

Podcasting Photogrammetry – A Contribution to Life-Long Learning

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ABSTRACT

The innovation and variety of products of the entertainment industry have also a huge impact on methods of learning and teaching. No matter at which level education takes place: at kindergarten, elementary school, high school, university and further education (individual or institutional) the learners of today (from 3 years age to 80) can choose amongst diverse methods of teaching. Meanwhile, most of them are offering corresponding infrastructures and high quality computerized education material. The Web allows for education at anytime and anywhere. *Edutainment* is the buzzword for these developments.

Using Apple's iPod, a mobile MP3 player with video capabilities receiving broadcasts of any audio/video content via Internet, another buzzword has become very popular: *Podcast*. Podcasting as a 'de facto' standard is also used in higher education, at several national and international High Ed institutions. The paper reflects several models for podcasting any content. Experiences are gained during the production of podcasts within several majors of the curriculum *Geodesy and Geoinformatics* at Universitaet Stuttgart for the benefit of the students, no matter of being on-campus or off-campus.

1. INTRODUCTION

Comprehensive education is one of the primary concerns of civilizations and human beings. Therefore, the collection and dissemination of knowledge is a logical follow-up and has led to remarkable institutions and infrastructures, during all ages of mankind. Visionary people have always tried to establish "locations of diversified knowledge", centralized in ancient times and totally decentralized today.

1.1. The Bibliotheca Alexandrina

The most famous institution in ancient times was the "Bibliotheca Alexandrina" in Alexandria/Egypt, **once the largest library in the world**. Launched 288 BC by Ptolemy II, under the guidance of Demetrius of Phaleron (by the way a student of Aristotle), the library did serve manifold. Besides the library function it was academy, research center, and a meeting point of intellectuals to attract the great thinkers of the age. Scientists, mathematicians, philosophers, poets from all civilizations visited this place to study, to teach, to meet and to exchange ideas. The library collected all known papyrus scrolls (books), handwritten manuscripts, maps, drawings, etc. to serve for the needs of the intellectuals. How did the collection of content grow so large? A story is told that by decree of Ptolemy III of Egypt, all visitors to the city were required to surrender all handwritten material (scrolls, maps, etc). These writings and drawings were copied by official scribes in such a professional manner, that afterwards the originals and the copies could not be differentiated at all. Thus, often the originals were put into the library, and the copies were delivered to the unsuspecting previous owners. For example, ships were allowed to anchor in the harbor of Alexandria only when the seamen delivered their original maps and map drawings – just a copy remained with them for the continuation of traveling. The library's collection was made of a huge number of papyrus scrolls. It is said that King Ptolemy II Philadelphus (309-246 BC) set an objective of 500.000 scrolls. When Cleopatra married Mark Antony she has got 200.000 scrolls as wedding gift, which were taken from the great Library of Pergamum.

Unfortunately, the ancient library was destroyed for several reasons: (1) partly, during Caesars conquest 48 BC, (2) during the attack of Aurelian in the 3rd century AD, (3) by the decree of

Theophilus in 391 AD, and (4) the Muslim conquest in 642 AD and thereafter. The old library disappeared but its spirit influenced many developments until today. Fortunately, under the auspices of the Egyptian First Couple, President Hosni and Mrs. Suzanne Mubarak, the Bibliotheca Alexandrina was reborn in 2004, as a leading institution of the digital age, fulfilling the needs of intellectuals and as a intercultural center for learning, tolerance, dialogue and understanding.



Fig. 1a: The famous Lighthouse of Alexandria (one of the seven wonders of the ancient world), drawn by Fisher von Erlach 1721 (Bibliotheca Alexandrina)



Fig. 1b: The new Bibliotheca Alexandrina, launched 2004

The new complex is much more than a library, but it serves for the same spirit as the ancient library did. Besides huge book shelves that can hold millions of books, it is a center for the Internet and its archive, has specialized libraries for audio-visual content, offers space for three museums, a planetarium and permanent and temporary exhibitions and has seven research institutes under its roof.

