THE ANALYSIS OF ELECTURE CREATION AND DISTRIBUTION SYSTEMS AT CAL POLY

by

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A Senior Project submitted in partial fulfillment of requirements
for the degree of Bachelor of Science in Industrial Engineering

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Graded by:_____ Date of Submission:_____

Checked by:_____ Approved by:_____

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Abstract

This report details the analysis of potential eLecture creation and distributions for Cal Poly San Luis Obispo. Specifically, this project will focus on a system for the College of Engineering. This project was completed using the Systems Engineering process and concentrated more specifically on the Systems Evaluation phase, in which the specifics for potential system solutions are discussed. The first step was to define the problem that must be addressed; Cal Poly currently uses eLectures in the classroom, but with the wide variety of eLecture creator and distribution alternatives available, there is no optimal system at the University. The next step was to determine the functional requirements for an eLecture creation and distribution system based on the needs of three separate stakeholders: the students, professors, and IT department. Next, research was conducted to establish the different technological approaches that may meet the stakeholder's needs, and consequently the system requirements. Finally, these alternatives were ranked in a functional requirements matrix to their ability to meet the system requirements. Analysis determined that Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U was the best choice for Cal Poly's College of Engineering. There is a cost of $43,000 associated with implementing this system, and with a savings of $52,500, it will be paid back in 10 months after implementation.

Introduction

Traditionally, higher-level education has been taught on the foundation of students attending a professor's lecture to understand a topic. The topics covered in lecture are then practiced outside of class by the student through further research and assignments. These lectures generally consist of a concept introduction, examples of the concept, and the application of the concept in a real world environment. Schools and professors spend extensive resources to formulate lectures plans to convey these concepts, and continue to spend additional resources to repeat these lectures term after term to students progressing through school. Although professors attempt to deliver an identical lecture to these various classes, variability is certain to occur in the lecture format, content, and delivery. This incumbent variability imposes a disadvantage to students; they expect to receive a concise, clear, and quality lecture regardless of other factors. Therefore, there is much room for improvement upon the "traditional" teaching style of the past.

Currently, Cal Poly uses an array of electronic mediums for the distribution of course lectures. While the model of electronic lecture distribution in education, known as eLectures, is presumed to be lead the way for future education, the lack of specificity and direction in the eLecture models used at Cal Poly causes a confusion regarding which system is the best. In order to embrace this new technology, Cal Poly must take a specific course of action to evaluate which eLecture distribution model is most effective for Cal Poly teachers and students.

The emergence of many 21st century technologies grants institutions with the ability to record lectures for repeated use. While it still costs a university time and money to produce a course, technology has made reproduction and distribution costs almost non-existent. A professor can deliver lectures to students by means of the internet through various distribution systems. Thus,

educational content can be made available to millions of students worldwide at a relatively low cost. This content has the potential to substantially improve the quality of life of learners around the world, and provides an immediate collection of information to a University student. However, Universities are struggling to determine the optimal way to deliver these recorded lectures. Due to the fact that the eLearning model is growing at a tremendous pace, it is critical that Cal Poly establishes the most effective method for content creation and delivery.

An effective eLearning system at Cal Poly will consequently relate to the Lean tools and techniques used by Industrial Engineers. These Lean concepts are used to reduce waste and increase quality in a system, while concurrently reducing costs associated with production. Although these techniques are generally practiced in a manufacturing environment, they may be mutually applied to a higher-education setting.

The objectives of this project are to:

- *Define the ideal system requirements for an eLecture system* – In the case of an eLecture creation and distribution system, the there are multiple stakeholders that must be considered. Therefore, it is important to design the model based on the requirements from each of the entities.

- *Determine alternative technological approaches* – In this section, we will determine the prevalent models that currently exist. Because multiple systems exist that may provide the functionality needed to satisfy our requirements, we will select systems that are viable for further evaluation.

- *Evaluate alternative technological approaches* – Using a strict and objective evaluation method, the alternatives will be rated as to how well they fulfill the functional requirements. As a result, each alternative will receive an overall score which will help with further analysis.

- *Select the highest rated technological approach* – Reinstate how the chosen approach will improve an inefficiency and essentially solve Cal Poly's problem in standardizing the eLecture creation and distribution model. In addition, the approach will be related to Lean concepts, tools and techniques.

- *Create an implementation plan for future application* – A top level implementation plan will be created to guide the University administration, professors, and IT in executing the system at the University. The students do not require as robust of a implementation plan because they will receive instructions on using the system through their professors in the classroom.

- *Justify the project through an economic analysis* – The project will be rationalized through a financial evaluation.

This report will focus on incorporating an eLecture creation and distribution system specifically for Cal Poly's College of Engineering. However, the resulting model system can be applied to Cal Poly's other colleges. The results from the report are targeted for use by administration, faculty, and the IT department at Cal Poly.

Background

This section of the report gives a brief background on the components of an eLecture creation and distribution system, and more specifically explains how eLectures fit in to Cal Poly's technological initiative. Furthermore, this section describes how eLectures are currently used at the University.

eLecture System Components

Learning Management System

Cal Poly is currently in the process of converting to a new learning management system (LMS), known as PolyLearn. A learning management system stores and manages course content and activities online, which streamlines the distribution and visibility of course materials. The system is a Cal Poly branded version of the Moodle learning management software, and will be fully operational in Spring 2012.

eLecture Creator

The eLecture creator consists of applications and tools configured for users to create quality eLectures in an online file format. Professors are the main users of the eLecture creator, and use the system to create and upload eLectures to Cal Poly's servers.

Cal Poly's Servers

Cal Poly's servers consist of computers and file storage networks that support students and faculty at Cal Poly. The servers store and distribute all data pertaining to the learning management system, eLectures, and the eLecture viewer.

eLecture Viewer

An eLecture viewer is necessary for the integration between eLecture files and the learning management system . An eLecture viewer works as the median for eLecture files and the learning management system, and allows for these files to be viewed by students within the learning management system.

In order for an eLecture system to be effective, it must integrate with PolyLearn. Therefore, it is imperative that our system define two solutions for Cal Poly; an eLecture creator, and eLecture viewer. These components interact with Cal Poly's current users and infrastructure, as shown in Figure 1: Functional System Mode below.

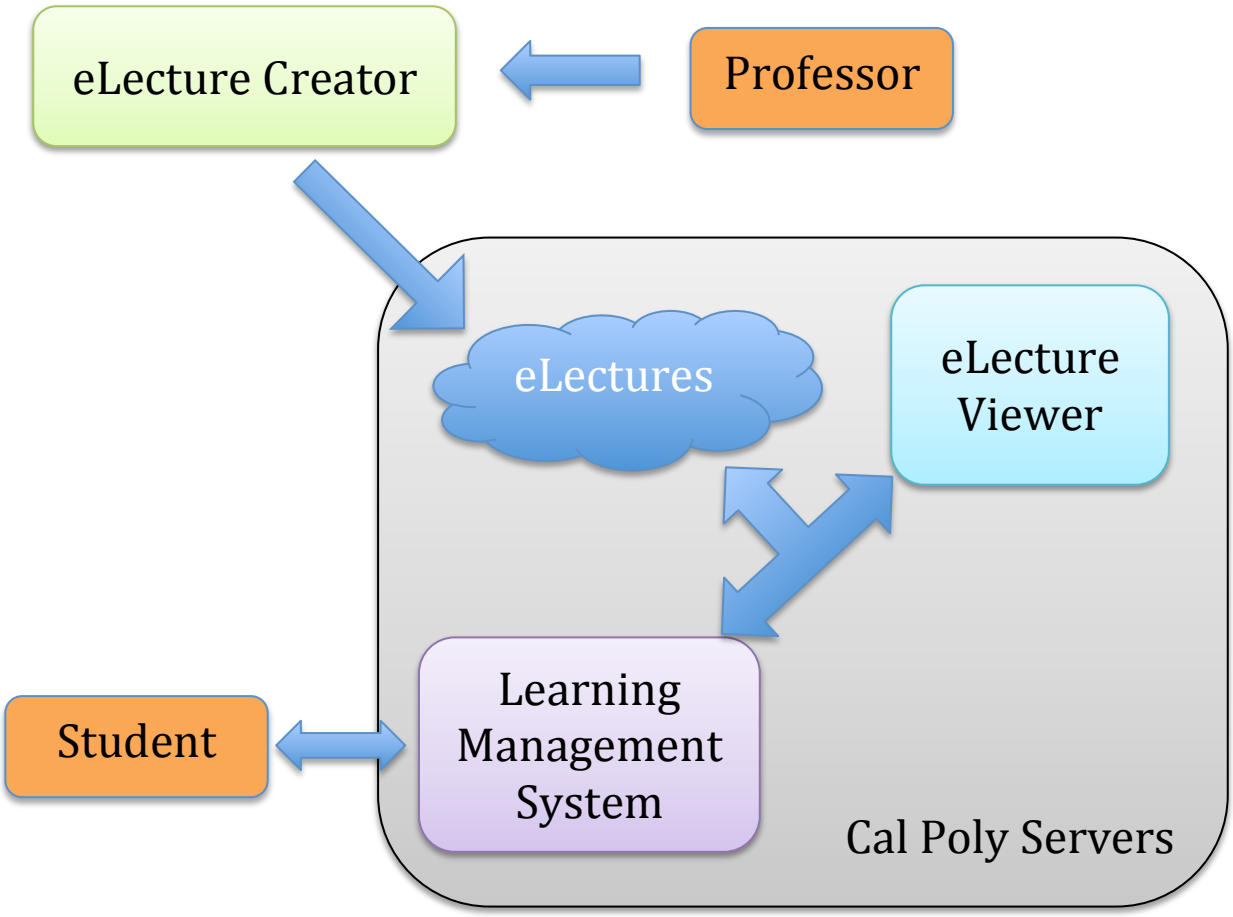


Figure 1: Functional System Model

Cal Poly's Current eLecture Usage

The current eLecture system at Cal Poly contains multiple steps, which are outlined in Figure 2: Current eLecture Use Model.

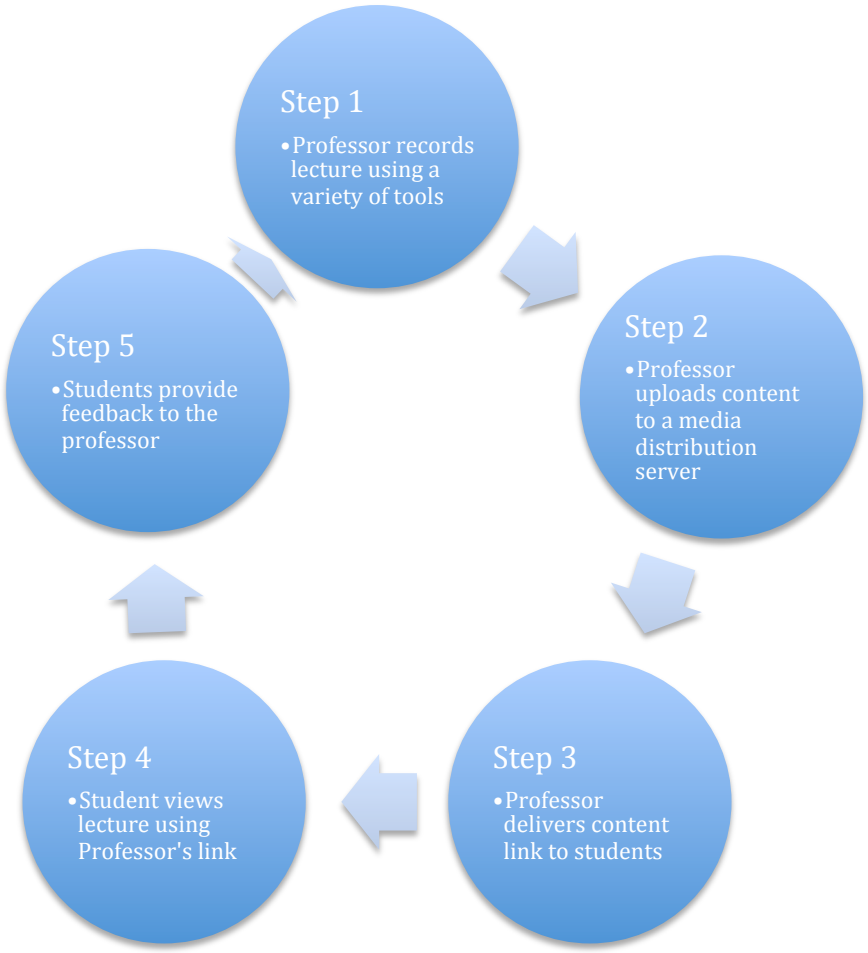


Figure 2: Current eLecture Use Model

Step 1

Professors currently use an assortment of applications and tools to create eLectures, because there is not a standardized system determined by Cal Poly. The lack of standardization causes eLectures within the same class to have a different look and feel. Professors tend to use whichever system that works well in their own classroom, while the systems vary from classroom to classroom.

