Digital Media Enhances Manufacturing Processes Teaching and Learning

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Abstract: The challenge of teaching a population of digital natives in the contemporary brick and mortar campus requires the use of innovative techniques not only to maintain student interest but as an enhancement to the learning process. The growth of the Internet and the ubiquitous nature of students' access to multimedia materials and the wealth of amateur and professional videos on a wide range of manufacturing processes make their inclusion in the classroom and lab a logical expansion and necessity. The manufacturing related courses are among the natural candidates for such experiments. They often require instructors to attempt to describe processes that the schools laboratories lack the equipment to demonstrate.

This paper reports an on-going effort to investigate whether such an approach yields better learning results and the degree and best ways of such inclusion. We believe, and as early results support such a notion, that the level and depth of understanding of students are significantly improved. To test such hypothesis, surveys will be conducted to identify whether and how it impacted student learning and knowledge retention, identify the optimum level of inclusion of such materials, and compare the performance of students with previous classes.

Students are required to search YouTube or other video sources for material related to the lecture prior to the class, watch the videos and select and send at least five such video links to the instructor. Instructor will also select a number of appropriate videos and post it through discussion groups and Facebook. During the lecture and subsequent class discussion of the processes under review, students are expected to add to the transfer of knowledge by sharing points and information gleaned from the digital sources and their textbook.

The lecture is supported by a weekly hands-on laboratory. Students are questioned, in a non-test environment, while working on their lab projects about relate theories and concepts.

Introduction

In an industrial Engineering curriculum, a manufacturing processes course meets three categories of students' employment needs after graduation: (1) Students whose professional career directly involves manufacturing: they must have a thorough understanding of the implementation of their industries processes, utilization of the machinery, and an understanding of the capabilities and limitations in the manufacturing of products; (2) Students, who indirectly work with the processes, need to evaluate the work done and projects undertaken necessitating an understanding of the general processes involved; (3) Students, who may have only occasional (direct or indirect) interaction with manufacturing processes, need to understand the services required by the first two groups as well as focusing on product generation and development.

In order to meet these needs, traditionally structured courses rely on laboratories for hands-on experience, textbooks for structured introduction of concepts and theories, and the lecture for the instructor to elaborate and explain the concepts by using images, transparencies, PowerPoint presentations, and discussion.

Herein is the crux of the problem. A considerable percentage of the class time has to be spent trying to draw a contextual reality for students who may not have the proper framework for understanding many of the characteristics of the processes under discussion. As such, they become easily frustrated and lose interest simply because they are not able to grasp the level of excitement and creativity involved in these processes. This in turn limits the ability of the instructor to cover the breadth of the processes involved due to time constraints.

Enhancing Course Delivery

In an effort to enhance student learning, increase understanding, and expand exposure to large number of manufacturing concepts beyond our ability to demonstrate, we have introduced the idea of using videos of processes as part of the course requirements. The inclusion of videos is a continuation of the use of multimedia [1] [2] in our course delivery methods. The instructor has a webpage [3] including supplemental class materials and the lab instructor has the basic outline of the labs on his webpage [4] (Figures 1and 2).

Although, the use of videos in classrooms is not a new phenomenon, note the growth of YouTube as an academic source [5]. Our incorporation is a new approach. In traditional formats videos are shown during the class period, with students viewing them often for the first time. In our approach videos are not shown during class time, they are assigned to be watched prior to the class (Figures 3). Students are asked to view them in preparation for the class lecture and they are discussed during the class which may then involve showing only parts of the videos (Figures 4).

The teaching methodology and delivery of the lecture is changed from *defining processes* to discussing *how* and *why* of processes. Students are incentivized to view multiple videos by increasing the assessment value of their class participation. These efforts are strengthened by the lab work in a coordinated environment between the course and lab instructors.

The philosophical underpinnings for our lab design focus on a hands-on approach. The high percentages of students in engineering today are not from a tradition of tinkerers. They have not the same history as many of their professors. Part of the goals for the lab aims at educating students hands, (see Figures 5, 6, &7) giving them the feel of tools and the wonderment that tools can achieve. In addition the program has a higher than average percentage of female students which may be less exposed to manufacturing work. Lab work aims to make sure that all students' in small teams are active in the labs regardless of gender. The sequence of projects move from an introduction to hand tools in the making of a nut and bolt from steel stock, to casting, to manual machine tools used in milling pocketed designs, through CNC lathe and mill programming, culminating in CAD, and then CAM post processing. There are also multiple casting and foundry labs included.

This methodology helps foster a respect for the skills required to implement design; creating a link between the designer and the design, thus enhancing the understanding of design across the

curriculum. Our students need to appreciate what skilled hands can do, what an innovatively unique design can achieve in the market place as well as the factory floor. The inspirational aspect of do-it-yourself (DIY) for engineering student can't be over emphasized.