1.2. The Memex of Vannevar Bush

When the ancient library of Alexandria disappeared it took quite a long time to re-establish locations of diversified knowledge. Although the system “university” was known to the Pharaohs and could be advanced in the Arab culture, the first European universities were founded late, towards the end of the 12th century. Here, Bologna, Paris, Montpellier, Cambridge, Prague and Salamanca have to be cited, which attracted intellectuals of the Middle Ages. Johannes Gutenberg invented about 1450 the “printing letters” – a technique with a huge impact on information archiving and dissemination. At those times secular institutions developed methods and basics of higher education. As a matter of fact, the more universities were founded the more centralization of knowledge could fade away. This development increased rapidly with inventing mechanical machines in the 18th century. Many famous technical universities were founded in the first half of the 19th century – just to name in Germany Aachen, Berlin, Braunschweig, Darmstadt, Dresden, Karlsruhe, Hannover, TU Munich, and Stuttgart (today TU9). ETH Zurich/Switzerland and the Massachusetts Institute of Technology (MIT) followed some 30 years later.

It was Vannevar Bush in the 1930s, working at the MIT, who was heading in the direction of hypertext linking. While George Stibitz and Konrad Zuse were trying to develop the circuitry that would eventually lead to the invention of a digital computer, Bush was developing a machine he later called the “Differential Analyzer”. This was an analog computer using all ten digits of the decimal system rather than using the binary system of digital computers. Claude Shannon, a student of Bush, was at the same time working on his Boolean algebra and electrical circuitry theories, by which finally the Differential Analyzer became obsolete. Bush went on to invent the “Rapid Selector”, a microfilm storage and retrieval device, that he expanded, at least in theory leading to the “Memory Expander” – just called *memex* (V. Bush, 1945). Memex, a proto-hypertext system, has foreshadowed modern computer and hypertext linking that gives Bush his place as a pioneer of

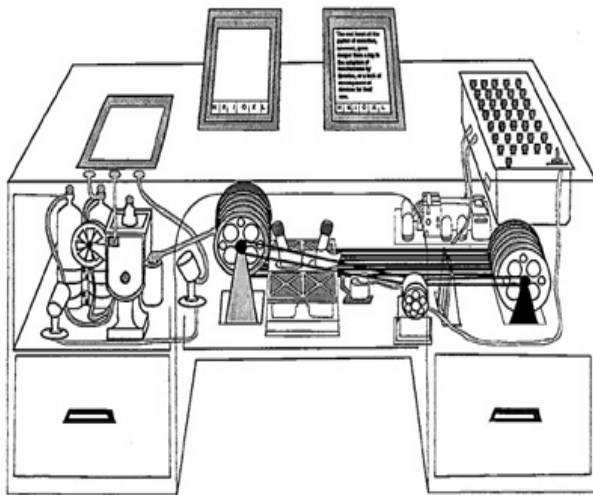


Fig. 2: The Memory Expander of V. Bush

the Internet.

Bush described the device as electronically linked to a library and able to display books and films from that library, with the capability to automatically follow cross-references from one work to another. A large desk was hiding a combination of electromechanical controls and microfilm cameras and readers. Most of the microfilm library would have been contained in this desk, but the user could add or remove microfilm at will. Obviously, the technology of memex is often confused with that of hypertext. Although Bush’s idea inspired the creation of hypertext, it is not considered to be hypertext. But taking Bush’s idea of

linking the device to a library and use it to display text, photographs and films comes very close to today’s performance of Apple’s iPod Video, iPhone and similar mobile devices of other vendors.

1.3. The NLS, ARPANET and Internet

The publication of V. Bush “As We May Think” has got the attention of another computer pioneer: Douglas Engelbart, who developed the basis for today’s computer interfaces, already during the 1960s. He liked Bush’s idea of a machine that would aid human cognition.

At that time, Engelbart founded the Augmentation Research Center (ARC), a development environment at the Stanford Research Institute (today SRI International, located in Menlo Park, near the Stanford University Campus). He and his colleagues, W.K. English and J.F. Rulifson, created the “oN-Line System (NLS)” – the world’s first hypertext implementation. NLS was an integrated environment for natural idea processing, at a time when most people (and even programmers) had no direct contact with a computer. This environment created already the mouse-pointing device for on-screen selection, a full windowing SW architecture, a one-hand chording device for keyboard entry, on-line help systems and the concept of consistency in user interfaces. Engelbart’s work directly influenced the R&D at Xerox PARK, which in turn was the inspiration for Apple computers. NLS was able to do hypertext linking, tele-conferencing, word-processing, emails and could be individually configured and programmed by the user. In 1991, Engelbart and his colleagues got the prestigious ACM Software System Award for their work on NLS. Development of NLS was more or less finished in 1968 – the “Mother of All Demos” demonstrated on December 9, 1968 its important features to a small crowd of specialists in San Francisco, via leased telephone lines which connected the ARC scientists to a huge screen at the meeting place.