Step 2

The choice of eLecture distribution methods is also chosen solely by the professor. For instance, some professors depend on YouTube for lecture distribution, based on the premise that YouTube is popular among students. While this assumption is correct, YouTube may not be the most effective tool for Cal Poly as a University.

Step 3

A professor must make students aware that a lecture is on the internet. This can happen through an eMail link, a link posted on the LMS, or an announcement in the classroom. Professors don't have a preferred means of delivering this link to the students, which creates ambiguity among students when searching for the most recent eLecture.

Step 4

Once a student has access to the lecture, they must immediately view the lecture in order to obtain the benefits prior to the next class meeting. Due to the fact that professors use various mediums for distribution, as well as different encoding techniques, students may have trouble viewing or accessing the lecture.

Step 5

Assuming the students were able to view the eLecture prior to the next class meeting, the class holds a discussion regarding the eLecture topic. At this time, students generally provide feedback on the eLecture, including the aspects they liked, and the areas they did not like.

eLectures in Education

More and more teachers utilize electronic teaching methods to increase the value of their classes and standardize the content. They do so by creating audio or video recordings and distributing them to their students. Many different applications and distribution channels are used by professors to deliver their content to students. In addition, multiple types of electronic lectures exist to supplement a student's learning experience. While some formats may be more beneficial than others, the true value of a lecture depends on its intended use.

Audio

Audio lectures consist of an audio file that a user listens to by means of an MP3 player, computer, or any other device that can process the audio. Audio only recordings were the first media type to quickly spread by means of the Internet due to their small file sizes and incredible versatility. Because users are not required to physically engage with a display, the use of audio lectures is applicable in a variety of settings.

Video

Video lectures add a visual component to the audio component., and can be listened to on a computer and some smartphones. Video recordings are becoming more widely used as they are being used to teach more applied classes like Math, Science, and Engineering where a visual component is necessary in learning the content. Video lectures can either be composed of a video recording of a teacher giving an actual or staged lecture, or from a teacher voicing over a video recording of a PowerPoint presentation. In addition, a combination of the two exist

Screen Capture

Screen captures bring the commonly used PowerPoint lecture style to an eLecture format. Generally, screen captures are a recording of an instructors computer screen. Screen captures are extremely useful when talking through PowerPoint demonstrations or giving a step by step software tutorial. This eLecture format is becoming very popular in the modern age of technology, because many popular tools are based on the computer. Thus, screen captures are the eLecture format of choice in these instances.

Benefits of eLectures

Increase Flexibility

Using eLectures in the classroom has a direct impact on an instructor's flexibility in their teaching style. For example, eLectures allow students to gain a general understanding of a topic prior to coming to class, which allows for a professor to conduct more in class activities that relate to the topic, rather than lecture on theory to the students.

Decrease Variability

The use of prerecorded eLectures can dramatically reduce the incumbent variability found in a lecture. It is nearly impossible for a professor to deliver the same lecture twice; students are not guaranteed the same knowledge term after term. For example, a professor may not be feeling well on a particular day or may forget to cover a certain aspect of a topic. By using prerecorded eLectures, students and professors can both safeguard against these misfortunes. If a mistake is found in an eLecture, the video can be immediately be fixed and redistributed to students.

Increase Value Added Time

eLectures provide the capability to increase value added time in a classroom by coinciding with the "inside out" learning style that many Universities are deploying. This style of teaching requires that students view eLectures outside of the classroom, and work on project based materials inside of the classroom. For instance, a student can view a lecture anywhere; it doesn't matter if students listen to the lecture live in the classroom, at home on their laptop, or on the bus using their smartphone. However, project based work consists of students working on assignment concurrently with a professor's guidance. This type of work cannot be replicated outside of the classroom, and may be much more beneficial to students compared to traditional lectures.

Literature Review

The following sections provide a basis of understanding for the research in this report.

University Background, Teaching Styles, and Associated Costs

Introduction to Engineering Education at Cal Poly

Cal Poly's College of Engineering is part of California Polytechnic State University, San Luis Obispo, and a nationally ranked, four-year, comprehensive public university. The emphasis of the university is "learn by doing" for its more than 18,000+ students. The California Polytechnic State University College of Engineering Strategic Plan states: ***"The mission of the College of Engineering is to be a flagship college of engineering that benefits humanity by educating socially responsible engineers inspired for life-long learning using an innovative learn by doing philosophy in partnership with industry and other stakeholders."*** (Crockett et al.)

Today, Cal Poly's College of Engineering hosts 5,000 engineering and computer science students, offering 13 undergraduate and nine graduate degree programs.

Traditional Classroom Teaching Style

The customary style of teaching in Higher Education places a high regard on a professor mastering a subject. The professor must then convert the information into a format that is understandable by students. Usually, this information is delivered in class, via a lecture. In an optimal environment, the professor will spend an entire class section explaining a concept. After being introduced to the concept, students will attempt to solve examples and apply the concept to homework and projects for further mastery. Upon arriving to the next class period, it is expected that the topic be mastered by students. However, this is rarely the case; professors often spend

additional time and resources in the following lecture to clarify key points from the previous concept as depicted in Figure 3: Traditional Learning Cycle below.

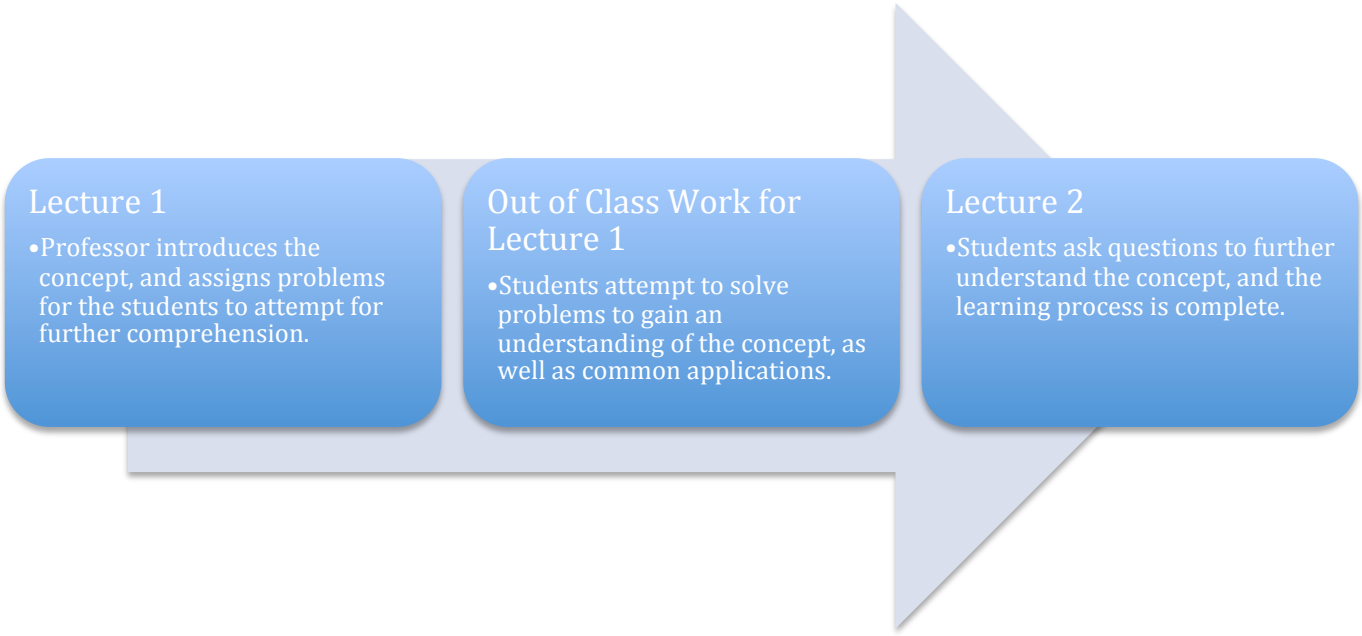


Figure 3: Traditional Learning Cycle

Ideally, the introduction and mastery of a topic should be completed between one lecture and one out of class work time frame. Professors currently schedule their syllabus in this manner, but the need to clarify concepts from the first lecture causes a carryover into the second lecture. This process becomes perpetual and triggers a typical class to immediately fall behind. In order to "catch up" on the class status, a professor may summarize lecture topics, or completely skip the topic. This provides a negative effect to the student's education as it does not provide them with the education they were intended to receive.

In addition to wasted time, the variability that inherently exists in human performance reduces the value of a class. It is difficult for a teacher to deliver the same quality of content from class section to section, let alone year to year. Additionally, many teachers may teach the same class,

which adds another dimension to the variability. The following list reveals many causes of variability in a given class:

- Offering multiple sections of the class
- Offering the class during multiple quarters
- Having different teachers teaching the same class
- Having a human teaching the class prone to human error: absence, mood, tiem of day, mistakes, sickness, etc.

These causes are inherent to the education system, and therefore cannot be completely eliminated. Therefore, the need to reduce the variability in the education system arises, which will in turn increase the value received by the student.

Rising Academic Fees

Academic fees have been steadily increasing over the past 40 years. Although the very reason for the rise in fees is debatable, the fact is that students are required to pay more money for an education. An article by The Economist, titled *Academic Inflation: Higher Education*, quotes "For decades, college fees have risen faster than our ability to pay them. Median household income has grown by a factor of 6.5 in the past 40 years, but the cost of attending a state college has increased by a factor of 15 for in-state students and 24 for out-of-state students. The cost of attending a private college has increased by a factor of more than 13. Academic inflation makes most other kinds look modest by comparison" (Academic Inflation 2010). This increasing trend can be seen in Figure 4: U.S. Inflation Trends below.