Assessment

To assess whether the new course strategy has had a positive impact on student learning and an increase in their interest in manufacturing, a survey was conducted. This survey [6] included instructions and background information for the respondents outlining the reason the survey, and how its outcome may impact new course delivery methods.

Table 1 represents the results of the survey. The survey was designed to elicit statistics in three different areas of concern:

1. Verification that students were watching the videos and how many.
2. Verification that the videos had an impact.
3. Feedback for either improvement or discontinuing the experiment.

It was structured to primarily investigate if the videos were having an impact and to verify that students were viewing the videos since they are not monitored and the activity is outside of class.

Fortunately, all class members participated in this voluntary survey.

Analysis of Results

A total of 80% of the students surveyed reported that they regularly viewed videos with 66% of them indicating that they could name at least 10 videos that have looked at since the beginning of the semester. All students agreed that videos have helped them "understand the process better and appreciate the complexity of the processes involved". None asserted that the textbook was adequate, thus supplanting the benefit of the videos. All recognized the rationale for the inclusion of videos in the class. There was almost universal sentiment that the videos should be part of the class structure going forward. However, students were almost evenly split on whether to assign specific videos or let each student randomly select their viewing preference which is the current structure. At this point a compromise of the two positions maybe the likely outcome for future classes; given the development of a video database which is underway. The database will contain between 720 and 1100 URL link submissions. A listing of best videos per process list will be made available to future classes.

Although the impact of the inclusion of videos in the class structure is judged in our estimation to be overwhelmingly positive, students indicated by a margin of 66% they would still like to observe processes directly by visiting manufacturing plants.

There are two additional observations in regards to the responses. The design of the course intentionally and deliberately leaves the choice of which videos to watch to the students. However, they are instructed as to how to do an intelligent search to find the most appropriate videos. The instructor's Facebook [7] (Figure 8) page actually includes many shared videos that he has selected on various processes as a suggested list of videos to watch.

The second observation in relation to weekly visits to manufacturing plants only can be used to measure the level of students' interest in the course as in reality the logistic and time issues involved in taking the class to visit manufacturing plants makes it almost impossible.

Continuing and Future Research

As the work is an ongoing research, the authors will continue to gather data and student feedback throughout the fall 2012 class and will analyze the results for improvement in succeeding offerings of the course. Close to 15 years of data from previous classes will be compared with the performance of the current class upon completion.

Positive student reception to the inclusion of videos prompted the production of in-house videos and an expansion of their use into other courses. This technique offers the opportunity to reduce the use of class instruction time for the introduction of software based supplemental tools, shifting that learning process outside the classroom.

These materials have been placed on a YouTube educational channel [8] which in a two month period since its inception has had over 3000 hits, mostly by the students in the class.

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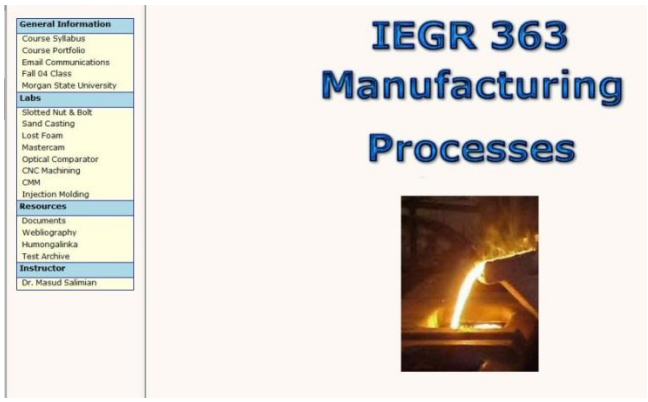