Parallel to the developments of ARC at SRI another important innovation project was launched in the beginning of the 1960s – the Advanced Research Projects Agency Networks (ARPANET). It was the world's first operational packet switching network, and the predecessor of the Internet. The packet switching concept revolutionized the methods of data communication. Previously, data communication was performed by circuit switching, in which a dedicated circuit is tied up for the duration of a phone call and communication takes place with a single user only, on the other end of the circuit. With packet switching each packet could be routed independently of other packets. The system was able to use one communication link to communicate with more than one machine by assembling the data into several packets.

Packet switching is therefore the basis for today's data transfer via Internet, independent of its application which is quite diverse: Text messages, E-mails (with/without attachments), Voice-over-IP (VoIP), MP3 audios (audio podcasts), MP4 videos, (video podcasts), Video-on-demand (VoD), and IP Television (IPTV).

But there was still a long way to go, from the first ideas of ARPANET **to today's largest library in the world: the Internet with its millions of WEB servers** (P.H. Salus, 1995). The earliest ideas of a computer network intended to allow general communication between users of various computers were formulated by J.C.R. Licklider (1962). His memos discussing "The Galactic Network" contained almost everything that the Internet is today. When he was appointed head at the US Department of Defense Advanced Research Projects Agency (DARPA), he was the one who convinced Ives Sutherland and Bob Taylor for the necessity of such a computer network. Licklider left DARPA before any actual work on his vision was performed.

Initial plans for the ARPANET began late spring and summer 1967 – about 40 years ago. It was Larry Roberts, a former associate of MIT Lincoln Laboratory, who got responsibility at DARPA for realizing the ARPANET idea (late 1966). The company Bolt, Beranek and Newman (BBN) was awarded with a contract to implement initial ARPANET deployments, on April 7, 1969. A first ARPANET link was established on Jan. 14, 1969, between the Network Measurement Center of UCLA and the D. Engelbart's ARC at SRI (where the NLS was already operating). BBN finished as contracted the entire 4-node network linking UC Los Angeles, UC Santa Barbara, SRI, and the University of Utah, by Dec. 5, 1969. BBN followed the plan of Roberts closely: small computers known as Interface Message Processors (IMPs) performed at each site store-and-forward packet switching functions. They were connected to each other using modems to leased lines, running at 50 Kbit/s. Host computers connected to the IMP and ARPANET via custom bit-serial interfaces. The first email via ARPANET was sent in 1971, by 1973 75% of ARPANET traffic was email. At the same year, the File Transfer Protocol (FTP) was defined and implemented to enable file transfer via ARPANET. Also, a voice traffic protocol was worked out in the 1970s, but conference calls did not work well with the ARPANET.

At the beginning the ARPANET relied on the 1822 protocol, which served well within the IMP nodes. With the growth of the network and its increased usage this protocol have been replaced by the Network Control Program (NCP) to use a more advanced standard method to establish reliable flow-controlled and bidirectional communication links between different processes on running on different hosts.

In 1983, TCP/IP protocols replaced NCP as the standard protocol of the ARPANET, and the ARPANET became just one component of the fledgling Internet. Also in 1983, the US military portion of ARPANET was broken off as a separate network, called MILNET. Obviously, there is a myth telling that ... *The ARPANET was designed to be a communication backbone that could survive a nuclear attack* ..., what is definitely not true. The ARPANET was shut down in 1990. Most university computers that were connected to it were moved to networks connected to the NSFNET, the Internet of today.

The Internet entered the public arena in 1994, when Tim Berners-Lee World Wide Web became accessible through the commercial browser NETSCAPE. In the last decade it has evolved to an

undispensable tool transforming business and politics, spawning its own industry of search engines (e.g. Google, Yahoo), and contributing to new concepts in education and teaching. An estimated 70 million computers serve around 300 million users in over 200 countries. The ancient largest library in the world, the library of Alexandria/Egypt, has been replaced by a decentralized computer network called Internet, or simply Web. Its content grows daily, and what is more important, it is accessible anytime and anywhere!