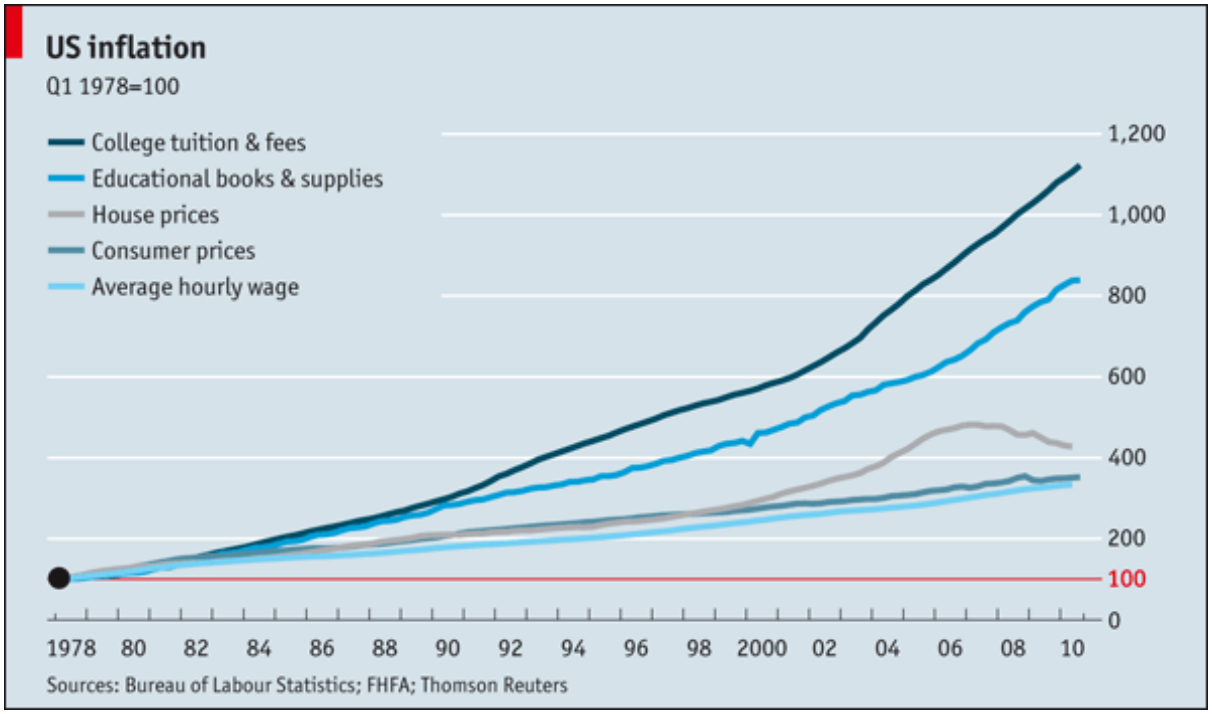


Figure 4: U.S. Inflation Trends

The rise of tuition and academic fees creates a critical need for students to get the most out of the education system. By making the education system more efficient, the benefits students receive will increase, and therefore, close the gap between the rising costs and value received.

In addition, waste causes a student to graduate with an undergraduate degree in more than the standard four years. By remaining in the education process for more than four years, students are forced to pay more for the education they should have received in four years. Furthermore, the government aid received by the University is dramatically reduced after four years, which directly affects the University's bottom line. The inequality between the value received from and the amount paid for the education process reveal there is potential to improve the system.

Lean Systems

The application of our technological approach should incorporate the features inherent in a Lean system. The term "lean", many times used in a manufacturing environment, stemmed from the Japanese production model in the automobile industry. The production model coined the term because it deals with deciphering value added activities from wasteful activities, which eliminates waste from the organization and its supply chain (Comm 2005). Taichi Ohno, one of the co-developers of the lean system, said, "waste accounts for nearly 95 percent of all costs" (Kilpatrick 2003). Lean thinking provides us with the tool set to accomplish more with less. Therefore, by applying lean concepts more tasks can be completed with less human interaction, less time, less money, and less waste, while providing the customer with the core deliverable.

Jeffrey Liker's 14 Lean Principles

Jeffrey Liker, author of The Toyota Way, defined 14 principles that constitute the Toyta Way, and define the Toyota Production System (TPS). The Toyota Production System has been a landmark system for the research and application of Industrial Engineering. The tools and concepts derived from TPS are applicable to any environment, enabling their use in a University setting. The following principles provide the foundational structure to the Toyota Production System:

1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.
2. Create a continuous process flow to bring problems to the surface.
3. Use "pull" systems to avoid overproduction.
4. Leveling out the workload (Haijunka)

- The Toyota Way promotes the elimination of Muda, Mury, and Mura. These are the 3Ms that describe the types of waste in a production system.
- Mura is defined as unevenness in the resourcing and scheduling. It is considered to be the causation, and resolution to the other two Ms in the Toyota Production System.
    i. In production systems, at times people are underutilized, and in other times, people are overworked. This unevenness is the result of an irregular production schedule.
    ii. Muda, defined as non-value added tasks, are usually a result of Mura. This includes wait time, transport time, queue time, and setup time.
    iii. Focusing only on eliminating Muda will run your system into the ground, due to fluctuations in demand.
- Haijunka is the Japanese term for leveling out production schedule by volume and product mix.
    i. Achieving Haijunka is fundamental in eliminating Mura, which helps us eliminate Mury and Muda.
    ii. To achieve Haijunka, we must take the total amount of orders in a period and level them out, so we can have level, even production.

5. Build a culture of stopping to fix problems, to get quality right the first time.
    - Stopping the manufacturing process to build in quality promotes Jidoka, which is the 2nd pillar of TPS.
        i. Jidoka empowers employees with more responsibility and decision making skills.

    ii. Building in quality to each station is much more cost effective than repairing the problems at the end of the process.

6. Standardized tasks and processes are the foundation for continuous improvement and employee empowerment.
    - By following standardized tasks, you ensure zero defects.
    - The difficulty in standardizing tasks is giving employees a rigid standard to follow, and yet the freedom to innovate and be creative to meet targets.
7. Use visual control so no problems are hidden.
    - It is important to make processes visual in the workplace, in order to easily identify and target problems.
    - Visual control systems also promote value added flow.
        i. Using visual control systems tells us how work is being done, and our deviation from the standard.
        ii. An example of a visual control system is a shadowed tool board. Employees can quickly see if tools are missing, and which tools belong in which area.
8. Use only reliable, thoroughly tested technology that serves your people and processes.
    - Make sure technology doesn't conflict with the Toyota principles, such as eliminating waste, and using people to make decisions.
9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.

- Do not view the leader's job as simply accomplishing tasks and having good people skills. Leaders must be role models of the company's philosophy and way of doing business.

10. Develop exceptional people and teams who follow your company's philosophy.
11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
12. Go and see for yourself to thoroughly understand the situation (genchi genbutsu).
    - Solve problems and improve processes by going to the source and observing and verifying data rather than theorizing on the basis of what other people or the computer screen tell you.
13. Make decisions slowly by consensus, thoroughly considering all options. Implement decisions rapidly (Nemawashi).
14. Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen).
    - Once you have established a stable process, use continuous improvement (kaizen) tools to determine the root cause of inefficiencies. Once you've identified the root cause of problems, create countermeasures.
    - Use hansei (reflection) at key milestones and after you finish a project to openly identify all the shortcomings of the project. Develop countermeasures to avoid the same mistakes again.

Types of Waste

Waste in an assembly line results in defects, increased costs, and increased variability. The same holds true in an educational environment; waste results in increased student fees, delayed

graduations, and an ineffective learning environment. The goal of a manufacturing environment is to eliminate waste and maintain quality, while concurrently reducing costs. The same principles hold true in a university; by reducing waste in a university, we will see increases in throughput and quality of the student's education. Jeffery Liker defines the seven types of waste as described below:

1. *Overproduction* - often considered on of the most critical wastes, as it leads to increased storage costs, inhibits quality, and increased WIP. To overcome this, Toyota implemented a Kanban system. A Kanban is a tool that tells you what to produce, in what quantity, and when it must be delivered (What is Kanban). It is a critical feature of the JIT (Just in Time) system, which delivers parts to workers as they are needed.

2. *Waiting Time* - occurs when time is not being used efficiently. This can happen when goods are not moving through the factory floor, machines break down, or items are waiting in a queue.

3. *Transportation* - the third waste, occurs when goods are moved throughout a facility. Any non-value-added movement of the product is considered to be waste.

4. *Over-processing* - occurs in situations where overly complex solutions are found to simple procedures, such as using a large inflexible machine instead of several small flexible ones (Hines et al. 1997).

5. *Excess Inventory* - increases our storage costs, and hides problems in the manufacturing process. By having an excess of inventory, a halt in the manufacturing line is not critical

to delivering the product to the customer. In turn, the excess inventory masks the problem in the manufacturing process.

6. *Unnecessary Movements* - usually associated with the ergonomics of the production process. These movements are attributed to times when employees are bending over, reaching, and picking items up, when these movements could be avoided.

7. *Defects* - final form of waste in a product, and are considered direct costs. The Toyota philosophy is that defects should be regarded as opportunities to improve rather than something to be traded off against what is ultimately poor management (Hines et al. 1997).

This review of literature directed the design and analysis for evaluating an eLecture system at Cal Poly.

Design

Systems Engineering Process

The systems engineering process provides a systematic and objective framework for evaluating potential solutions that will solve a problem, fill a need, or eliminate an inefficiency. In this case, many alternative approaches exist to create and distribute eLectures. Therefore, in order to ensure the best system is selected based on Cal Poly's specific needs, the systems engineering process should be utilized. The evaluation phase of the process includes definition of the problem, identification of the need, and system feasibility analysis as shown in Figure 5: The Systems Engineering Process from Anna Hopper's article titled *Evaluating University Research Network Alternatives through the System Engineering Process* (Hopper). By following the systems engineering process, Cal Poly can be sure that the chosen system best fits the user requirements.

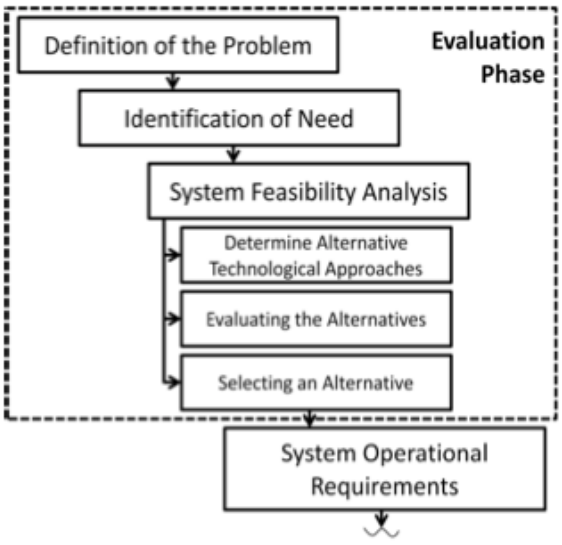


Figure 5: The Systems Engineering Process *(Hopper 2011)*

Definition of the Problem

A system should only be considered if its existence will fill an absence, improve an insufficiency, or essentially solve a problem. Therefore, the problem must be clearly defined in order to meet the customer's need. Defining the problem should include the description of the absence or insufficiency and the risks involved if the problem is not addressed.

Identification of the Need

System stakeholders must state their needs that must exist in order to solve the problem. This activity is commonly called a "needs analysis." The stakeholder's needs must then be analyzed and translated into the system's functional requirements. The system's functional requirements determine the design and features of the system.

Determining the Alternatives

Brainstorming and researching are necessary to determine potential technological approaches. A helpful place to start is researching what other companies or institutions use to solve a similar problem. If a similar system does not exist, then brainstorming will be the main method of idea generation. Additionally, talking to experts in the area, professional contacts, and stakeholders will result in the generation of many ideas and perspectives on the available technology.

Evaluating the Alternatives

Once the technological approaches are determined, they can be evaluated for feasibility of fitting Cal Poly San Luis Obispo's requirements. This evaluation is performed using the functional requirements matrix. The matrix is shown in Figure 6: Functional Requirements Matrix.

		Alternative	
Functional Requirements	**Weight (%)**	Rating (%)	Score (%)
Functional Requirement 1			
Functional Requirement 2			
Functional Requirement 3			
Functional Requirement 4			
Functional Requirement 5			
Functional Requirement 6			
TOTAL	**100%**		

Figure 6: Functional Requirements Matrix

Each requirement should be assigned a weight of importance; the greater the weight, the greater the importance. The importance of each requirement should be defined by the original customer needs, or the functions that are most necessary to solve the existing absence or insufficiency. Next, assignment of a rating to each alternative and requirement combination is performed. The rating should be a percentage indicating how well the approach will satisfy the requirement. The score is calculated by multiplying the weight by the rating, and the resulting value should be less than 1, or less than 100%. The scores are added up to determine the total score per approach.