Figure 1. Lecture Webpage

Figure 2. Lab Webpage

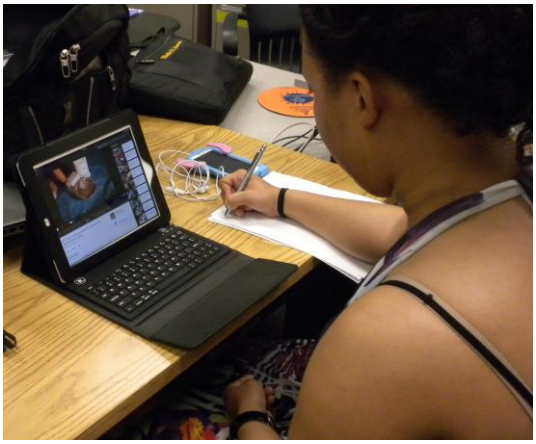

Figure 3. Taking notes while viewing video

Figure 4. Instructor and student

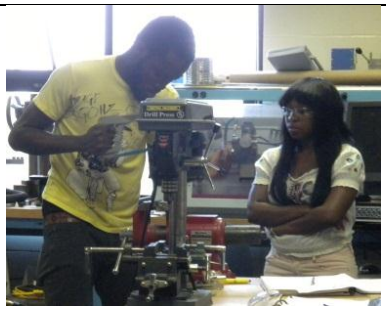

Figure 5. Students working in the lab

Figure 6. Students working in the lab

Figure 7. Students working in the lab

Table 1. Tabulated Survey Results					
Question	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**	**NA**
I regularly watch videos related to the class.	**40%**	**40%**	**20%**		
I can name at least 10 videos I have watched in its entirety from the start of the semester.	**20%**	**46%**	**26%**		
I am not sure why I have to watch videos, so I usually don't watch them.			**40%**	**53%**	**6%**
Most of the videos are of the same quality and just repeat the same information.	**33%**	**33%**	**26%**	**6%**	
I have watched the videos but they do not help me in understanding the course material.			**46%**	**40%**	**6%**
Videos help me understand the process better and appreciate the complexity of the processes involved.	**33%**	**66%**			
I get confused by the processes involved and can't follow them.			**80%**	**13%**	**6%**
I can get more studying the textbook, so I don't need to watch videos.			**73%**	**20%**	**6%**
I think videos help and should be included in the course.	**26%**	**60%**	**6%**		
I do not mind the videos being part of the course, but the videos need to be assigned rather left to the student choice.	**6%**	**46%**	**46%**		
I rather we went to manufacturing plants every week, so we could actually see the processes ourselves.	**26%**	**40%**	**26%**		
I think videos help tremendously. I hope we have videos made for our lab assignments too.		**60%**	**20%**	**6%**	**13%**

