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Using Multiple Methods to Promote Technological Literacy

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Abstract

Since the beginning of time, humans have utilized technologies to create tools in order to make their lives safer, easier, and somewhat better. The early tools were extremely crude and simple, but they served their purpose and worked. Over time, the sophistication of these tools slowly but gradually increased leading eventually to our modern devices. It could be characterized as an incremental development process that included many challenges and misfortunes with frequent failures and limited success. Regrettably, most of these ancient tools and technologies were lost over time simply decomposing back into dust. Technological change has accelerated rapidly to a point where what is new today is obsolete tomorrow. No longer are products repaired for future use as they were for centuries, they are simply thrown away and replaced with new models with more features. This is especially true for technological artifacts from the past hundred or so years. The artifacts remaining were often left in attics, basements, sheds, closets, and other overlooked spaces. They were hidden from sight, simply forgotten gathering dust, eventually discarded, and ended up in a dump or landfill. Twelve years ago a project was initiated to find, reclaim, and rescue as many of these historical artifacts as possible. This project also included reproducing ancient artifacts using the same tools and methods originally utilized. These collections were then employed in the classroom in a variety of ways to promote technological literacy. Due to expansion of the Engineering Technology and Engineering Programs, an unknown collection of antique electrical items and equipment was discovered. These relics were from the 1900s ranging from radios demonstration units to a variety of other types of test equipment. After their discovery, they were nearly discarded but where salvaged for historical reasons. The problem then became what to do with them. The solution was to display them in a public place for people to examine much as a museum does. To that end, a plan was initiated to locate unused or underutilized display cases on campus that could be filled with old technological artifacts. These display cases would give today's students a realistic look at antique technologies in a way that is superior to pictures and textual descriptions. The objective was to enhance the student's understanding of the history of past technologies and how they are related to today's technologies. This paper reviews the continuing efforts to promote technological literacy by using a wide variety of approaches ranging from the old to new. It discusses how an old method using display cases can become an effective technique and looks into the future to other means that could be used to promote technological literacy.

Introduction

This story begins in 1999 when engineers and technologists were concentrating their efforts on averting catastrophic failures on January 1, 2000. This event was widely referred to as "Y2K." Computers in the 1900s typically used just two numbers to represent the year due to the limited amount and high cost of memory. The dilemma became, when the new century begins would the software consider the year to be 1900 or 2000. As a result, scientists, engineers, programmers, and technicians gave significant attention to the problem. Newspapers, radio, and television were constantly reporting on the possible consequences and scenarios that might occur. Therefore, technology became the main focus of our attention.

At that point, it was realized that the University did not offer a single course that concentrated on technologies impact on society. This void created an opportunity for the introduction of a new course that studied and promoted technological literacy. However, "teaching about technology and engineering is a challenge, given the impressive speed of technological development. If the goal is to educate for the future instead of the present or past, rapid changes in the technological domain make this work challenging" (de Vries, Hacker, & Burghard[3], 2010).

In response, a new interdisciplinary course that also satisfied the University's International Studies graduation requirement was developed in 2000 to expose students to technologies from the past and fill this void. This junior level course, "TECH393: Technology in World Civilization" (Loendorf[9], 2004) traces the interconnected events and cultures in which technology developed. It investigates how technologies are inter-related and how cultural factors affect the acceptance or rejection of technology. The intent of the course was to enhance the student's understanding of how technologies developed and why.

The social, political, economic and cultural impacts of technologies (Loendorf[10], 2010) are also explored to determine their positive and negative effects. It was designed to broaden the student's perspective of past technologies and how they were discovered and used. In this context the two biggest technology drivers of agriculture and war are studied in detail. Throughout the course, numerous technologies are scrutinized and examined in terms of their cost versus benefit to society. The main objectives of the course were to: (a) promote awareness of technological development, and (b) provide a rudimentary understanding of the social, political, economic, and cultural impact.

The course content explores innovations and inventions associated with ancient as well as retro technologies in the fields of agriculture, weapons, time measurement, industrialization, transportation, communication, and the environment (Loendorf & Geyer[14], 2009). These encompass every aspect of engineering and engineering technology including mechanical, electrical, industrial, civil, and environmental. By understanding the development, use, impact, and consequences of past technologies, students are better equipped to tackle the challenging problems the future will bring.