Selecting a Solution

After successfully completing the Functional Requirements Evaluation Matrix, the technological approach with the highest total score in the Functional Requirements Evaluation Matrix will be most for an eLecture creation and distribution system at Cal Poly San Luis Obispo.

Now that the evaluation phase has been defined and described, the following sections reveal the application specific for Cal Poly.

Methodology

As described in the Introduction section of the report, the problem is that Cal Poly currently does not have an ideal system for creating and distributing eLectures to students.

Identification of Need

The system must adhere to three different stakeholders at Cal Poly, all of whom have different needs:

- Students – The students are the end users of an eLecture system, and are limited to Cal Poly Engineering students. The scope of this project is bounded by the Engineering college at Cal Poly, and therefore, the system should only target Engineering students at this time.

- Professors – The professors provide and manage the content for an eLecture system. By addressing the professor's needs, the system will be useful and scalable to these users. At this time, professors are limited to those within the Cal Poly College of Engineering.

- Information Technologies (IT) – IT is responsible for managing the system from a technological standpoint. Their functions include maintenance, upkeep, and accessibility.

These stakeholders have very different needs that must be satisfied by the system. If the stakeholder's needs are not met by the system, the system will be sub-optimal.

Student Requirements

To define student requirements for the system, a survey was conducted through SurveyMonkey among Engineering students at Cal Poly. Cal Poly Engineering students are the end users of our

system since they interface with the LMS and the eLectures created by teachers. The sample size for the survey was 108 participants (N=108). Based on results of the student surveys (seen in Appendix 1: Student Requirements Survey), the system must contain the following features to meet the needs of Cal Poly Engineering students:

Public eLectures

eLectures should be open to the public, allowing for distribution between students attending Cal Poly and individuals not attending Cal Poly. This is important to students as it matches the efforts of other Universities, and gives Cal Poly a positive reputation in the eLecture world. Furthermore, due to the growth in internet media, education content has surged in the open-source arena.

Local Storage

Students require the ability to store eLectures on their computer for an indefinite amount of time. In effect, the system must be able to both stream eLectures from a host location, and also allow for eLectures to be downloaded and stored on a user's computer. In the short term, this give students the ability to watch saved lectures on devices, regardless of internet connection. In the long term, students have the ability to refer to class lectures when working in industry.

Mobile Device Integration

The system should be compatible with mobile devices, such as smartphones and tablet computers. This feature allows users to stream eLectures to any device, and view eLectures in a variety of locations. With the growth in mobile computing and tablet devices, it is important that the system meet the needs of modern technology.

Automatic Downloads

Students should have the ability to "subscribe" to a course's eLecture material, allowing for new lectures to be automatically download as they are published. This ensures eLectures are with students immediately after they are posted online, eliminating the need for students to continuously check for updates.

By addressing these needs, students will be able to more readily embrace the selected system at Cal Poly.

Professor Requirements

The primary input users of the system are the professors. Their participation in the system is critical to its adoption throughout Cal Poly since they supply information and lectures to the system. The professor requirements were drafted by interviewing three professors at Cal Poly's campus, all of whom had prior experience using eLectures in the classroom.

Personal Computer Use to Create & Upload Lectures

The system should include the capability for professors to create and publish eLectures. Professors require the ability to do this from their own computer, assuming the computer has a microphone and webcam. Therefore, our system should support both the Mac and Windows platforms.

Publish Lectures Publically and Privately

Professors should have the ability to publish their lectures to both students and the global community. This allows Cal Poly to share knowledge with the global population, and educate life-long learners around the world.

Searchable eLectures

Professors want to enable students with the ability to search their eLectures for key terms. This allows students to quickly jump to the content they need in a eLecture. This includes searching eLecture titles and topics, as well as keywords within the eLecture.

Use Various eLecture Formats

The system should be able to produce a variety of lecture formats, including video, audio, and screen capture. This is important to professors, as it gives them a wide array of tools to best convey the knowledge they're sharing with students. Some eLecture formats are better than others at conveying specific ideas, and therefore the system should support multiple eLecture formats.

Professors are the main content creators for the system. Their active participation and liking of the system is necessary to ensure Cal Poly has a variety of beneficial content available to students.

Information Technologies (IT) Requirements

The IT department is responsible for managing Cal Poly's servers, software, and installed applications. This includes all tools and applications associated with the eLecture creator, eLecture viewer, learning management system, and the various users enrolled in the system. Essentially, IT will "own" the system, and oversee its development and maintenance in future progress. These requirements were conducted based on meetings with representatives of the IT department, including: Daniel Mull (ITS), Linda Sandy (ITS), and Tonia Malone (ITS).

Integration with LMS

The eLecture system must integrate with Cal Poly's upcoming learning management system (PolyLearn). Professors should be able to manage their eLectures within the LMS without relying on IT's assistance. Furthermore, students should be able to seamlessly access eLectures within the LMS.

Efficient Use of Storage

File sizes are a large area of concern with eLectures. High quality video lectures can potentially consume a large amount of hard drive space. This requires IT to purchase more storage equipment, which increases costs, and creates a more difficult system to manage. Therefore, our system should allow for file compression in efficient formats.

Cal State University's ATI

The Accessible Technology Initiative (ATI) reflects the California State University's ongoing commitment to provide access to information resources and technologies to individuals with disabilities. In regards to eLectures, the ATI requires lectures to be accessible by the hearing impaired. Therefore, our system should allow for the inclusion of closed captions within videos.

Scalability

The eLecture system should be easily scalable among the entire Cal Poly University once proven as successful within the College of Engineering. Professors and students from various colleges should find the system as effective given their potentially different teaching style.

IT's acceptance and participation with the chosen system is absolutely necessary to ensure the system's support and progress at Cal Poly.

System Functional Requirements

Now that the system requirements for each stakeholder is defined, they are grouped together to form the final compilation of system requirements shown below:

- Use Personal Computer to Create and Upload eLectures
- Various Output Formats and Efficient Use of Storage
- View eLectures Publically and Privately
- Automatic eLecture Downloads
- Local eLecture Storage
- Scalability
- Supports Searchable eLectures
- Adheres to Cal State ATI
- Supports Various eLecture Formats

The requirements may apply to one of the two main sub-systems, the eLecture creator and eLecture viewer, or to the system as a whole. It should be noted that all eLecture creator and viewing solutions integrate with Cal Poly's learning management system, and therefore, no further analysis is needed in this area.

eLecture Creator Requirements

- Use Personal Computer to Create and Upload eLectures

- Various Output Formats and Efficient Use of Storage

eLecture Viewer Requirements

- View Lectures Publically and Privately
- Automatic Lecture Downloads
- Local Lecture Storage

System Requirements

- Scalability
- Supports Searchable eLectures
- Adheres to Cal State ATI
- Supports Various eLecture Formats

Determine Alternative Technological Approaches

Now that the requirements are defined and applied to either the eLecture Creator, eLecture Viewer, or the system as a whole, the different system alternatives are determined and evaluated. These alternatives include the available software packages that fit the conceptual model discussed earlier in Figure 1: Functional System Mode.

eLecture Creator Options

Camtasia Relay

Camtasia Relay is a software package created by the TechSmith Corporation. The software is described as lecture and presentation capture system for an entire organization.

Panopto Focus (as Creator)

Panopto Focus is a flexible and easy to use presentation capture platform that lets users capture, edit, stream, archive and share recordings that preserve critical knowledge.

EchoSystem Personal Capture

The Echo360 company is known for their campus-wide eLecture solutions. Their system, known as the EchoSystem, is compiled of multiple software and hardware products that integrate for a complex eLecture system. However, for this report, the system will only analyze the Personal Capture software. Designed specifically with the needs of professors in mind, the personal version of Echo360 capture is optimized for the self-creation of learning modules, screencasts and tutorials.

eLecture Viewer Options

Panopto Focus (as Viewer)

Panpto Focus' viewer software is only compatible with the Panopto Focus eLecture creator software. The viewer is based upon Microsoft Silverlight technology, which is compatible with Mac, Windows, and other operating system platforms.

EchoSystem Player

The EchoSystem Player includes a full-motion replay of every course visual synchronized with the instructor's voice for a highly engaging experience. By using Adobe Flash technology, students on Windows, Mac and Linux platforms can replay lectures on any browser without client software downloads.

iTunes U

iTunes U brings the power of the iTunes Store to education, making it simple to distribute eLectures to students and faculty or to lifelong learners all over the world. With an iTunes U site, an institution has a single home for all the digital content created or curated by educators, which can then be easily downloaded and viewed on any Mac, PC, iPod, or iPhone.

YouTube

YouTube was considered as an option for professors to upload and share eLectures with students. However, this option was disregarded because YouTube does not fit the boundaries of the logical model shown in Figure 1: Functional System Mode. For example, content uploaded to YouTube cannot be stored or managed directly on Cal Poly's servers. Furthermore, YouTube does not allow for user account integration with Cal Poly's student directory, nor integration with the Learning Management System; eLectures cannot be limited Cal Poly students exclusively.

Determine Alternatives

The options above provide functionality to either the eLecture creator sub-system or the eLecture viewer sub-system. In order to determine an ideal system as a whole for Cal Poly, these sub-system options must be paired with one another, and evaluated as a system. The following list of sub-system pairs comprises the potential alternatives to be evaluated. Some sub-system pairs cannot be evaluated due to compatibility issues.

- Do Nothing
- Camtasia Relay & iTunes U

- Panopto Focus (as Creator) & iTunes U
- Echo360 & iTunes U
- Panopto Focus (as Creator) & Panopto Focus (as Viewer)
- Echo360 & EchoSystem Player
- Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U
- Echo360 & EchoSystem Player & iTunes U

Evaluating Alternatives

Functional Requirements Matrix

The functional requirements matrix formulation can be applied to each of the potential solutions. The solutions are given a rating percentage on how well they address each of the determined functional requirements. Functional requirement weights are assigned based on the importance of the functional requirement in regard to the system as a whole. The functional requirements weight and justifications can be found in Appendix 2: Functional Requirements Matrix Justifications.

Alternative 1: Do Nothing

Functional Requirements	Weight (%)	Rating (%)	Score
Use Personal Computer to Create and Upload eLectures	15%	50%	8%
Various Output Formats and Efficient Use of Storage	10%	50%	5%
View eLectures Publically and Privately	10%	30%	3%
Automatic Lecture Downloads	5%	0%	0%
Local Lecture Storage	10%	40%	4%
Scalability	15%	10%	2%
Supports Searchable eLectures	10%	0%	0%
Supports Various eLecture Formats	15%	80%	12%
Adheres to Cal State ATI	10%	50%	5%
TOTAL	**100%**		**38%**

Table 1: Do Nothing

Alternative 2: Camtasia Relay & iTunes U

Camtasia Relay & iTunes U			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	15%	100%	15%
Various Output Formats and Efficient Use of Storage	10%	40%	4%
View eLectures Publically and Privately	10%	100%	10%
Automatic Lecture Downloads	5%	100%	5%
Local Lecture Storage	10%	100%	10%
Scalability	15%	100%	15%
Supports Searchable eLectures	10%	40%	4%
Adheres to Cal State ATI	10%	100%	10%
Supports Various eLecture Formats	15%	30%	5%
TOTAL	**100%**		**78%**

Table 2: Camtasia Relay & iTunes U

Alternative 3: Echo360 & iTunes U

Echo360 & iTunes U			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	15%	100%	15%
Various Output Formats and Efficient Use of Storage	10%	50%	5%
View eLectures Publically and Privately	10%	100%	10%
Automatic Lecture Downloads	5%	100%	5%
Local Lecture Storage	10%	100%	10%
Scalability	15%	70%	11%
Supports Searchable eLectures	10%	50%	5%
Supports Various eLecture Formats	15%	100%	15%
Adheres to Cal State ATI	10%	50%	5%
TOTAL	**100%**		**81%**

