$	Carrier signal	Modulating signal	f_m [Hz] Mod. Fr.	Δf [Hz] Mod. by	B [Hz]
1. FM1 	Base Fr. 5000 Hz	internal sine	10	4000	
2. FM2 	Base Fr. 5000 Hz	internal sine	250	1000	
3. FM3 	Base Fr. 5000 Hz	internal sine	250	500	

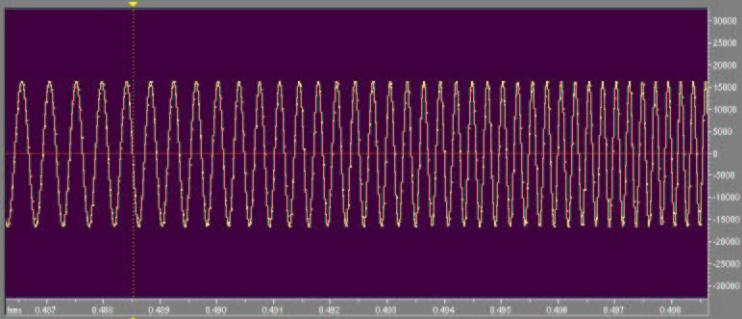


Fig. 1.1: Graph of FM1 signal

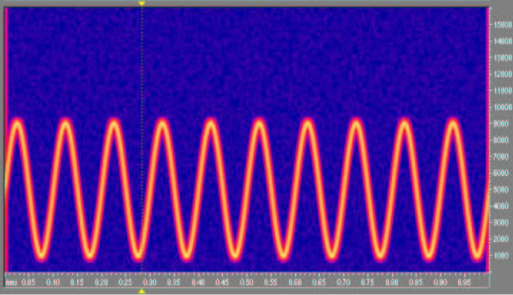


Fig. 1.2: Graph of 3D spectrum for FM1 signal

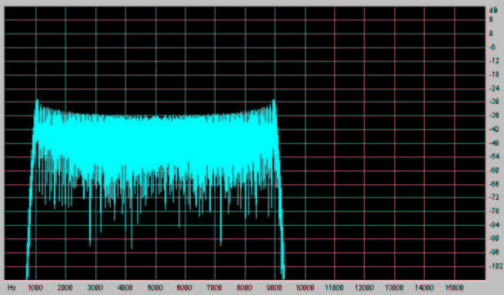


Fig. 1.3: Graph of 2D spectrum for FM1 signal

Fig. 9. Sample of a multimedia e-workplace report

4. Cost⁴ effectiveness

The point is that when we look to buy software or services, we need to look at the end result rather than the flashy words. I think I'd rather approach an e-workplace with someone that knows my business, a company

⁴ Time and money, not the money only!

that has been in business since at least the pre-dot com era and one that has the intellectual capacity and experience to help me with the challenges I'm addressing. I think I'd also be wary of the vendor that offers me a Cadillac solution to a Volkswagen problem. I would choose a reliable resolution rather than one that almost meets my requirements but includes a range of functions I don't really need. Maybe we need to cut through the jargon to the cold hard real words of business. Words like efficiency, accuracy, clarity, reliability and service all come to mind. If you think it makes a difference, you can hang an "e" in front of them all.

Al Horner [3]

The dominant cost of an electronic workplace is in telecommunications⁵ (40%) and operations⁶ (35%), as Gartner's report [4] states. Excluding PC and LAN, server hardware typically accounts for less than 10 percent of total spending and software licenses typically account for 5 percent to 8 percent of total spending.

The strategy of cost reducing was to eliminate telecommunications (no distance work), and to work on individual PCs (no server needed). Operation cost⁷ is dispersed among students, educator and already existing system engineer. Student's work on e-workplace establishing and maintenance is a part of their education and training, so the time spent isn't a "cost" at all. Educator's additional engagement on lectures adaptations is a part of normal and expected teacher's activity, so the dilemma about that part of costs is the private one; it depends on ones attitude towards the job he or she is performing. PCs and LAN exist, active or passive their lifecycle time is limited anyway so, it is the basic economy reason to exploit all the resources existed (asymptotically 24/7). Finally, the last source of possible additional expense is in software licences. They can be reduced by adopting already installed software (MS Windows, Office and shareware, tool free version of CoolEdit, and student versions of i.e. MatLab or Tina).

Further cost analysis is possible through the similarity with on-line teaching programs. Cost categories [12] identified are:

- Development
- Presentation
- Technical overhead

⁵ WAN fees and remote access telephone charges.

⁶ Administration, backup, end-user support, maintenance, tuning and troubleshooting.

⁷ Only non-financial cost - time

On-line teaching materials are similar to e-workplace materials, so the development time (per teaching hour) is to be comparable:

- face-to-face lecture 2-10 hours;
- e-workplace (on-line) material 5-23 hours;

Time for development depends on familiarity with materials, skill in editing documents (*.html i.e. *.doc), course management systems and technical support available. Numbers presented confirms with well known fact that electronic materials of any kind (on-line or face-to-face) are difficult to establish at initial phase.

Most of the extra time needed relates to testing procedures. Each new component is to be tested alone and as a part of a system. And finally, when everything is assembled and seems to be finished, the chance of failure is in hardware or software platform, operating system on student's work stations etc. Once established e-workplace editing is comparable with maintenance of classic teaching materials - correcting paper printed lecture notes, redrawing overhead transparencies etc.

Next two costs: presentation and technical overhead cost, are correlated with the specific environment. If the resource needed exists and is available to be exploited, then there is no additional cost. But, if communication line or web-site space are to be rented, or new laboratory to be equipped, then it is obvious that further cost will arise.

