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The role of structured multimedia to improve the teaching impact in process integration

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The methodology demonstrated in this paper suggests a way how to efficiently develop multimedia presentations and deliver them to improve the teaching impact whilst not unnecessarily wasting the time and resources. The effectiveness of teaching processes can be improved by implementing an alternative to conventional presentations. The role of multimedia in teaching is considerable as it offers various information presentation formats simultaneously. The combination of text, audio, still images, animation, video and interactivity, as well as hyperlinks has an advantage of using both of the two main channels (visual and verbal) for presentation in an efficient way. It is capable of reducing the overall cognitive effort for given amount of presented information. The advantageous features can be applied in process integration courses as well, both on student and presenter side.

1. Introduction

Computer based and assisted presentations are very common throughout the advanced higher education institutions around the world. For most of the university lecturers PowerPoint slides containing plain text and drawings are a frequent way for providing presentations. Some lecturers even in 21st century still prefer the conventional blackboard and chalk or whiteboard and marker pen. It is doubtless that they all have their strong points. However, the teaching impact can be increased significantly by appropriate multimedia presentations.

There are blurring boundaries between the different content formats used in modern teaching practice. Multimedia is a combination of them. Higher education as well as corporate presentations may combine all forms of media content as part of a live performance. These multiple content forms can be even interactive, which is the highest level of 'learning by doing'. Interactive multimedia has some additional device requirements; however, the effects are worth the investment in most cases.

Multimedia presentations can be linear or non-linear (e.g. hypermedia). They have several comprehensive features. Computer simulations can be used from entertainment to training of chemical engineers. In addition, multimedia is capable of producing computer-based training courses, which are adequate for educational purposes.

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2. Problem statement

Although the advantages of multimedia presentations are well known, they are not too widely used as they should be because of some of their drawbacks. These features could be handled in a different way to eliminate potential problems and still use all the advantages of multimedia. Very important drawbacks are the cost of presentation preparation and additional equipment required. A reasonable time and effort needed to prepare multimedia presentations is probably the main problem. It is doubtless that static content is obsolete in some cases. Animations are much more interesting than still images, not to mention simple texts. However, multimedia content should be worth the time required to prepare them. It should be decided whether the presentation takes advantage of the dual channel structure of the human information processing system, by presenting complementary material in words, pictures, and animations. Sometimes, when a complex procedure or sequence is explained, slow animation or a sequence of still images may be the best way to present it. This provides the audience some time to absorb the verbal explanations given in parallel. The key is to find the right balance between the time used for creating multimedia content, its applicability, and the ability of the audience to comprehend/absorb the delivered information.

The classic slideshows can be extended using several not very time consuming features, which can make the presentation considerably more interesting and efficient; easier to understand and memorize. Examples are voiceover, colours, and simple animations. These features can catch the attention of students easily through live action demonstrations, animations, colourful graphs, and narration.

It takes both of the two main points of view in teaching into account: the student side and the lecturer side. Multimedia presentations can lead to teaching improvements in lectures via better student understanding; moreover, it can be applied for computer-based self-training/studying outside the school. A further possibility is online sharing, especially if the multimedia contents are created with a web interface. The process of creating multimedia presentations might help the lecturer as well by providing him a feedback by listening and checking his voice over. In addition, it may help students to select, organise and integrate the important facts of the presentation. The approach is simple and still helpful. It provides structured multimedia presentations in a modular structure which is easy to develop, correct, update and maintain. Coherence is another advantageous feature of these course materials.

The presentations can be used for different types of courses, including undergraduate and postgraduate students. While in some course materials there are only a few changes (e.g. mathematics), others need to reflect recent achievements. The changing frequency of course materials should be considered while developing multimedia presentations.

