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The Balance Between Visual and Textual Training Material: How much is a picture really worth?

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Abstract
The Canadian Safeguards Support Program (CSSP) has been providing the IAEA with instructional materials for many years, including training modules such as CANDU reactor fundamentals used in the Introductory Course on Agency Safeguards (ICAS) which is taken by all inspectors. Numerous standalone courses for instrumentation, such as the CANDU spent fuel monitor and the Digital Čerenkov Viewing Device, have also been developed to train IAEA staff.

The CSSP has pioneered the use of video and animation in both computer- and web-based self-study modules for instructing inspectors. In 2008 the CSSP delivered a multi-media, web-based training module for the IAEA's Quality Management System. This module was deployed on the IAEA intranet for self-instruction by all staff in the Department of Safeguards.

For analytical work, the CSSP has sponsored the development of tools, techniques, and training material for satellite image analysis, and a Visualization Interface for Text Analysis (VITA).

One of the phrases often quoted is that "*a picture is worth a thousand words*". But is that always true? The authors' experience suggests that pictures, videos, and animations are very valuable, but instructional material needs to be designed for the intended audience. This involves a judicious mixture of text, images, video, sound, and animation and needs to take into account how the information will be accessed by the user.

In this paper, the authors look at several CSSP-IAEA collaborative efforts to extract some "lessons learned" about when and how to use visual and textual material including: the results of switching from static images to animations in the CANDU spent fuel monitor course; the value of visualizing search results with VITA; the surprising case where analysts preferred words to pictures; and delivery platforms for instructional material. The suggestions and conclusions in this paper will be of value to organizations with similar mandates.

1. Introduction

In many cases, when preparing training or presentation materials, words are not enough. Or, to be more accurate, it is often much more difficult to describe something with words than to show someone a picture. Deciding what kind of "picture" to use, and where it is appropriate can be a difficult task. In this paper the authors hope to provide a few guidelines about which kind of visual material to use and when to use it. We do this in part by providing a simple classification of visual material. The theoretical discussions are supplemented with examples taken from training materials prepared by the CSSP for the IAEA that use a variety of visual materials.

2. What is a "picture"?

The simple word "picture" is not an adequate description of the range of visual materials available to instructional designers. There is no need to be restricted to the photographs, schematics, and cartoons that are the typical visual materials used in PowerPoint presentations. If the delivery platform (described below) supports them, videos and animations can provide dramatically more engaging presentations. One simple method of describing the types of visual material available is to classify them along two orthogonal axes: realism and dynamism. Or, to use a picture to express this concept:

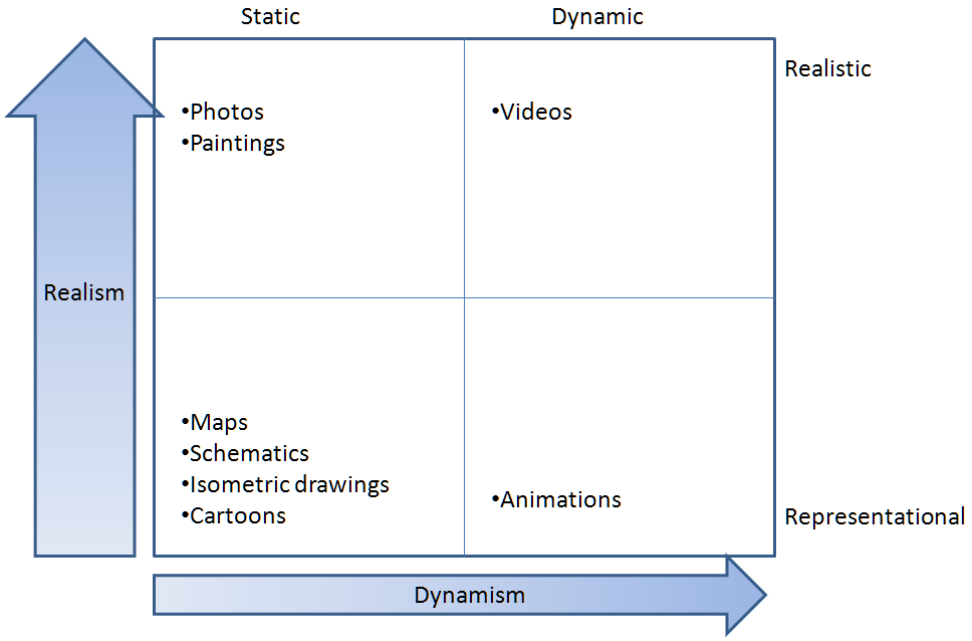

Figure 1: Realism versus dynamism

From this diagram it becomes immediately obvious that the majority of the visual vocabulary used in "corporate" teaching materials (as opposed to video materials produced by professional educational organs such as PBS) is representational and static.