2. PODCASTS

The success of Apple's iPod family together with the iTunes user interface and the corresponding iTunes Store portal is more than impressive. It seems, that Apple's CEO Steve Jobs re-invented digital music selling and consumption in 2002, despite the fact, that the MP3 data compression format was invented already in 1982. At that time, Karlheinz Brandenburger and his team at the Fraunhofer Institute of Integrated Circuits, Erlangen, started the work on digital audio compression, in cooperation with the Friedrich-Alexander University Erlangen-Nuremberg, AT&T Bell Labs and Thomson. Obviously, it took 20 years to come out with the right products at the right time, integrated in an overall strategy for music dissemination. Since 2002 more than 100 million iPods have been sold - the 4th and 5th generation iPods display also videos. **Podcasting** has become the buzzword of 2006 (New Oxford American Dictionary). Competitors of Apple use it as well.



Podcast Definition (Wikipedia):

*“A podcast is a digital media file, or a series of such files, that is distributed over the Internet using syndication feeds for playback on portable media players and personal computers. A podcast is a specific type of webcast which like ‘radio’, can mean either the content itself or the method by which it is syndicated; the latter is also termed **podcasting**. The host or author of a podcast is often called **podcaster**.”*



Fig. 3: Apple's iPod family and the iTunes GUI (Copyright: Apple)

The podcast material is pre-recorded and the users can check out the material at their leisure, on-line and offline. Certain podcasts can even be live and interactive – dozens of podcast enthusiasts can be on at once, with the host being able to control the audience in the same way a radio host can.

3. MODELS FOR PODCASTING

Using podcasts in a higher education environment has driven Apple to offer the iTunes University portal. Comprehensive tests were made in the US, at several renowned universities, such as Berkeley, Duke, Harvard, MIT, and Stanford, to name just a few. One problem to overcome have been the Digital Rights Management (DRM) regulations, what is solved for the music dissemination more or less sufficiently, but is not yet fully resolved for high ed content. Fortunately, the music industry has made one big step forward - EMI has started to offer DRM-free music pieces to be copied without any restrictions for the user. Obviously, DRM differs from continent to continent, what has iTunes U stepped down a bit. Nevertheless, in Spring 2007 more than 400 US universities and schools collaborated with Apple to podcast teaching units.

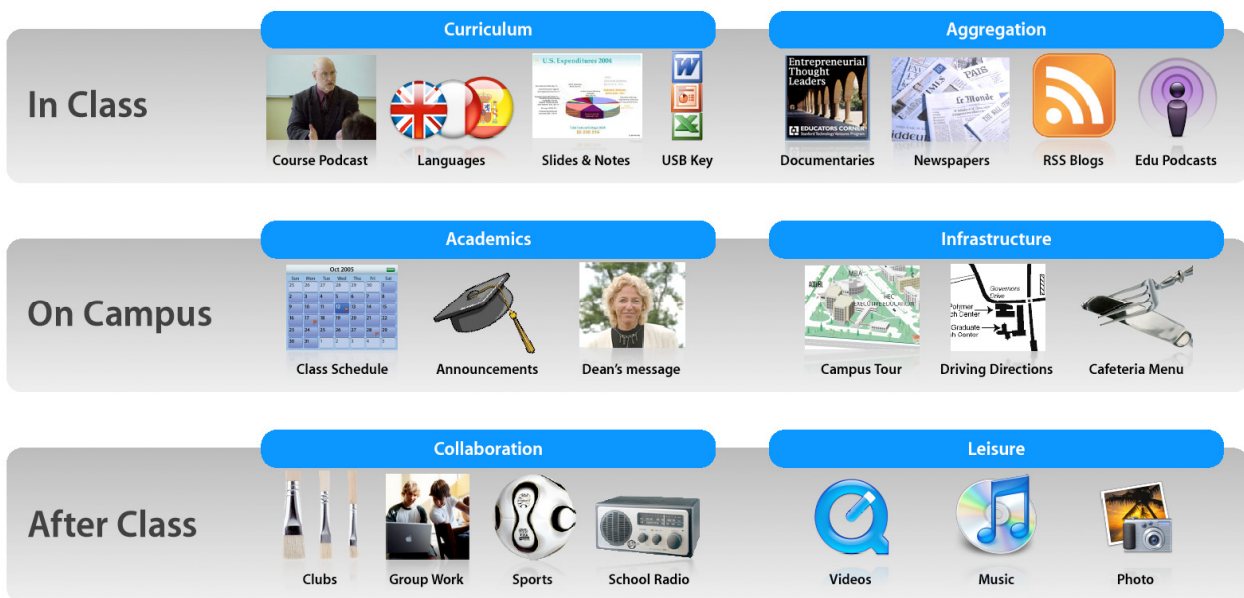


Fig. 4: Using podcasts in a learning environment (Copyright: Apple)

There are several options available to produce podcasts and to put them on a web server. According to the workflow *create – distribute – access* we will differentiate between competing and complementary processes. The podcaster and the user can totally rely on Apple hardware and software, but might also use other components, as we will see in chapter 4.