5. How to choose and complete e-workplace software bundle?

In the education process, it is possible to affect the efficiency⁸ by inverting the cost into the benefit. If an additional activity is not a part of a syllable, then it is a waste (expense). But if it is as a segment included in education or training, then the same time consumed is a gain (from denominator it "climbs" to nominator, or from "-" sign it becomes "+") so the efficiency increases.

From that point of view, specialised and sophisticated software tool may be counter productive in an educational process. Fancy options, controls, buttons etc. attract students and educators attention and diverge the workflow from the mainstream to side alleys - nice and

⁸ Efficiency is the quotient or difference of resources (time and money) invested in education process and the value gained (the students knowledge upgrade)

interesting, but time consuming. One of the key aspects is MISS⁹ i.e. KISS whenever and wherever it is possible and rational. The "tool of choice" has to be:

- Already know and previously well trained (by student and especially by educator);
- General purpose rather than specialised;
- Few simple tools instead of one integrated and complicated;
- The simplest available version;
- Maximally reduced options installed.

The question possible is about the easiest way: one integrated or few partial software tools? One integrated tool is the better choice if it will be used many times during study, but the probability for that is low in various study subjects. Tools of general purpose are "recyclable" and may be used anywhere. If it is possible, use MS Excel for calculations instead of MatLab, or MatLab instead of Mathematica and so on.

For the e-workplace described and implemented the software platform were MS Windows '98 for development and MS Windows NT for implementation. The general purpose tools were from MS Office '97 packet: MS Word as text editor and Excel for data processing, and MS Paint for pictures editing. Some special calculations (digital filter design) were performed by MatLab 4.0 - student edition. Signals were created, analysed, visualized and reproduced as audio with Syntrilliums¹⁰ CoolEdit '96.

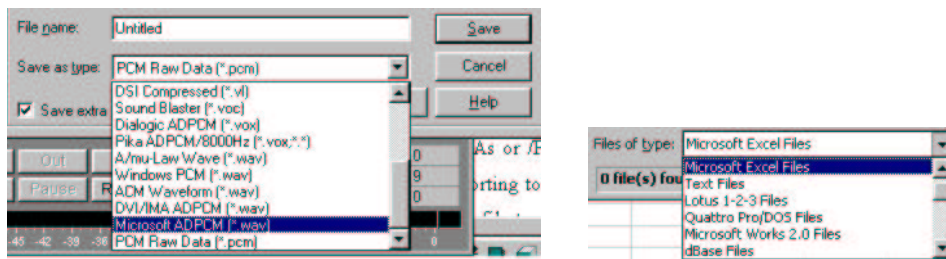


Fig. 10. Some of CoolEdit and MS Excel data formats

If a set of simple tools is implemented, then the problem of their interfacing appears. All the construction fails if there is not a suitable way of data transfer from one processing stage to another. During the tool system establishing it is important to test and practice interfacing procedures as many times as possible, and choose the most convenient one. It may not be the simplest, or the fastest one. Criteria for the decision include didactic value, transparency of the process, the clearness of explanation and size of files generated.

⁹ Make It Simple ..., Keep It Simple ...

¹⁰ Syntrillium Software Corporation

Certain data is to be presented in different formats (fig. 10) for various purpose - one¹¹ (*.txt) for data processing and analysing, and another¹² (*.wav) for the report editing. That depends on the final report media - if it is a floppy disk, then 1,44 MB is the limit, the capacity insufficient for usual multimedia document. CD has enough capacity for all files archiving, but it is not as convenient for frequent small file copying and transfer during collaboration as floppy is. In that sense, the compromise is the best - floppies as temporary backup and "lunch box" and CDs for the final reports archiving.

Task 6:

With CoolEdit open file **AM4.txt**, reproduce signal, save it as **AM4.wav** (Microsoft ADPCM).

Fig. 11. Interfacing instruction

Interfacing instructions are to be extremely precise and exact (fig. 11.). Any discrepancy in file format their designations or procedure misunderstanding influences the function chain of the e-workplace, may cause some difficulty to trace problems in the following task execution.

6. Conclusion

Teaching performed in e-workplace environment is an argument more for thinking about teaching and learning revision [9]. According to fig. 1 experience gained shows that new concept looks as bottom-up or upside-down compared to the classical education approach, but it is more likely to be forward-backward reversed (fig. 4.). Educator stands behind the students, he or she is an assistant or a server rather than a supreme governor in the classroom, it is difficult to keep workflow consistent and to assure lesson to start and finish according to time schedule. E-workplace based learning starts as synchronous, but individual work and student specific pace, transform the process to the asynchronous¹³ one, suitable and attractive for students, although cumbersome and sometimes frustrating for the educator. The same situation naturally and spontaneously generates and promotes collaboration student-to-

¹¹ Signals in the audio frequencies domain.

¹² Compact, compressed, but slightly and unreversibly changed:

s11.txt	202 kB
s11.wav	16 kB

¹³ Principle 7: Respect Diverse Talents and Ways of Learning [8]

student or teacher-to-student. For the moment, collaboration is direct, peer-to-peer or face to face, but there is no any obstacle to become LAN, or Internet based one.

Report's graphic design may be domain of student's creativity, individuality and artistic freedom. The number of examples spanned between the minimum and maximum one is an "elastic buffer" for extremely unsynchronised student's workflow. For the slowest ones, homework is possible, with or without additional instructions out of regular lessons schedule. This is another motivation for collaboration, Internet searching for a layout suitable and IT tools deeper adopting.

It is evident that e-workplace development is not an easy-to-establish process. Once implemented, e-workplace modifications from a generation to generation are possible and all suggestions from students, assistants and other educators are useful and welcome.

So far, e-workplace has proved to be both a viable learning technology and didactically acceptable.

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