There is another axis (or dimension) that can be added to some of the items in this diagram: ***interactivity.*** Interactivity provides a much richer experience for the viewer, and if successful, converts them from a passive viewer to an active participant. Several examples of such interactive visuals are listed below:

- Google Maps is an excellent example of a static image (map) with interactive features (pop up photos, local feature info, etc.) added to it to make it more engaging, instructive, and useful.

- Google has blurred the distinctions between a drawing and a photo by providing satellite views with map (street) overlays and has added interactivity by allowing the user to switch features on and off and control the display through direct manipulation.
- Many companies are pushing the boundaries of photographs through a virtual-reality interface that allows the user to pan, zoom and move through a virtual photographic world. Both Google's StreetView and Microsoft's Live Maps provide such features and many real-estate companies and hotels provide "virtual tours" of their properties. Several museums allow you to tour their galleries and examine individual objects in great detail.
- Modern video games have made "animations" into highly realistic images that are approaching video quality. The viewer/player interacts with the virtual world through a simple controller.

You have probably seen or used such feature-rich systems, but more importantly, your audience has too, and they may have much higher expectations for a compelling visual experience and interactivity than they would have even just a few years ago. If we are willing to expand our definition of a "picture" to include interactive videos and simulations, then there is ample evidence that pictures can be worth much more than a thousand words.

3. The cost/benefit question

There are convincing arguments of the benefits of providing good visual aids with training material, but the benefits must justify the added costs of producing the visuals. A few years ago the costs for producing videos or creating animations made them impractical for all but the largest projects. Equipment costs have plummeted and relatively simple software is now available to produce high-quality visual materials that would have been unthinkable for small budget projects.

However, not everyone who can pick up a camera or use an editing package can produce compelling (or even watchable) videos or animations. It is worthwhile seeking the help of production professionals. If there are relatively few times per year when advanced visual aids are required, then it is more cost-effective to contract out work on an as-needed basis. If the production of advanced visual aids is an ongoing and frequent requirement, it can be more cost-effective to establish in-house resources with the required skill sets.

4. Stepwise improvements

For organizations with existing training materials, it is usually impractical to replace them all with newer, more visually compelling courseware. In the case of the IAEA and the CSSP there have been many courses cooperatively developed over the years. As part of their annual planning exercise, the IAEA identifies the teaching areas that are of greatest importance to them and they are then able to plan the order in which courseware will be revised.

Some of the teaching materials (the VIFM course is a good example) are in almost continuous use, courses being given once or twice a year. In addition to the frequent presentation of the material, the instrument described by the course has undergone continuous enhancement - requiring changes to the course at almost every presentation. The CSSP and the IAEA have turned this challenge into an opportunity to upgrade the course material in small, manageable steps. In the case of some of the other material (the DCVD for example) a new instrument required completely new teaching materials and a substantial amount of visual material and interactivity was built in from the start.

5. Delivery platforms

How will the training material be delivered to the audience? And what are the advantages and disadvantages of each platform? Here is a quick thumbnail guide:

Platform	Pros	Cons
Printed manuals	• easy to use • can include any kind of static imagery • relatively inexpensive to produce • no additional hardware needed for delivery • easy for users to annotate	• can be bulky • easily goes out of date • no dynamic images • not interactive
Instructor-led presentations	• many students learn best in a classroom situation • instructor can answer questions not necessarily covered by the materials or at least present the materials in an alternate manner • instructor can gauge student comprehension and adjust the presentation accordingly	• can incur significant travel costs if instructor and students are not co-located • scheduling can be problematic • qualified instructors may be in high demand
Tele-presence	• same as instructor-led above • makes qualified instructors available in many more places *(Tele-presence is an extension of video conferencing that allows a live instructor to interact with several remote students.)*	• high cost of equipment purchase or rental needs to offset the travel costs • does not solve scheduling problem
Video on DVD	• very high quality and realistic presentation • possible to easily combine all types of visual material • well rehearsed and scripted videos run very smoothly • very low post-production unit cost • no expensive equipment required for viewing	• no interactivity, material can become dated • initial production costs can be high
Computer-based training	• possible to easily combine all types of visual material • excellent interactivity • very low post-production unit cost • no expensive equipment required for viewing	• material can become dated • requires disciplined users to assure completion and comprehension
Web-based training	• possible to easily combine all types of visual material • excellent interactivity • no inventory required • material can be easily revised at a module level • some delivery engines can track student progress	• requires a network connection • video content can require high bandwidth • confidential materials can only be delivered on secure channels

6. Examples

Over the years that the CSSP has worked with the IAEA on training development, there has been a steady improvement in the infrastructure available for content delivery. The CSSP has often been in the forefront of using these new technologies. The examples in this section cover a wide time span, and that is reflected in the different techniques used in each.