Table 3: Echo360 & iTunes U

Alternative 4: Panopto Focus (as Creator) & iTunes U

Panopto Focus (as Creator) & iTunes U			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	10%	100%	10%
Various Output Formats and Efficient Use of Storage	10%	50%	5%
View eLectures Publically and Privately	10%	100%	10%
Automatic Lecture Downloads	5%	100%	5%
Local Lecture Storage	10%	100%	10%
Scalability	10%	100%	10%
Supports Searchable eLectures	15%	50%	8%
Adheres to Cal State ATI	20%	100%	20%
Supports Various eLecture Formats	10%	50%	5%
TOTAL	**100%**		**83%**

Table 4: Panopto Focus (as Creator) & iTunes U

Alternative 5: Panopto Focus (as Creator) & Panopto Focus (as Viewer)

Functional Requirements	Weight (%)	Rating (%)	Score
Use Personal Computer to Create and Upload eLectures	10%	100%	10%
Various Output Formats and Efficient Use of Storage	10%	100%	10%
View eLectures Publically and Privately	10%	50%	5%
Automatic Lecture Downloads	5%	0%	0%
Local Lecture Storage	10%	0%	0%
Scalability	10%	100%	10%
Supports Searchable eLectures	15%	100%	15%
Adheres to Cal State ATI	20%	100%	20%
Supports Various eLecture Formats	10%	100%	10%
TOTAL	**100%**		**80%**

Table 5: Panopto Focus (as Creator) & Panopto Focus (as Viewer)

Alternative 6: Echo360 & EchoSystem Player

Echo360 & EchoSystem Player			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	10%	100%	10%
Various Output Formats and Efficient Use of Storage	10%	100%	10%
View eLectures Publically and Privately	10%	50%	5%
Automatic Lecture Downloads	5%	0%	0%
Local Lecture Storage	10%	0%	0%
Scalability	10%	70%	7%
Supports Searchable eLectures	15%	100%	15%
Adheres to Cal State ATI	20%	100%	20%
Supports Various eLecture Formats	10%	100%	10%
TOTAL	**100%**		**77%**

Table 6: Echo360 & EchoSystem Player

Alternative 7: Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U

Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	10%	100%	10%
Various Output Formats and Efficient Use of Storage	10%	100%	10%
View eLectures Publically and Privately	10%	100%	10%
Automatic Lecture Downloads	5%	100%	5%
Local Lecture Storage	10%	100%	10%
Scalability	10%	100%	10%
Supports Searchable eLectures	15%	100%	15%
Adheres to Cal State ATI	20%	100%	20%
Supports Various eLecture Formats	10%	100%	10%
TOTAL	**100%**		**100%**

Table 7: Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U

Alternative 8: Echo360 & EchoSystem Player & iTunes U

Echo360 & EchoSystem Player & iTunes U			
Functional Requirements	**Weight (%)**	**Rating (%)**	**Score**
Use Personal Computer to Create and Upload eLectures	10%	100%	10%
Various Output Formats and Efficient Use of Storage	10%	100%	10%
View eLectures Publically and Privately	10%	100%	10%
Automatic Lecture Downloads	5%	100%	5%
Local Lecture Storage	10%	100%	10%
Scalability	10%	70%	7%
Supports Searchable eLectures	15%	100%	15%
Adheres to Cal State ATI	20%	100%	20%
Supports Various eLecture Formats	10%	100%	10%
TOTAL	**100%**		**97%**

Table 8: Echo360 & EchoSystem Player & iTunes U

System Costs

The relative costs for each individual system are very similar. Additionally, the overall cost of each individual system is fairly inexpensive in relations to the general expenditures of the University and the IT department. For this reason, an in-depth cost analysis was not conducted for the individual systems. However, a top-level cost for the systems is listed below. These costs include three years of software, licensing, maintenance, and support fees associated with using the listed system within Cal Poly's College of Engineering, and were identified either through the company's website, or through company representatives. Note: iTunes U is a free service, and does not require any additional fees for the University, and therefore it is not listed below.

Software Package	3 Year Costs ($USD)
Panopto Focus	$52500
Camtasia Relay	$26250
Echo360 & EchoSystem Player	$58220

Figure 7: 3 Year System Licensing & Support Costs

Additional costs may include: new server hardware, maintenance, and supplemental data storage devices. However, these additional costs are nearly equal amongst all of the prospective systems. Therefore, their cost implications need not be evaluated at this time A further cost analysis is included on the selected system further in the report.

Results

Selecting a Solution

Based on the Functional Requirements Matrices shown in the previous section, the system with the highest overall score should be selected. Alternative 7, which includes: Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U is the most desirable for this system, due to its score of 100% when compared to the Functional Requirements.

Professors and students will reap immediate benefits from implementing an eLecture creation and distribution system at Cal Poly. As seen below in Figure 8: Improved Learning Cycle, the streamlined introduction of eLectures into the educational arena removes much of the wasted time in traditional lecture styles, as seen in Figure 3: Traditional Learning Cycle.

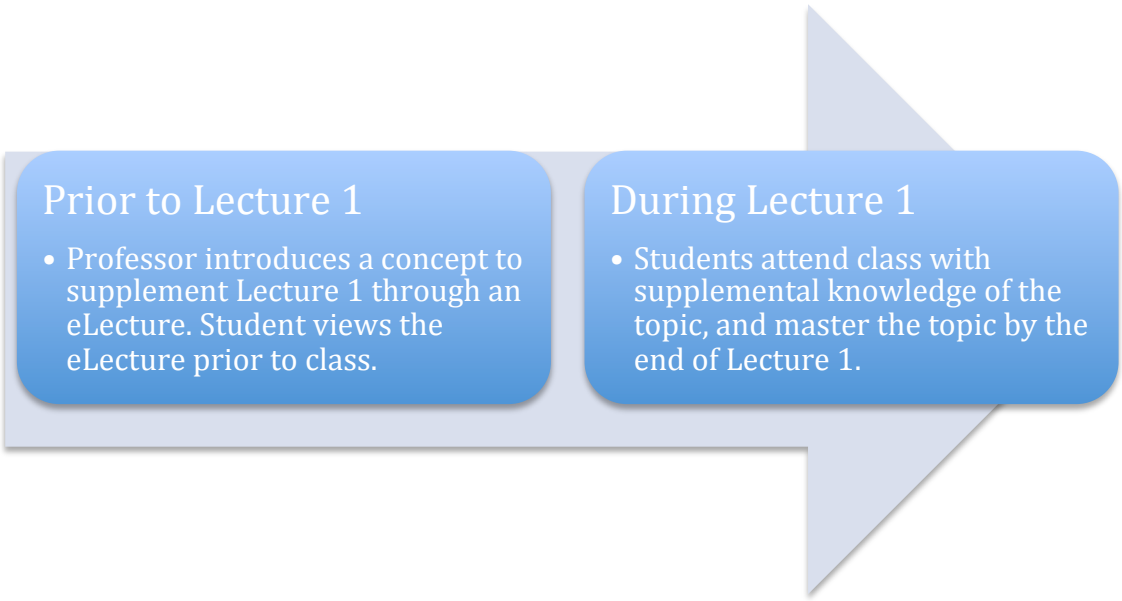


Figure 8: Improved Learning Cycle

The use of this system directly relates to many of the core Industrial Engineering concepts discussed in the Literature Review. These concepts include the removal of waste, the reduction of defects, and the standardization of workflows and tasks.

Waste is removed from the system by eliminating the need for instructors to review materials that should be understood by students prior to a lecture. For instance, a professor would not need to spend 20% of the allotted lecture time reviewing a theory that the lecture builds upon. Rather, the instructor can compile a short eLecture for the students and instruct the students to view the eLecture prior to the lecture.

By using eLectures, defects are reduced in the lectures that a professor delivers to students. In a traditional lecture, a professor may forget to touch on certain topics, fail to communicate a concept effectively, or even deliver a poor lecture due to illness or other issues. eLectures allow for lectures to be of a constant caliber and quality, which ensures students receive a top tier education. Furthermore, because eLectures are prerecorded and editable, they can constantly be improved upon over time. Thus, eLectures are the perfect tool for professor's to use Kaizen, or continuous improvement, in the classroom.

eLectures promote standardization in lecture length, style, quality, and feel. Adopting the eLecture system at Cal Poly will influence professors throughout the University to create lectures that share these features. By incorporating eLectures at the University, Cal Poly will ascertain a specific "branding" that many other top Universities have achieved.

Implementation

The system can be implemented by the Cal Poly IT Department for use throughout the College of Engineering. The system should be broken into three different subsystems to be properly analyzed. This system can, and should, be implemented with the Moodle LMS implementation in Spring 2012. To reach this goal, the University must be highly involved with the system execution.

iTunes Subsystem

In order for Cal Poly to have an iTunes U site, a minimum of 100 eLectures must be available prior to the site creation. This is a Apple's requirement, and it is enforced to ensure that Universities maintain a useful and continuously updated iTunes U site. Professors are not able to create eLectures without the use of the Panopto Focus (as Creator) software. Therefore, this subsystem is the lowest priority in terms of implementation deadline for the University.

Panopto Focus (as Creator) Subsystem

The Panopto Focus (as Creator) application must be installed on the computers of all professors that plan to use eLectures to supplement their class. The application can be installed by the individual professors, using a hyperlink provided by the I.T. department. Once the software is installed, professors can begin recording, editing, and creating eLectures. However, the software is ineffective without the use of Panopto Focus (as Viewer) server software.

Panopto Focus (as Viewer) Subsystem

The Panopto Focus (as Viewer) is a piece of software that runs on Cal Poly's servers, and ties the iTunes U subsystem with the Panopto Focus (as Creator) subsystem. Furthermore, in order for professors to effectively use Panopto Focus (as Creator), it is required that the Panopto Focus (as Viewer) software be running prior to full-scale implementation. Therefore, this system should be implemented prior to the others.

University Involvement

The University, and more specifically the IT department at Cal Poly, will play a major role in the implementation of the eLecture system. Currently, Cal Poly is experimenting with Panopto Focus as the sole eLecture creation and distribution system at the University. However, the current pilot system has not yet been selected for a campus wide implementation, and the results from this report support the use of iTunes U in addition to Panopto's software. Therefore, the individuals spearheading the eLecture pilot program at Cal Poly should review the recommendations in this report, and move forward with an eLecture system application accordingly. These individuals include:

- **Dan Mull** – Information Technology Services (Media Distribution)
- **Tonia Malone** – Information Technology Services (Collaboration Support)
- **Linda Sandy** – Information Technology Services (Information Services)

Economic Justification

The system will first be implemented within the College of Engineering at Cal Poly. iTunes U is a free system, and the University is only required to apply for with Apple. Panopto on the other hand, is not free, and bases their system costs by the number of full time enrollments that will use the system, as seen in Figure 9: Panopto Fees. The College of Engineering contains roughly 5,500 students, and 200 faculty members. For evaluation purposes, we will round the number of students to 5,000.

By Maximum Full Time Enrollment (Unlimited Recorder Installs)	1,000	2,500	5,000	10,000	15,000	20,000	30,000	40,000	40,000+
Silver Deployed - Annual Software License and Support	$10,000	$12,000	$17,500	$25,000	$32,000	$40,000	$50,000	$65,000	$1.50 / FTE
Gold Deployed - Annual Software License and Support	$12,500	$15,000	$22,000	$31,000	$40,000	$50,000	$63,000	$80,000	$1.85 / FTE
Number of Authorized Support Contacts	1	1	2	2	2	3	3	4	4

Figure 9: Panopto Fees

Assumptions must be made regarding eLecture creation costs, hardware costs, software costs, maintenance costs, and time savings. These assumptions can be seen in Appendix 3: Economic Justification . Payback calculations can be seen in this

Table 11: System Savings. The system has a payback period of .81 years or 10 months, demonstrated in Equation 1: System Payback Calculation.

The system implementation costs for the first year of use total $43,000. This includes Panopto licensing fees, new hardware costs, and costs associated with the additional time spent professors

by creating eLectures. The system costs are expected to decrease dramatically over time, as new hardware purchases are not necessary, professors will not have to recreate lectures.