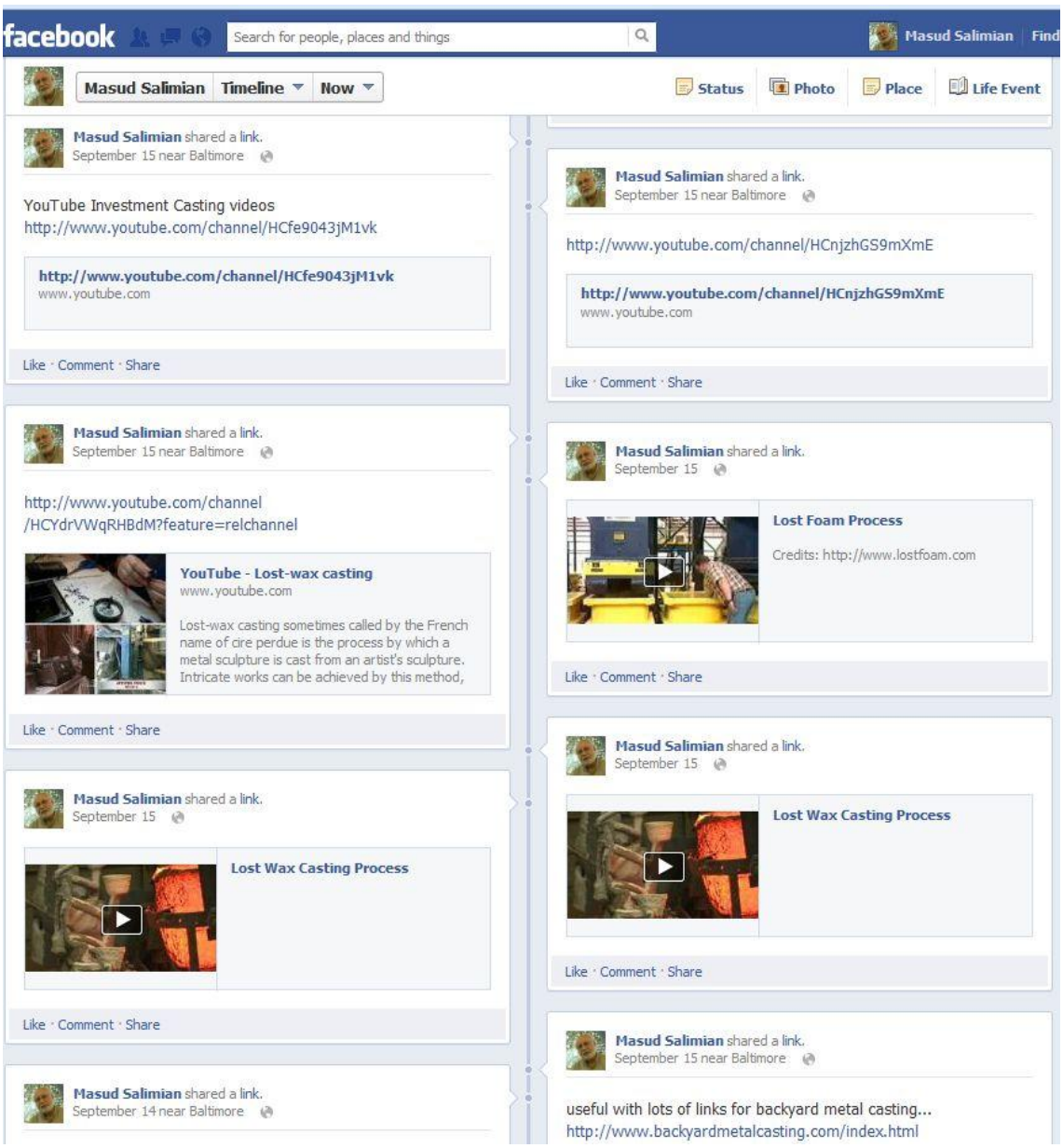

Figure 8. Instructor's Facebook page

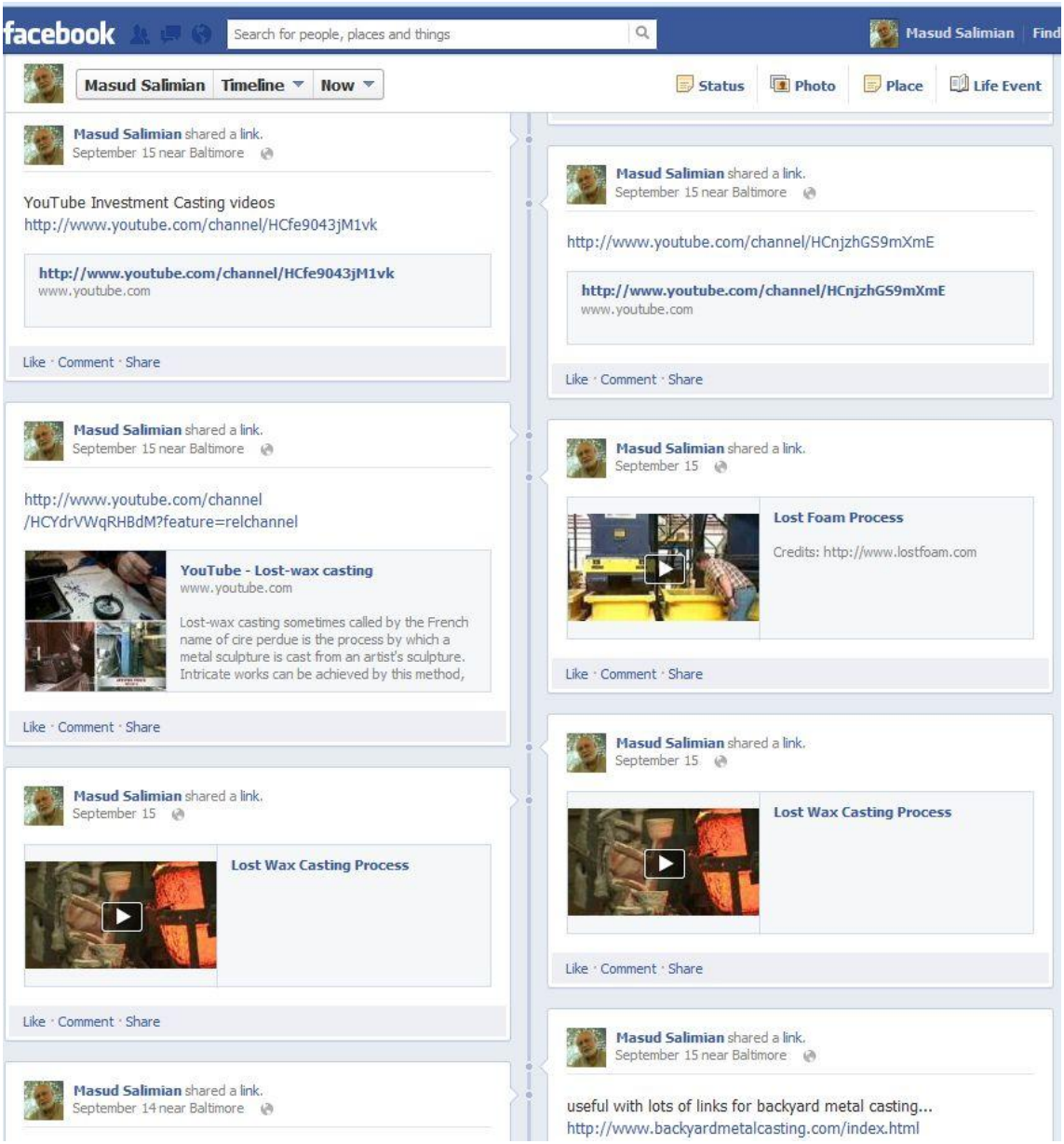

Figure 8 Instructor's Facebook page