CANDU Spent Fuel Monitor (VIFM) Course: This is a 3-day, instructor-led course given to IAEA inspectors responsible for CANDU facilities. The teaching material initially consisted of two reference manuals and several PowerPoint slide presentations with photos and drawings. The first stepwise improvement was to add video clips of some of the station equipment to the PowerPoint slides. These helped, but they could only be used to illustrate equipment and processes that could be safely photographed or videotaped.

For example, there was no way to show a video of online refueling core discharges because all of "the action" takes place inside the reactor calandria and fuelling machines. The next stepwise improvement to the course material was to add a cutaway animation of the interior of the reactor. This had immediate benefits because the students could now see operations that had been invisible before. In fact, the best results were obtained when the animation was enhanced to cover different fuelling schemes. Not only did the instructors use the animation to illustrate fuelling principles, they also provided the animation with interactive controls to the students so that they could "play, rewind, and review" different fuelling operations.

The success of this animation led to students requesting similar animations to illustrate operation of the spent fuel bundle counters. While the first animation was created with an almost cartoon-like 2-D representational view of the core, the bundle counter animation (a sample shot is shown in Figure 2) was produced with a more realistic 3-D image where the camera tracks the moving fuelling machine and performs entirely impossible operations such as passing through a concrete wall to show objects on the other side.

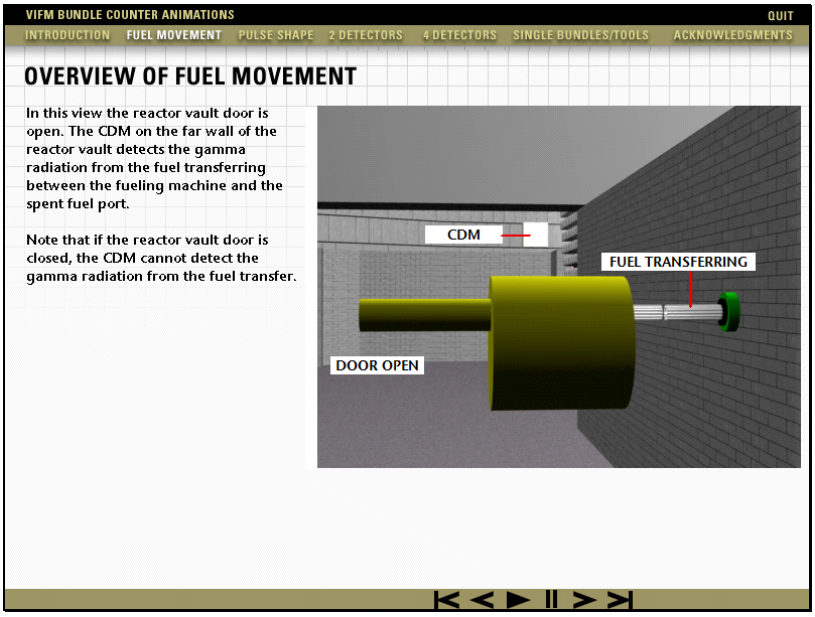

Figure 2: Realistic CANDU Fuelling Animation

Together, these two animations have reduced the length of time it takes to explain CANDU fuelling, and they have improved student comprehension of the processes involved.

Digital Čerenkov Viewing Device (DCVD): This is a relatively new instrument developed under CSSP sponsorship for the IAEA to inspect fuel stored in spent fuel bays. There was no pre-existing teaching material, which gave the instructional designers complete freedom to use the most current technologies. Much of the learning experience for this instrument takes place during hands-on exercises at the spent fuel bay of an operating facility. Access to operating facilities and to the DCVD instrument itself is limited, so the

teaching materials were designed to accommodate various learning scenarios. Printed manuals are supplemented by self-study computer-based training that features animations, extensive video coverage, and interactivity. Portions of this material can be easily used in instructor-led classes, and there are separate CDs the instructor and for self-study components. The instructional design used interactive photographs of the equipment, which presented video-based explanations of each component. The complete assembly of the equipment in the field was presented as a series of discrete videos.

Figure 3 shows a sample screen from the self-study material with user-controllable video, textual descriptions, an equipment photo with callouts, and navigation controls.