The system savings assume that only half of the professors in the College of Engineering decide to use the eLecture system, and that these professors create a total of 30 eLectures each to supplement all of the classes they instruct. It is also assumed that the professors will save 30 minutes of in class lecture time from each eLecture, and that the cost of time for the professors is $35.00 per hour.

Equation 1: System Payback Calculation

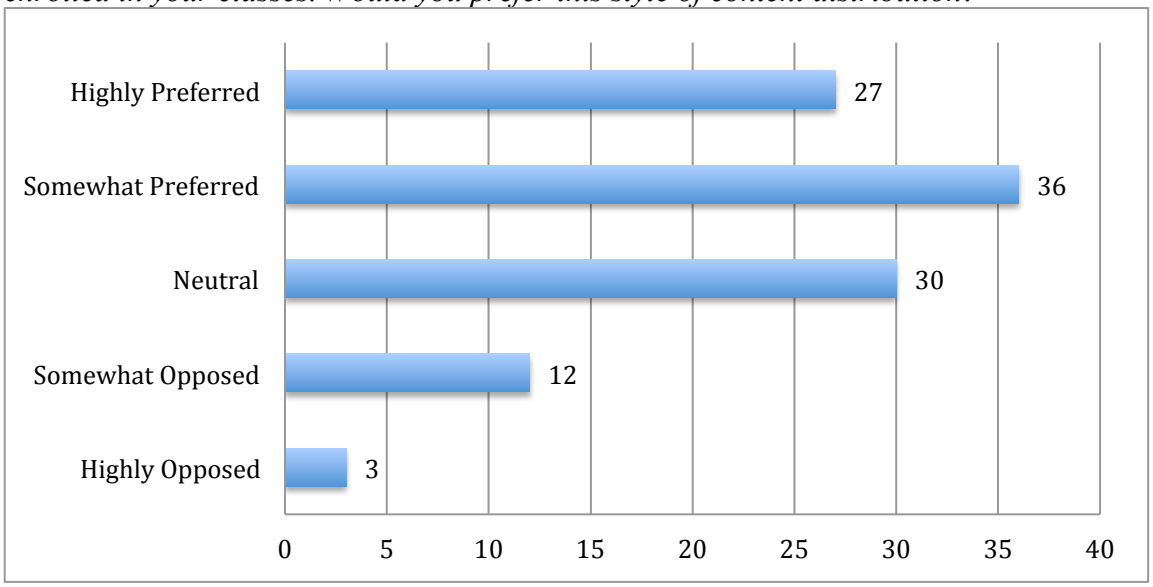
$$\frac{System\ Implementation\ Costs\ (per\ year)}{System\ Savings\ (per\ year)} = \frac{\$43{,}000}{\$52{,}500} = .819\ years \approx 10\ months$$

Conclusion

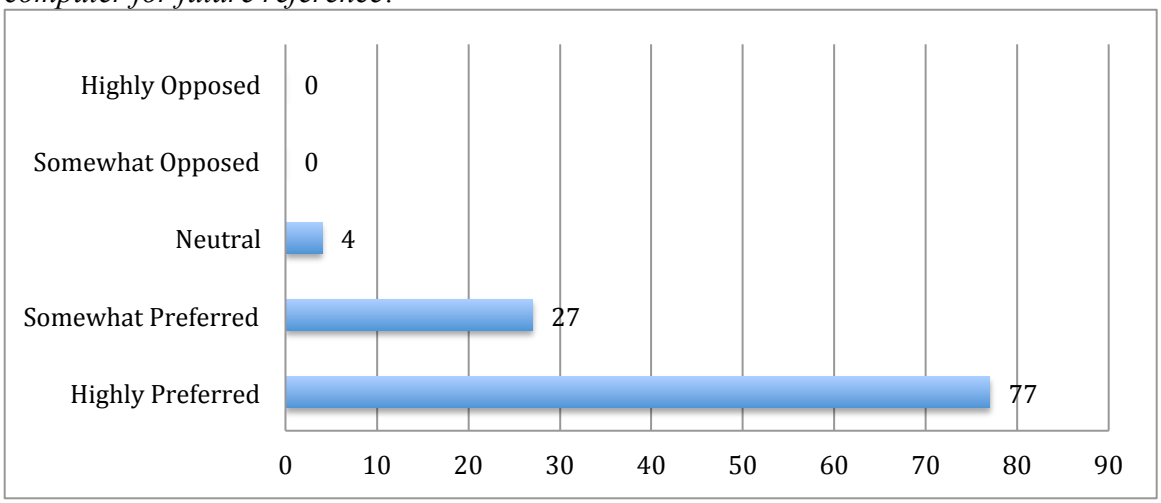
In conclusion, the use of an ideal eLecture creation and delivery system can be very beneficial to Cal Poly. This solution completely meets the requirements of all stakeholders involved with the system. By fulfilling the stakeholder's requirements, the system will quickly and effectively be adopted throughout the University. The highest ranked solution, shown in Table 7: Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U is of high quality and well supported in the report. The implementations recommended in this report are the result of careful analysis and all recommendations are supported with industry leading evaluation techniques. It is hoped that this report will guide Cal Poly in the selection of an eLecture creation and distribution system.

Appendix 1: Student Requirements Survey

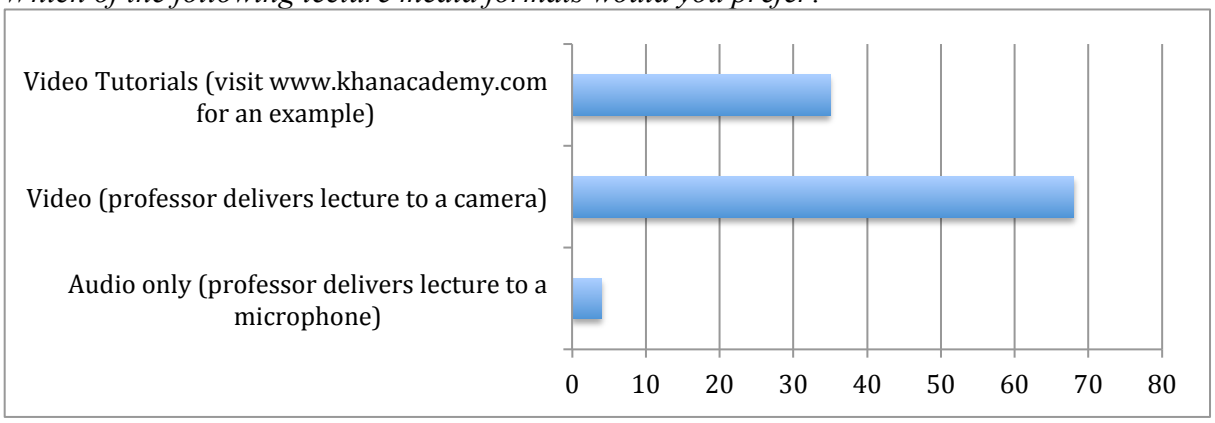
1. *Some learning management systems are open-source, meaning uploaded content is available to anyone for viewing (similar to Wikipedia or YouTube). In these instances, you can share lectures with family, friends, and colleagues even though they're not enrolled in your classes. Would you prefer this style of content distribution?*



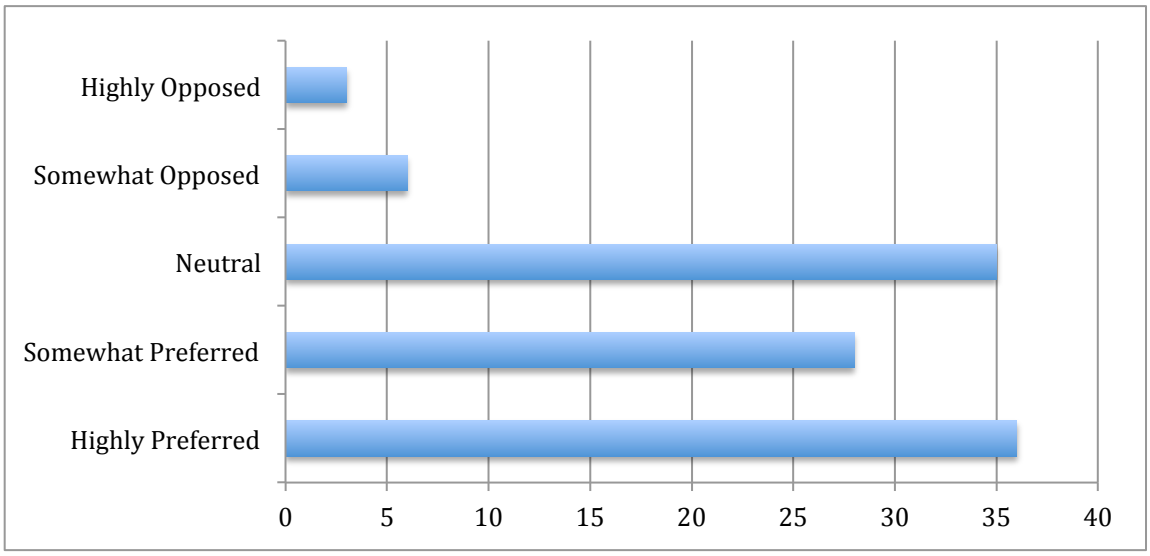
2. *Would you like the ability to download (and keep) certain class lectures on your computer for future reference?*



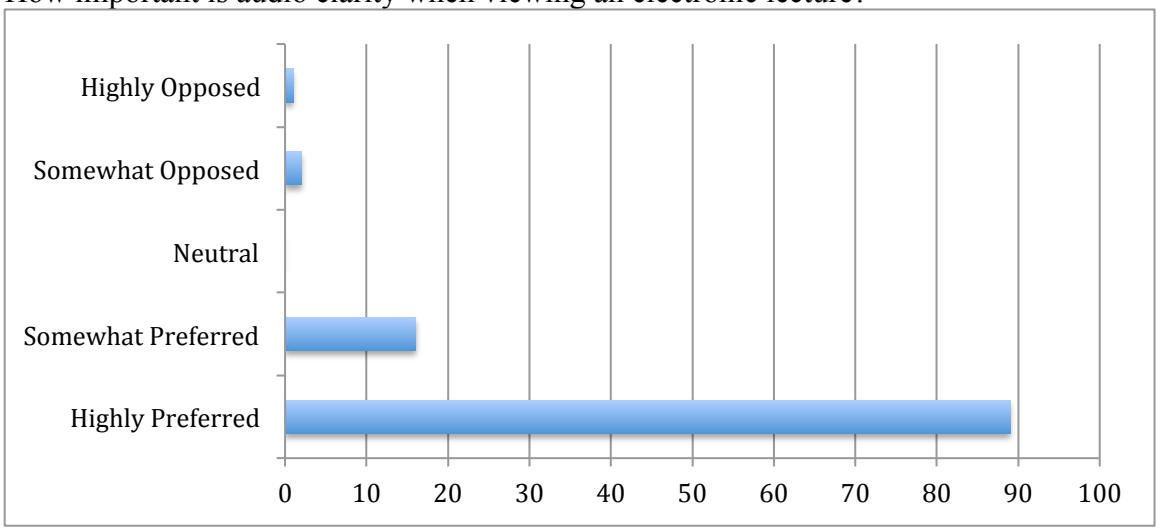
3. *Which of the following lecture media formats would you prefer?*