3.1. Create the podcast

During the phase of podcast creation several recording models have to be reflected. Finally, a selection is made having an impact on the equipment set-up. In the following just video podcasts are considered and no audio podcasts, although the latter ones are very helpful for humanities studies, for example, to learn languages, to study intercultural relations, and to study milestones in history.

- (1) Audio and screen: this video podcast renders the lecture notes (txt, doc, ppt, pdf files) projected onto a large screen with synchronous audio. A small microphone is plugged into the presentation computer, that's all – the podcasting software performs the necessary synchronization of time tags and delivers suitable data formats: raw, H.264 AAC (for iPod) and others.

- (2) Audio and video (Webcam, camcorder): use a Webcam or camcorder to simultaneously render the presentation material with your voice and video imagery. Also here, the podcasting SW will deliver the desired output.
- (3) Audio and video (computer animations): sometimes computer animations are necessary to explain complex subjects, or to keep the teaching more interesting. Here, the computer screen has to be recorded, what makes the set-up a bit more complicated. A VGA splitter may be used for the simultaneous projection and recording.
- (4) Multiplexed classroom computer's podcast: the instructor and the students are sitting in front of their computer screens, looking at the same screen content. The podcasting SW does the recording of the instructor's screen, which can be rendered by audio and video.

According to the announcements of Apple, video podcasts can be created in three mouse clicks: (i) login to your account, (ii) click record to start the lecture, and (iii) click stop. As pointed out in chapter 4 also other options are available and easy to use.

3.2. Process and distribute the podcast

Although the podcast software, which is performing the four recording modes, is capable to deliver directly video podcasts of different resolutions, it is more appropriate to store the raw recording data. This file can be sent as post-processing job to a software agent, running on a back-office computer. Very often, the audio signal has to be processed to remove recording noise, or to spread the signal itself. Moreover, a decision has to be made about the video resolution of the podcast. Typically, iPods can display 320x240 pixel (Half SD) and 640x480 pixel (SD or VGA), depending of the 4th and 5th generation, respectively. But podcasts can be displayed on many other devices, such as personal computers, mobile phones, etc. Today, the range of video resolution varies from 2.5G mobile network devices to Full High Definition TV sets. The higher the resolution, the more bandwidth is needed to transfer the podcast to the client. Starting with a 'stamp-like' display of a mobile phone with a resolution of 176x144 pixel would require 50-160 kbps, the 640x480 SD about 1-2 Mbps, 1280x720 HD about 5-6 Mbps, and 1920x1080 Full HD about 7-10 Mbps.

In general, two network designs are available at universities: the university public network (Internet), on which teachers and students interact with the podcast solution through HTTP, and the Intranet (private) for administrators and associates. A very simple way is to transfer the raw podcast recording via Intranet to the agent computer which performs the final podcast processing. Afterwards, the podcast is rendered by metadata tags and copied to a user portal (or web server).

3.3. Access the podcast

Podcasts enable students and teachers to share information with anyone at anytime. An absent student can download the podcast of the recorded lesson, but this is just a byproduct of podcasting. The overall objective is to improve the quality of teaching and to archive it! The download of podcasts is very simple. First, the Apple iTunes module is available for the Mac users and PC users, free-of charge. It offers an automatic mechanism transferring multimedia computer files from a server to a client, which pulls down XML files containing the Internet addresses of the media files. Secondly, a podcast can also be manually accessed through an internet link.

More than 80% of podcasts are consumed on the PC, although the iPod (or more recently the iPhone) is an appropriate mobile device for 'learning on-the-go'. Within a university environment special Apple programs have been started to offer iPods to freshmen, simply to increase its ability for having all learning content always with them. Unfortunately, the product pricing is not yet down at a level most of the students can afford. Here, we respect that Apple is a vendor for consumer electronic devices and does not provide customized solutions for enterprises. But, it would help

much if the Apple strategy in future could be more open to clients, who once will become decision makers in industry and business: the graduates of our universities.