In Process Integration multimedia presentations have an important role. Generally, multimedia is efficient in many engineering fields, including modelling and simulation. In Process Integration, the number of effects and colours to be used can be limited to a few and still resulting in a very easy structure for the students to follow. Colour mapping and shading have a significant impact on how easy the slides can be understood. Colours should be constantly dedicated to semantics. Cascading and process modifications can be effectively presented by animations.

The proposed methodology can be extended by several additional features, including interactivity, which is one of the most effective types of studying. Note that some whiteboards have interactivity features as well and thus can be used as an additional device to support this multimedia feature. However, standard projectors are enough for multimedia presentations, along with an amplifier and speakers.
A new style of teaching using e-learning and e-teaching is even more stressing a proper balance of specific multimedia features (Perry and Klemeš, 2004, 2005a).

3. Limitations

Multimedia presentations have many advantages but the limitations should be considered as well. They depend on the way of use, either as teaching media or as presentation materials. The reason is simple: the aim of a presentation is to make the students understand the material only and not necessarily to keeping a proper track in their memory for the first time.
Researchers have shown that multiple representations of information do not always help learning (e.g. Seufert, 2003; Sakar & Ercetin, 2005). Limitations depend on the subject as well. Several authors have claimed that the use of multimedia materials might, under certain circumstances, even hinder learning. Plass et al. (2003, p. 236) described that "multimedia information, which is generally expected to lead to more effective learning, can potentially have deleterious effects depending on the learning conditions and the individual differences of the learners".
Although some of the research on this topic has not been conducted in the process integration field, there are contributions to the effectiveness of multimedia in teaching and presentation processes of the digital era. Researchers emphasise the need for multimedia instruction and learning materials to be designed in accordance with individual cognitive limitations. This requires an understanding of how people react to various multimedia materials when performing a given task. Several researchers (e.g. Mayer, 2001; Moreno, 2006) have conducted extensive empirical research in order to explain how learning from multiple representations or multimodal learning in computer-based environments works.

4. Assessments of various aspects

The multimedia presentations of Process Integration have different aspects, including pedagogical, technical and technological ones.

4.1 Teaching points of view

Psychological as well as pedagogical practices can be applied to catch the attention of students and make slides easier to understand and see than conventional slides. The applications depend on many aspects.
The groups with various demands should be differentiated. There are different types of multimedia presentations, involved in courses of undergraduate and postgraduate students. Further professional development courses are another group of factors to be considered.

The need for reflecting recent achievements varies, depending on the audience. That is why developing for a specific audience is so important. However this requires extra time to make different versions and subversions.
Even if standard multimedia presentations are quite efficient, one feature can be applied for further improvement of the teaching impact: interactivity. Typical examples are forms, online automated calculations in real-time for testing etc.

4.2 Technical and Process Engineering aspects

As the application of multimedia presentations strongly depends on the subject, specific features of process engineering should be taken into account. The notation should be consistent and not diverting the attention by excessive variations. If *colours* are constantly dedicated to semantics, they are very easy to follow, e.g. cold streams to warm up drawn in blue and hot streams to cool down denoted by red. In certain cases, further notations can be used for differentiating purposes. A deeper *shading*, for example, might denote a hotter stream. *Colour gradients* may have their own meaning.

Static drawings are widely used (e.g. HEN structure). However, adding multimedia features can widen the opportunities. Here are some typical examples the different multimedia presentation elements in process integration can be used for:

- *Animation:* one of the most useful multimedia elements in this field. Examples: shifting Composite Curves; building a heat cascade, a Grand Composite Curve, Total Site Profiles; denoting the Pinch location, Pinch design principle, HEN design in action (e.g. altering temperatures, interaction between heat exchangers), comparison of designs, animated streams, stream population, process modifications, retrofit etc.
- *Video:* examples from real life applications, e.g. a HEN from the industry – however should not be too excessive to divert students' attention.
- *Photo:* unlike printouts, presentations have no additional costs when including colour photographs. However, their application has limitations. E.g. plant, heat exchangers, effects of fouling etc.
- *Interactivity:* a learning part of a multimedia slideshow to activate the audience. E.g. Problem Table Algorithm, Pinch location etc.
- *Audio/voiceover:* typically used for static comments, but it can provide a kind of feedback to the lecturer to check slides. Recording the voice over has got very strong positive impact on the lecturers – by checking and listening their recordings. Additionally, audio files can be parts of web-based course materials shared for individual learning and preparation for examinations.