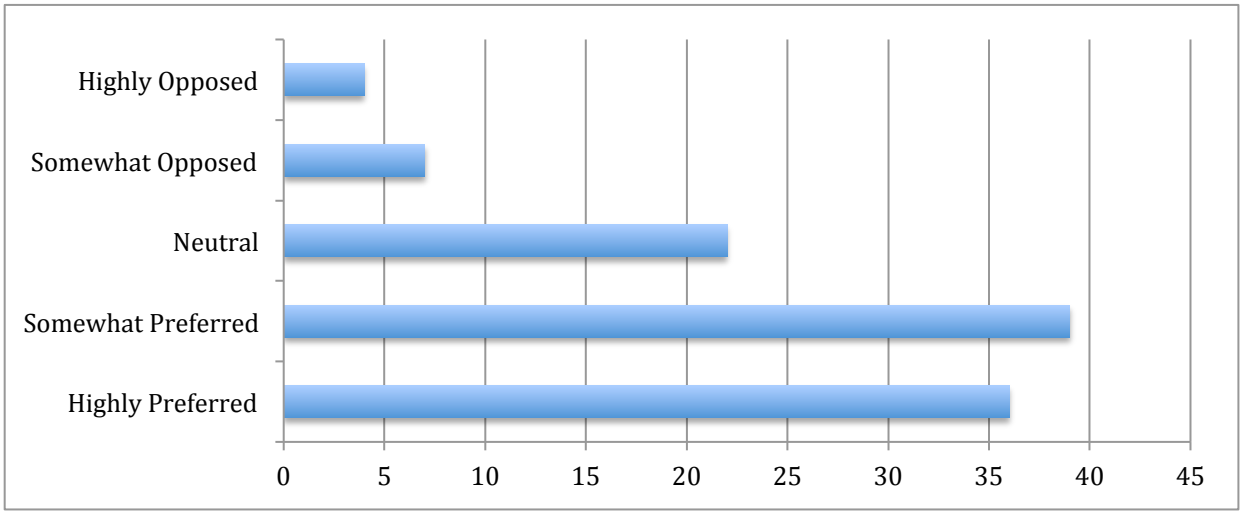
4. *Would you prefer lecture integration with mobile devices (Phones, iPods, Tablets)? Example: Ability to watch lectures on your phone while riding the bus.*



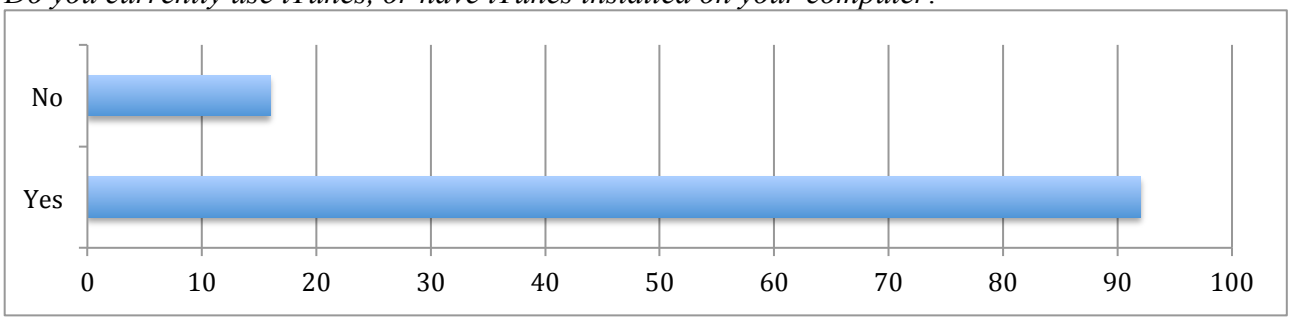
5. How important is audio clarity when viewing an electronic lecture?



6. *Does the ability to automatically "push" lectures to your device appeal to you? Example: New lectures are automatically downloaded to your phone or laptop. There's no need to check for new-posted lectures.*



7. *Do you currently use iTunes, or have iTunes installed on your computer?*



Appendix 2: Functional Requirements Matrix Justifications

Alternative 1: Do Nothing

- Use Personal Computer to Create and Upload eLectures
    - By doing nothing, professors will continue to use the fragmented eLecture system in place. They will continue to create eLectures on their personal computers, but there will not be a standard format or tool for creating these lectures. Furthermore, because of the disconnect in the system, these lectures cannot easily be uploaded to Cal Poly's servers.
    - **Rating: 50% - No standard tools specified by Cal Poly.**
- Various Output Formats and Efficient Use of Storage
    - The use of storage depends on how professors choose to create and compress their eLectures. Without a standardized system in place, professors lack a clear choice of the file format that both maximizes eLecture quality while minimizing storage space.
    - **Rating: 50% - Lack of specified output formats.**
- View Lectures Publically and Privately
    - Using the current system means lectures are shared by distributing links to students. Students are then able to share the links with whomever they choose, however, this system does not allow the general public to easily navigate lectures.
    - **Rating: 0% - Lectures cannot be browsed by the public.**
- Automatic Lecture Downloads
    - Students are not able to download lectures automatically with this system.
    - **Rating: 0% - Not easily possible with this system.**
- Local Lecture Storage
    - Depending on the eLecture distribution method that a professor chooses, students may or may not have the ability to download lectures.
    - **Rating: 0% - Not easily possible with this system.**
- Scalability
    - Cal Poly's current system is not scalable. There are no guidelines for professors at the University to follow when creating eLectures. Many professors are unaware of the tools and methods that other professors are using, because the University has not taken a stance on this issue.
    - **Rating: 10% - This system is not scalable.**
- Supports Searchable eLectures
    - Users may be able to search for terms in eLectures, but there are no guidelines for this functionality.
    - **Rating: 0% - No guidelines for this functionality.**
- Adheres to Cal State ATI
    - The current tools that a professor may use to create an eLecture to not adhere to the Cal State ATI. The Cal State ATI requires all lectures are able to include captioning if required. Captioning requires close integration between

the eLecture creator and closed captioning providers. This integration is not evident in the current system employed by Cal Poly professors.
    - **Rating: 50% - Captions may be added to eLectures, although there is no defined way to do so.**
- Supports Various eLecture Formats
    - Professors will be able to create lectures in a variety of eLecture formats, assuming they know which tools to use.
    - **Rating: 80% - This system allows for a variety of eLecture formats to be used.**

Alternative 2: Camtasia Relay & iTunes U

- Use Personal Computer to Create and Upload eLectures
    - Camtasia Relay provides software installation packages for both Mac and Windows platforms. After eLectures are recorded, the captured media is automatically sent to the server and prepared for viewing. Preset profiles are applied, and the video is instantly produced into one or more formats, and sent off to one or more destinations. The software allow for files to be saved in formats which can be distributed using iTunes U.
    - **Rating: 100%**
- Various File Output Formats and Efficient Use of Storage
    - Camtasia Relay is able to output lectures in a variety of file formats, including Flash, Silverlight, and MP4. The specific file attributes, including video and audio bitrates, compression formats, encoders, and frame rates can also be adjusted. This allows users to determine the ideal combination of settings to create the highest possible quality eLecture, while keeping file sizes at a minimum. However, because iTunes U is only compatible with the MP4 format supported by Camtasia Relay, some functionality from the eLectures may be lost.
    - Camtasia Relay also does not provide professors with the ability to edit or modify lectures. It is solely for the purpose of recording and saving items on a user's screen.
    - **Rating: 40% - Not all file output formats are possible with this system due to the compatibility needs of iTunes.**
- View Lectures Publically and Privately
    - iTunes U supports simultaneous public and private sites, allowing for eLectures to be safeguarded to those within the University, or open to the public.
    - **Rating: 100%**
- Automatic Lecture Downloads
    - iTunes U eLectures support a automatic downloads through a subscription feature. As new eLectures are made available, they will be automatically downloaded to a students computer, assuming the student has subscribed to the course eLectures.
    - **Rating: 100%**
- Local Lecture Storage

    - iTunes U allows for students to download and store eLectures to a personal computer for an indefinite amount of time.
    - **Rating: 100%**
- Scalability
    - Camtasia Relay software can be installed on each professor's computer for eLecture creation. The software can also be installed on a flash drive, allowing professors to use the software on any computer. iTunes is also required, and can be quickly installed on a user's computer.
    - **Rating: 100%**
- Supports Searchable eLectures
    - iTunes U assigns supplemental information about a media file type, known as metadata. Metadata makes browsing and searching in the iTunes Store much more efficient and helpful to the audience. Listeners can search by the information in the Artist field, search by your groupings (for private sites), or any other category.
    - **Rating: 50% - iTunes doesn't support the search for words within eLectures or PowerPoint presentations.**
- Adheres to Cal State ATI
    - Camtasia Relay and iTunes U support the use of closed-captions with eLectures. Camtasia Relay allows users to add captions directly in to their eLectures. Users can type the captioning as the audio file plays, and adjust the timing until the audio and text match accordingly. Furthermore, users can import caption files directly in to the eLecture file, and adjust the captions until they overlay perfectly with the audio. The software also gives users the ability to split the audio portion of their eLecture, and submit it to a 3rd party for captioning. This meets the requirements of the Cal State ATI.
    - **Rating: 100%**
- Supports Various eLecture Formats
    - Camtasia Relay supports the creation of audio, video, and screen captures for eLectures. Any combination of the three alternatives can be used. The eLecture must be saved in an iTunes compatible format for distribution and viewing.
    - **Rating: 50% - Saving files in an iTunes format does not allow for many features within eLectures that otherwise would be possible.**

Alternative 3: Echo360 & iTunes U

- Use Personal Computer to Create and Upload eLectures
    - EchoSystem Personal Capture provides software installation packages for both Mac and Windows platforms. eLectures can be uploaded directly to Cal Poly's servers within the Personal Capture software. EchoSystem Personal Capture can also save files in formats which can be distributed using iTunes U.
    - **Rating: 100%**
- Various File Output Formats and Efficient Use of Storage
    - EchoSystem Personal Capture supports a variety of file output formats, including those compatible with iTunes U.

    - **Rating: 50% - Not all file output formats are possible with this system due to the compatibility needs of iTunes.**
- View Lectures Publically and Privately
    - iTunes U supports simultaneous public and private sites, allowing for eLectures to be safeguarded to those within the University, or open to the public.
    - **Rating: 100%**
- Automatic Lecture Downloads
    - iTunes U eLectures support a automatic downloads through a subscription feature. As new eLectures are made available, they will be automatically downloaded to a students computer, assuming the student has subscribed to the course eLectures.
    - **Rating: 100%**
- Local Lecture Storage
    - iTunes U allows for students to download and store eLectures to a personal computer for an indefinite amount of time.
    - **Rating: 100%**
- Scalability
    - Echo360 Personal Capture works on individual computers for eLecture creation, however, Echo360 Company prefers an ecosystem approach with their products, referred to as EchoSystem. The company believes the Personal Capture software plays a small part in the scheme of creating eLectures, and contribute most of their efforts to other solutions.
    - **Rating: 70% - Echo360 does not prefer solely use of their Personal Capture software as an eLecture creator solution.**
- Supports Searchable eLectures
    - iTunes U assigns supplemental information about a media file type, known as metadata. Metadata makes browsing and searching in the iTunes Store much more efficient and helpful to the audience. Listeners can search by the information in the Artist field, search by your groupings (for private sites), or any other category.
    - **Rating: 50% - iTunes doesn't support the search for words within eLectures or PowerPoint presentations.**
- Adheres to Cal State ATI
    - eLectures created with Echo360 Personal Capture can be edited to include captions, which complies to the Cal State ATI. iTunes U also support the use of closed-captions with eLectures.
    - **Rating: 100%**
- Supports Various eLecture Formats
    - EchoSystem Personal Capture records video, audio, and PowerPoint media. The eLecture can then be saved in an iTunes compatible format for distribution and viewing
    - **Rating: 50% - Saving files in an iTunes format does not allow for many features within eLectures that otherwise would be possible**

Alternative 4: Panopto Focus (as Creator) & iTunes U

- Use Personal Computer to Create and Upload eLectures
    - Panopto Focus is a software package that works on both Mac and PC computers, and allows for eLectures to be uploaded to Cal Poly servers.
    - **Rating: 100%**
- Various Output Formats and Efficient Use of Storage
    - Panopto Focus supports eLecture output formats that are compatible with iTunes U. The eLectures can be encoded using advanced techniques which allow for an ideal eLecture file size to eLecture file quality ratio.
    - **Rating: 50% - Not all file output formats are possible with this system due to the compatible needs of iTunes.**
- View Lectures Publically and Privately
    - iTunes U supports simultaneous public and private sites, allowing for eLectures to be safeguarded to those within the University, or open to the public.
    - **Rating: 100%**
- Automatic Lecture Downloads
    - iTunes U supports automatic downloads through a subscription feature. As new eLectures are made available, they will be automatically downloaded to a students computer, assuming the student has subscribed to the course eLectures.
    - **Rating: 100%**
- Local Lecture Storage
    - iTunes U allows for students to download and store eLectures to a personal computer for an indefinite amount of time.
    - **Rating: 100%**
- Scalability
    - Panopto Focus and iTunes can easily be installed on any computer.
    - **Rating: 100%**
- Supports Searchable eLectures
    - iTunes U assigns supplemental information about a media file type, known as metadata. Metadata makes browsing and searching in the iTunes Store much more efficient and helpful to the audience. Listeners can search by the information in the Artist field, search by your groupings (for private sites), or any other category.
    - **Rating: 50% - iTunes doesn't support the search for words within eLectures or PowerPoint presentations.**
- Adheres to Cal State ATI
    - eLectures created with Panapto Focus can be edited to include captions, which complies to the Cal State ATI. iTunes U also support the use of closed-captions with eLectures.
    - **Rating: 100%**
- Supports Various eLecture Formats
    - Panopto Focus records video, audio, and PowerPoint media. The eLecture files must then be saved in an iTunes compatible format for distribution and viewing.