4. PODCASTING PHOTOGRAMMETRY

With the experiences of having served for a six years term as Rector of the Universitaet Stuttgart UniS), in which elearning and blended learning were key issues of the university development programs, we started podcast production of photogrammetric modules in October 2006. What was the overall outcome of the management and implementation of the very successful UniS elearning programs: *100online, selfstudy online and campus online*? **Keep it simple and use standards!** Therefore the key items to record and archive lectures in photogrammetry and related fields can be summarized as follows:

- (1) Improve the quality of the lectures and the lecture notes and keep the students interested
- (2) Keep the efforts reasonable and use standards
- (3) Replace blackboard writing (notes) by rendering the lecture notes with handwritten explanations (text and formula derivations)
- (4) Offer the rendered lecture notes directly after the lecture, as a pdf file on the web
- (5) Provide podcasts at two different resolutions: 320x240 (Half SD) and 640x480 pixel (SD)

A pilot project was started to process the four winter lectures of the author in the fields of digital signal processing (German and English language), statistical inference I and geoinformatics I. First of all, an easy-to-use recording environment had to be selected with the capability of producing handwritten notes. For some years, notepad computers are offered by several vendors, such as Fujitsu/Siemens, Hewlett Packard, Lenovo, and Toshiba, to name just a few. Those computers run under MS Windows (XP, Vista) and have become very powerful. Thus, a Fujitsu/Siemens LIFEBOOK T Series was chosen for the lecture recordings. Camtasia Studio 4 (TechSmith) seemed to be an ideal screen recording and presentation software, having the features we were looking for. Thus, the recording hardware and software came off-the-shelve, was cheap and solved the tasks we had in mind.

Being equipped with the necessary tools for a “Poor Man Podcast Production Environment (PoMaPPEn)” the following workflow could be maintained all the time:

- (1) Select the portion of the lecture notes (txt, doc, ppt, pdf, etc.) to be presented and convert it to a journal file (jnt)
- (2) Start the Camtasia Studio 4 recording software according to the video podcast creation model (1) and let the sampling rate of the screen recording not be less than 7 fps
- (3) Present the lecture in front of the students, who look at the screen and see all the spontaneous rendering of the lecture notes
- (4) After the lecture is finished store the jnt file, print it in pdf format, and put it on the web. Store the raw video file for editing, postprocessing and podcast production.

Note, that these four steps are really simple and help also to improve the convenience of the instructor, who may sit relaxed on a chair in front of the students to do the lecture notes rendering on the notepad computer.

The pilot project was extended in Summer 2007 to offer all lectures and exercises of the Institute for Photogrammetry, UniS, for several curricula in this manner, with great success. An evaluation was made by the students with very positive results – most of them wished that all lectures and exercises in their curricula should be offered in this excellent way of teaching.

5. CONCLUSIONS

The paper has reflected the podcast production of high ed learning modules. Podcasting is and will be very popular in future – its widespread use in education, news services and entertainment indicates the value of anytime and anywhere information retrieval. New mobile devices such as the iPhone, iPod, Nokia's N95, and others will offer - besides their future-oriented user interfaces and gimmicks – access to the biggest library on Earth, the Net with its Web servers, to overcome any problem in our professional and daily life. It seems today, that the podcasts of the web have replaced the huge number of papyrus scrolls of the ancient Bibliotheca Alexandrina.

Photogrammetry as a science of collecting and processing imagery (airborne, space-borne, and close-range) will make its contribution to the fascinating developments towards a digital globe. In order to keep the professional knowledge up-to-date podcast portals and services could deliver the necessary modules. Extending the methods of data indexing (*data spidering*) to audio and video will even make the Web search more comfortable – after typing in a few keywords and the desired rating the suitable module(s) will appear on the screen. Further education business models have to be developed to make the download of a *DGPS/INS integration* module as simple as taking the latest MP3/AAC album of James Blunt, offered by the Apple iTunes MusicStore portal.

With the development and testing of the Apple iTunes U(niversity) portal first experiences are gained in this respect, at several US universities. Obviously, the Digital Rights Management (DRM) regulations of any content vary between the US and Europe, what prevented its introduction in Europe so far. We all hope, that these problems will be overcome very soon.

The vision for the future is very clear. There will be offered many podcasts for higher and further education on the web. The users will do their own rating, for example, using a ten star rating scale. The student who wants to download the podcast reflects the rating and selects - amongst the top rating lectures - the suitable subject he wants to study. The on-campus student can download the lecture free of charge, the off-campus student pays a small fee, let us say, EUR 1.99 for the *GPS/INS Integration* lecture of the Institute for Photogrammetry, Universitaet Stuttgart. In this way, life-long learning becomes very pleasant, and is performed anytime and anywhere.

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