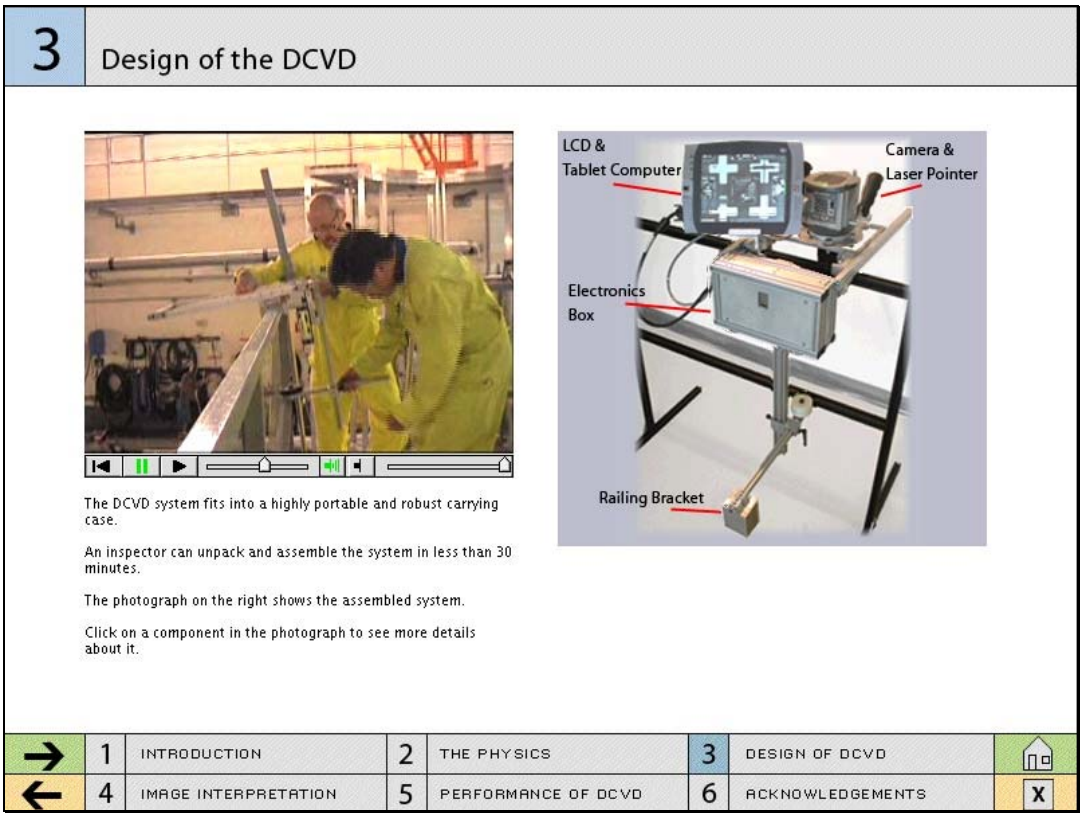

Figure 3: DCVD self-study sample screen

Livelink Navigation Procedure: The IAEA uses Livelink for document and records management. For part of a collaborative workspace project supported by the CSSP, it was necessary to provide navigation instructions to Safeguards analysts to material being stored on Livelink. The initial version of the instructions were heavily illustrated, but it proved to be unpopular with the test audience because the analysts (who worked almost exclusively with textual material) preferred and expected procedures to be written as a step-by-step list.

This surprising result served as a reminder to the designers that you must always consider your audience when preparing instructional material. While illustrations would seem to be able to convey information more efficiently than words, it is not necessarily true if your audience is heavily biased towards words as they were in this case. Subsequent examination of procedure documents that these users prepared for themselves confirmed the preference for words. Any illustrations that were used tended to be quite small and were used parenthetically to confirm a verbal description. An example is shown in Figure 4.

Figure 4: The target audience preferred the more verbal description

QMS web-delivery: In 2008 the CSSP delivered a multi-media, web-based training module for the IAEA's Quality Management System. This module was deployed on the IAEA intranet for self-instruction by all staff in the Department of Safeguards. Figure 5 shows one of the main screens.

Figure 5: QMS main screen

Users sitting in their own offices can study any of the many QMS modules using a simple web browser whenever they have time available. Video clips of prominent and knowledgeable staff members provide access to on-demand lectures that could only ever be delivered a few times in person. The web delivery platform makes it possible to update segments of the material whenever required without having to scrap valuable inventory (there is none). The instructional design uses a video-based host to lead learners through each section of the material. It also has "colleagues extolling practical use of QMS" video clips for working level reinforcement and video clips by senior management to emphasize full endorsement by senior management of QMS and processes.