- **Rating: 50% - Saving files in an iTunes format does not allow for many features within eLectures that otherwise would be possible**

Alternative 5: Panopto Focus (as Creator) & Panopto Focus (as Viewer)

- Use Personal Computer to Create and Upload eLectures
  - Panopto Focus is a software package that works on both Mac and PC computers, and allows for eLectures to be uploaded to Cal Poly servers.
  - **Rating: 100%**
- Various Output Formats and Efficient Use of Storage
  - Panopto Focus supports a variety of eLecture output formats. However, when using Panopto Focus (Viewer), eLectures must be saved in Microsoft Silverlight for compatibility with the eLecture viewer.
  - **Rating: 100%**
- View Lectures Publically and Privately
  - Lectures can be viewed publically and privately, depending on how they are hosted on Cal Poly's servers. However, the public audience is not as large using Panopto Focus (Viewer), because the public isn't able to easily access Cal Poly's eLectures through a central distribution channel.
  - **Rating: 50% - While the eLectures are public, they are not easily accessible to the world.**
- Automatic Lecture Downloads
  - Panopto Focus (Viewer) does not support automatic lecture downloads.
  - **Rating: 0%**
- Local Lecture Storage
  - Panopto Focus (Viewer) does not allow for eLectures to be downloaded to a student's computer.
  - **Rating: 0%**
- Scalability
  - Panopto Focus can easily be installed on any computer.
  - **Rating: 100%**
- Supports Searchable eLectures
  - Panopto Focus (Viewer) provides the option for users to search for terms used within the video portion of an eLecture, as well as terms used in the text portion of a PowerPoint.
  - **Rating: 100%**
- Adheres to Cal State ATI
  - eLectures created with Panapto Focus can be edited to include captions, which complies to the Cal State ATI. Panopto Focus (Viewer) also supports captions.
  - **Rating: 100%**
- Supports Various eLecture Formats
  - Panapto Focus records video, audio, and PowerPoint media. The eLectures can then be saved in a a Microsoft Silverlight file for consumption. This file

format supports additional features that are not available in traditional file formats.
    - **Rating: 100%**

Alternative 6: Echo360 & EchoSystem Player

- Use Personal Computer to Create and Upload eLectures
    - EchoSystem Personal Capture provides software installation packages for both Mac and Windows platforms. eLectures can be uploaded directly to Cal Poly's servers within the Personal Capture software. eLectures can then be uploaded to Cal Poly's servers.
    - **Rating: 100%**
- Various File Output Formats and Efficient Use of Storage
    - EchoSystem Personal Capture supports a variety of file output formats.
    - **Rating: 100%**
- View Lectures Publically and Privately
    - EchoSystem Player is based on Adobe Flash technology, which is commonly used in computers around the world. However, the public audience is not as large using EchoSystem Player, because the public isn't able to easily access Cal Poly's eLectures through a central distribution channel.
    - **Rating: 50% - While the eLectures are public, they are not easily accessible to the world.**
- Automatic Lecture Downloads
    - EchoSystem Player does not allow for lectures to be automatically downloaded by user computers. Users are notified of new lecture postings, and are required to visit the link to download new eLectures.
    - **Rating: 0%**
- Local Lecture Storage
    - EchoSystem Player does not allow for lectures to be downloaded and stored on a student's personal computer.
    - **Rating: 0%**
- Scalability
    - Echo360 Personal Capture works on individual computers for eLecture creation. EchoSystem Player does not require end users to install any additional software to view eLectures. By using Adobe Flash technology, students on Windows, Mac and Linux platforms can replay lectures on any browser without client software downloads.
    - **Rating: 70% - Echo360 does not prefer solely use of their Personal Capture software as an eLecture creator solution.**
- Supports Searchable eLectures
    - EchoSystem Player allows for users to search keywords, and captions within eLectures.
    - **Rating: 100%**
- Adheres to Cal State ATI
    - eLectures created with Echo360 Personal Capture can be edited to include captions, which complies to the Cal State ATI. The EchoSystem Player also supports captioning in eLectures.

    - **Rating: 100%**
- Supports Various eLecture Formats
    - EchoSystem Personal Capture records video, audio, and PowerPoint media. The eLecture must then be saved in an Adobe Flash format for compatibility with EchoSytem Player.
    - **Rating: 100%**

Alternative 7: Panopto Focus (as Creator) & Panopto Focus (as Viewer) & iTunes U

- Use Personal Computer to Create and Upload eLectures
    - Panopto Focus is a software package that works on both Mac and PC computers, and allows for eLectures to be uploaded to Cal Poly servers.
    - **Rating: 100%**
- Various Output Formats and Efficient Use of Storage
    - Panopto Focus supports a variety of eLecture output formats that are compatible with iTunes U, as well as Panopto Focus (Viewer).
    - **Rating: 100%**
- View Lectures Publically and Privately
    - Lectures can be viewed publically and privately using the combination of iTunes U and Panopto Focus (Viewer). iTunes U supports simultaneous public and private sites, allowing for eLectures to be safeguarded to those within the University, or open to the public. Furthermore, lectures can be viewed using Panopto Focus (Viewer), directly through the learning management system.
    - **Rating: 100%**
- Automatic Lecture Downloads
    - iTunes U supports automatic downloads through a subscription feature. As new eLectures are made available, they will be automatically downloaded to a students computer, assuming the student has subscribed to the course eLectures.
    - **Rating: 100%**
- Local Lecture Storage
    - iTunes U allows for students to download and store eLectures to a personal computer for an indefinite amount of time.
    - **Rating: 100%**
- Scalability
    - Panopto Focus can easily be installed on any computer for eLecture creation. Furthermore, eLectures can be viewed using iTunes, or using Panopto Focus (Viewer) and a web browser.
    - **Rating: 100%**
- Supports Searchable eLectures
    - Panopto Focus (Viewer) provides the option for users to search for terms used within the video portion of an eLecture, as well as terms used in the text portion of a PowerPoint. In addition, iTunes U assigns supplemental information about a media file type, known as metadata. Metadata makes browsing and searching in the iTunes Store much more efficient and helpful to

the audience. Listeners can search by the information in the Artist field, search by your groupings (for private sites), or any other category.
    - **Rating: 100%**
- Adheres to Cal State ATI
    - eLectures created with Panapto Focus can be edited to include captions, which complies to the Cal State ATI. Panopto Focus (Viewer) also supports captions. iTunes U also support the use of closed-captions with eLectures.
    - **Rating: 100%**
- Supports Various eLecture Formats
    - Panapto Focus records video, audio, and PowerPoint media. The eLectures must then be saved in a variety of formats, including Microsoft Silverlight file for consumption using Panopto Focus (Viewer), as well as iTunes U compatible formats. Scalability
    - **Rating: 100%**

Echo360 & EchoSystem Player & iTunes U

- Use Personal Computer to Create and Upload eLectures
    - EchoSystem Personal Capture provides software installation packages for both Mac and Windows platforms. eLectures can be uploaded directly to Cal Poly's servers within the Personal Capture software. eLectures can then be uploaded to Cal Poly's servers.
    - **Rating: 100%**
- Various File Output Formats and Efficient Use of Storage
    - EchoSystem Personal Capture supports a variety of file output formats.
    - **Rating: 100%**
- View Lectures Publically and Privately
    - EchoSystem Player and iTunes can be paired to create a vast public and private lecture distribution system.
    - **Rating: 100%**
- Automatic Lecture Downloads
    - iTunes allows for lectures the automatic downloading of eLectures.
    - **Rating: 100%**
- Local Lecture Storage
    - iTunes allows for lectures to be stored indefinitely on a users computer.
    - **Rating: 100%**
- Scalability
    - Echo360 Personal Capture works on individual computers for eLecture creation, however, Echo360 Company prefers an ecosystem approach with their products, referred to as EchoSystem. The company believes the Personal Capture software plays a small part in the scheme of creating eLectures, and contribute most of their efforts to other solutions.
    - **Rating: 70% - Echo360 does not prefer solely use of their Personal Capture software as an eLecture creator solution.**
- Supports Searchable eLectures
    - EchoSystem Player allows for users to search keywords, and captions within eLectures.

    - **Rating: 100%**
- Adheres to Cal State ATI
    - eLectures created with Echo360 Personal Capture can be edited to include captions, which complies to the Cal State ATI. The EchoSystem Player also supports captioning in eLectures.
    - **Rating: 100%**
- Supports Various eLecture Formats
    - EchoSystem Personal Capture records video, audio, and PowerPoint media. The eLecture must then be saved in an Adobe Flash format for compatibility with EchoSytem Player.
    - **Rating: 100%**

Appendix 3: Economic Justification

eLecture Creation Costs and Savings

- Only 50% of the professors within the College of Engineering decide to use the eLecture system, which equates to 100 professors.
- Professors spend an average of 1 hour creating an individual eLecture, however, this time is irrelevant because it is assumed this time is spent regardless in the preparation of lesson plans and lectures.
- One eLecture is equivalent to 30 minutes of saved in-class lecture time.
- Professors create an average of 30 eLectures each.
- To use the Panopto and iTunes U system, a professor must spend 5 hours installing and learning the system.
- A professor's time is valued at $35.00 per hour.

Hardware, Software Costs

- The University requires two new data servers to host the data associated with the new system. These servers cost $4,000 each, with an upkeep cost of $400 per year.
- The College of Engineering requires Panopto's Silver Deployed Annual Software, at a cost of $17,500 per year.

- There are no additional bandwidth fees, as the University already hosts a multitude of material.

- There are no additional personnel fees in the I.T. Department. The system is meant to be sustainable, and will not require additional staff for support. The system is user driven, and supported by the faculty and students.

Payback Calculations

Hardware + Software Costs	
Panopto Software	17500
Additional Servers	8000
Total Hardware + Software Costs	25500

Table 9: Hardware + Software Costs

Professor Instruction Costs	
Number of Professors Using System	100
Time Spent Learning System (hours)	5
Cost of Time ($USD per hour)	35
Total Professor Instruction Costs	17500

Table 10: Professor Instruction Costs

Savings	
Number of Professors Using System	100
eLectures Created (each)	30
Savings per eLecture (hours)	0.5
Cost of Time ($USD)	35
Total Savings	**52500**

Table 11: System Savings

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