4.1 Technical points of view

If the developers of multimedia presentations want to minimise the additional work, time and inconveniences, basic good practices should be introduced and technical decisions be made.

- *Schema/template of presentation slides for developers.* It significantly reduces the time required for creating new slides or to modify existing ones. It is very easy to be consistent by applying templates. The template shall be uniform for a

team/laboratory/school and perhaps even a university – it should be a link of a trade mark.

- *Unified and large enough font.* A presentation using several different types and too many sizes looks untidy and is distractive. A slide which has got considerable part empty and fonts are still not large enough to be easily readable lower considerably the efficiency of the presentation.
- *Software conventions.* A decision should be made what software to use: PowerPoint (.pps/.ppsx, .ppt, .pptx, .pdf), Latex beamer (.pdf), or a web interface with Slidy (.htm). There are some very sophisticated software tools, but at the end the spread and availability of PowerPoint makes it a winner.
- *Format conventions* for slide, text, and sound.
- *Fool proof presentations via applying standards:* presentations can be presented on various PCs around the world without inconveniences. Furthermore, additional alternative versions can avoid the problems of embedding and linking (e.g. PDF) and should not be sensitive to various screen/projector set-ups.
- *File size optimisations:* too large videos and audio files can slow down the presentation significantly. They are more complicated to store or copy to flash memories or even send over the internet (sharing problems). A golden rule is that a demonstration based on serious or pre-recorded slides is safer (a Murphy 's Law always works), smoother and eliminates some unwanted side effects – as waiting for the problem to converge or searching the directories for the right problem data etc.
- *Sharing:* this may involve disc (CD/DVD) and file sharing (e.g. within the local network), web sharing (catch attention of future students, homeworks, individual learning of course materials, preparing for tests). Public and private access to files. Multimedia discs include tutorials complete with voice segments, animations, and video segments that assist students in completing the input forms, and in using models of the process units (including videos of the process units). They are organized both by content and by index, and usually driven by a web browser.
- *Modular structure* gives additional freedom to both the developers and the lecturers.

It should be mentioned that the use of existing multimedia elements from the internet might have copyright issues. The developers and users of presentations should completely understand the terms of use in each case.

5. Conclusions

Multimedia presentations have a considerable potential to improve the teaching impact of chemical and process engineers. As an example we have used our long term experience in the field of Process Integration. There are limitations to be considered, and the additional cost and time may result in refusal from many university lecturers.

The key point is to find the right balance to make it worth the investment of time and money. Presentation developers should make decision about rules and apply them consistently. Animation seems to be one of promising multimedia elements in Process Integration, due to the wide variety of demonstrations to be used for. The further possibilities, such as web sharing or multimedia disc development, are additional advantages.

Well prepared conventional slideshows are quite efficient in many cases. However, the use of even simple multimedia elements (colours, animations, voice-over, interactive testing) can contribute to a more efficient, interesting and popular course material, which attracts the student attention and motivates them.

Another issue which has been dealt with elsewhere (Perry and Klemeš, 2005b) is computer supported assessment and testing. It has been used at different establishments at different level of sophistications, however not always designed by and for teachers and students convenience. This issue deserves more discussion and information exchange as well.

The presentation based on this text provides typical examples of various options of simple and more sophisticated teaching materials. It demonstrates the advantage of using colours and simple animation. It also demonstrates helpful and less helpful templates.

This contribution has been intended as a base for a wider discussion and exchange of experience amongst university lectures and postgraduate students highlighting good practice experience from various parts of world.

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