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An Industry Sponsored Video Course for Control Engineering Practitioners

Kevin Starr[1], Margret Bauer[2,3], Alexander Horch[2]

[1]*ABB Inc., Westerville, CO 80305 USA (Tel: +1 614 818 6394; e-mail: kevin.starr@us.abb.com).*

[2]*ABB Corporate Research, Wallstadter Str. 59, 68526 Ladenburg, Germany (e-mail: alexander.horch@de.abb.com)*

[3]*School of Electrical and Information Engineering, University of the Witwatersrand, Johannesburg 2050, South Africa (email: margret.bauer@wits.ac.za)*

Abstract: Video lectures are finding their way into education – there are numerous advantages and they can be used in different contexts within formal, non-formal and informal education. Control systems is a subject in formal education that can be viewed from a practitioner's angle. This paper describes a video lecture on control systems that is sponsored by ABB and available on YouTube. The lecture was developed by control practitioners for an audience that (1) does not have a strong engineering background and (2) have an engineering background but has not been shown the linkage to the real world. The difference between formal control systems lectures and this course are discussed.

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1. INTRODUCTION

Control engineering is a subject usually taught at undergraduate level to electrical, mechanical, industrial, and chemical engineering students. Control systems take mathematical theory relating to feedback control and applies it to any dynamic process, from automotive to industrial production application. Control systems in education has been comprehensively described by, for example, Kheir et al., 1996.

In addition to formal education, non-formal education is becoming more and more important in a world of globalization and technical advancement. Globalization focuses on improved product and service quality, greater work responsibility and teamwork approaches (Merriam et al., 2012). At the same time technology is advancing quickly in all areas affecting industrial production. This together puts an emphasis on training in automation by corporate companies in a non-formal education form.

Non-formal education can be of a supplementary nature, which means that it is "a quick reaction to educational, social and economic needs because formal education is too slow in response (if it does in fact decide to respond) to those needs" (Brennan et al, 1997). The course described in this paper is non-formal and supplementary, that is, many aspects are not covered by control systems courses taught at university level.

With the advance of internet technologies – it is estimated that 40% of the world population has an internet connection today[1] – video lectures have become widespread for use in the classroom. Recently, the concept of the flipped classroom has been introduced. Herreid et al. (2013) explain the essence of the flipped classroom model: What is normally done in class and what is normally done as homework is switched or flipped. Often, the flipped classroom experience is equated with the use of internet technology in general and videos specifically.

Videos are sometimes 'copies' of the normal lecture. Wieling and Hofman (2010) showed that attending either the lecture in person or view the videos results in better performance of the students. Further benefits of video lectures in the engineering context have been reported (Liu & Kender, 2004; Mason et al., 2013).

The quality and content of videos available online, most dominantly on YouTube[2], varies significantly. These online videos can be grouped according to the following criteria

- Realization: Filmed lectures, presentations with voice overs, animations, or a combination thereof.
- Designation of presenter: Academic institution, industrial institution, private person.
- Technical quality: Sound, camera.

There are several obvious benefits and disadvantages of online lectures. The key benefit is that the learner can view the video lecture at a preferred time, place and most importantly at her own pace. Videos allow pausing and re-playing which is crucial for effective learning. A key disadvantage is that the learner cannot interrupt the lecture to ask questions and discuss the lecture with peers during class

[1] http://www.internetlivestats.com/internet-users/

[2] https://www.youtube.com/yt/press/en/statistics.html

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breaks. However, these difficulties can be easily overcome with the flipped classroom concept.

The internet offers more than video lectures. For example, a control tutorial is offered in Matlab and Simulink[3] by academic institutions. Control system experts from Emerson have published a website that provides workshop material with process industries applications[4], which is supported by videos.

In this paper, we review video lectures available in control engineering which act as a support for control engineering courses. In addition, we will investigate material available to control engineering practitioners in continued education and training-on-the-job. The main contribution of this paper is to describe the purpose, contents and methodology of the online video lectures presented by an industrial supplier and which describes control engineering education from the practitioner's point of view. The technical realization of the videos and the targeted audience are presented. Lastly, the differences between control engineering for undergraduate students and control engineering for practitioners used in training-on-the-job are discussed.

2. VIDEO LECTURES IN CONTROL ENGINEERING

Videos explaining the fundamentals of control are ubiquitous but vary dramatically in quality. However, in this day and age with internet search functions available, helpful material can be easily identified. Tab. 1 gives a list of undergraduate control courses that enjoy a popularity and which will be referred to when comparing the industry sponsored video lectures described in this paper. Screenshots of the videos are shown in Fig. 1 to give a feeling of the presentation type. Three of these four courses are by academic lecturers who made their material available online while the most successful lectures – in terms of views – is produced for the purpose of video lectures only by an extremely talented and successful control practitioner. It is noteworthy that all video lectures in Tab. 1 have been placed online in the last three years. This is in accordance with the trend to move higher education to YouTube and social networks (Gilroy, 2010).

The abundance of online material which is freely available speaks for the concept of the flipped classroom to be used in control engineering education. Also, any undergraduate student with access to the internet cannot blame 'poor lecturing skills' for not understanding parts of the subject.

3. NON-FORMAL CONROL ENGINEERING EDUCATION

In education, there are two strong movements observed in recent years (Jarvis et al., 2003): (1) from theoretical to practical and (2) from single discipline to multidisciplinary to integrated knowledge. The latter is particularly true for control engineering, as described by Murray and co-workers (2003): "Increasingly, the modern control engineer is put in the role of being a systems engineer, responsible for linking the many elements of a complex product or system. This requires not only a solid grounding in the framework and tools of control, but also the ability to understand the technical details of a wide variety of disciplines, including physics, chemistry, electronics, computer science, and operations research."

Control engineering is taught at undergraduate level within almost exclusively engineering disciplines, most commonly within electrical, mechanical, chemical and industrial engineering. Because of these traditional department structures of today, control is typically only a small aspect of any curriculum. It is usually difficult to change the contents and structure of control courses so that necessary changes that are required by the two movements cannot be accommodated.

Because of the shift from theory to practice and the integration of knowledge, teaching control systems by practitioners has a different flavour as well as urgency. Engineering in general and control engineering in particular is tightly bound to applications and practice.

All in all, it is important to tailor control courses to an experienced audience who have domain knowledge but no necessary previous exposure to control systems. Sometimes, engineers and technicians may have attended a control course as part of their first education many years ago. In some cases, this experience may have had a negative connotation. All three authors of this paper are control engineering educators and have found that even technically inclined professionals may view control systems as intimidating.

Table 1. Control systems fundamental video series available on the internet. The videos can be found on YouTube by searching for the names of the presenters, adding the search item 'control'.

No	Presenter	Affiliation	Description	Year	Views
1	Brian Douglas	Planetary Resources, USA	Designed video lectures with pen tables for drawing text and images and Photoshop software	2012	2,000-100,000
2	Benjamin Drew	University of the West of England, UK	Filmed lecture with projector style presentation	2014	100-300
3	James K. Roberg	MIT USA	Filmed lecture with chalk on board presentation, produced professionally in 1985	2013 (1985)	3,000-50,000
4	Anthony Rossiter	University of Sheffield, UK	Power point lectures with voice over, built on university course offering (Rossiter, 2013; Rossiter, 2014).	2013	300-4,000

[3] http://ctms.engin.umich.edu/CTMS/
[4] http://www.controlloopfoundation.com/

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