Visual Interface for Textual Analysis (VITA): The CSSP has sponsored the development of VITA to help IAEA analysts quickly find relevant documents in terabytes of textual data. Although this is not strictly a training tool, it does illustrate the value of pictures and direct interaction with the viewer. As shown in Figure 6, VITA draws a 3-D representation of the results of a search on a vast store of documents (such as the results of a Google search). The "hits" from the search are represented by green cylinders distributed in space according to "gravity rules" that makes similar documents cluster together. Analysts can quickly discard irrelevant information by using the VITA hiding feature in order to home in on the most relevant documents. Rather than having to wade through hundreds of documents looking for ones that may be relevant, they can narrow the search down to the few tens that best fit the search criteria, resulting in significant time savings.

VITA also can expose unexpected relationships between documents that can spark further, more refined searches. The 3-D diagram produced by VITA can be directly manipulated by the user in a manner that is both engaging and informative.

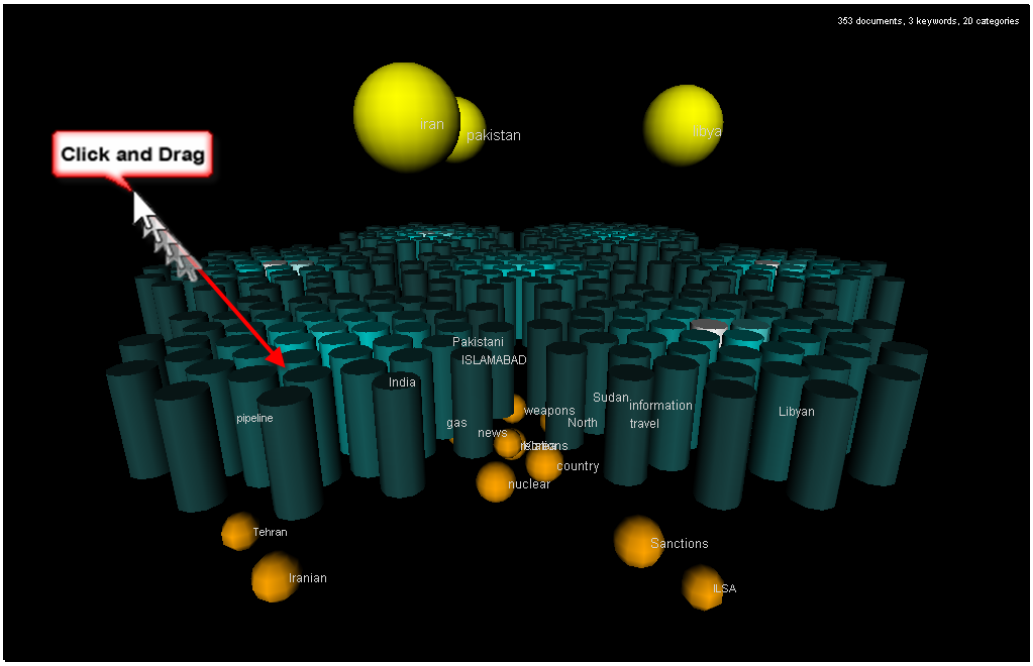

Figure 6: VITA allows direct manipulation of the 3-D representation

7. Concluding Remarks

As shown in the preceding examples, pictures can be worth a thousand words or more, but they need to be appropriate for the users. The rules of thumb for producing compelling visual material closely parallel the rules for producing compelling textual material, namely:

- Understand your audience
- Don't provide excessive detail
- Give context for pictures
- Use high quality images
- Keep it simple

Addressing each of these points will result in a training package with high-impact presentation.

We invite anyone interested in further information about these topics to visit our wiki at http://saturn.eton.ca/. It features live web links, contact information, and expanded discussion of this paper.

REFERENCES

1) Truong, Q.S. (Bob); Keeffe, R.; Desson, K.; *Integrating Learning & Doing: Single-Portal Access to Instruction, Decision-Making Tools and Information Sharing,* paper presented at the INMM 44th Annual Meeting, Phoenix, AZ, USA, July 27, 2003.
2) A WikiWikiWeb site with live web links, contact information, and expanded discussion of this paper: http://saturn.eton.ca/ .
3) Truong, Q.S. (Bob); McArdle, S.; Yang, J.; Grover, P.; Piller, C.; *Information Portal and Open-Source Tools for Nuclear Material Management*, paper presented at the INMM 48th Annual Meeting, Tucson, AZ, USA, July 8-12, 2007.