Typically, two or three books are used for reading assignments and discussion purposes. They are periodically changed as new or updated texts become available. Excellent example books are available from Alcorn[1] (2003), Hjorth, Eichler, Khan, and Morello[5] (2003), Johnson, Gostelow, and King[8] (2000), Pacey[21] (2001), Stross[24] (1989), Teich[25] (2003), Voland[26] (1999), and Volti[27] (2014). However, the texts by Volti[27] (2014) and Pacey[21] (2001) are most frequently used.

Initially, the course was lecture and discussion based with a few videos included for variety. This format proved successful and the popularity of the course grew. Soon students from all disciplines across campus started enrolling in the course and it became apparent that the scope and method of delivery had to be enhanced to suit this diverse audience. The focus of the course would stay the same with a new added emphasis on teaching methods.

Implementation

One of the most difficult aspects of teaching is presenting material in a fresh and appealing way. This is especially true for technical subjects. Now imagine an even more difficult hurdle, a course covering past technologies ranging from the ancient to the recently outdated. A historical perspective is offered featuring technologies that have greatly influenced and effected civilizations and societies since the beginning of time. In 2008, a project was initiated to enhance the practical connections or hands-on aspects of past technologies by adding some active learning components to these technical literacy lessons (Loendorf & Geyer[13], 2008).

A way was also needed to involve the students in a more dynamic, hands-on, and participative manner. The solution was to physically bring the technology to the students for them to touch, feel, and use in an active learning environment. The project began by focusing on recreating the basic tools from the Stone Age. Examples of these recreated artifacts built using the basic tools are shown in Figure 1 below. These items including arrowheads, axe, and scraper were discussed and then passed around the classroom for the students to touch and comment on.

Figure 1. Stone Age tools.

The shift toward active learning in the classroom was implemented in several phases. Each of the phases required considerable preparation time by the professors for obtaining the raw materials and other resources required for recreating and collecting the artifacts. The impact on limited class time for hands-on activities versus lectures was also evaluated for each phase along with the potential risk that students would not participate or learn sufficient content from the next phase. This phased implementation approach allowed for assessment and examination of each phase independently prior to committing resources for enacting the next phase.

The first step was the modification of traditional lectures to include brief demonstrations of ancient technologies. This was coupled with an in-depth discussion of the technologies utilized. Students were shown exactly how ancient tools were created, sometimes by incorporating other ancient tools, along with how they were used. All of the materials used were described as well as how they were obtained or where they were found. Why one type of stone or wood was selected over another is also explained in detail.

The second phase included controlled exercises requiring student involvement and participation. Great caution had to be exercised at this point to assure student safety since most ancient tools, artifacts, and other items were extremely sharp and dangerous. All of the objects that would be handled by the students were deliberately dulled by rounding or blunting for their protection. Further instructions outlined additional precautions for handling the items. Then a hands-on intervention allowed each student to touch, handle, and feel how the implement functioned while performing its task. The actual use of the object was emphasized in class. This included how the tool fit into your hand along with how it felt like a natural extension of your body. In many ways, these tools actually felt like they were ready to work. Students need to be exposed to, and made aware of, how a technology works before they can move on to actually recreating them.

The third phase, which was just recently implemented (Loendorf, Geyer, & Richter[16], 2013) involves the actual student recreation of ancient and other historical artifacts. In order to make it practical scale models of ancient technologies were created. This process could then be expanded to replicate technologies that are of a more recent nature over time. The challenge is how to fit these projects into a lecture based course. Without a laboratory segment for the course, each of these projects had to be completed outside of class without the professor's supervision.

To help with the classroom delivery of these newly created and collected technological items, a number of old audio-visual (AV) carts were acquired from the University's Surplus Equipment Facility, cleaned, and decorated. The term "Educational Delivery Vehicle" or "EDV" (Loendorf & Geyer[14], 2009) was devised to help convey the purpose of the AV carts. Since classrooms are scheduled centrally, a means to transport the artifacts to various classrooms was needed; no instructor is assigned a permanent classroom.

The EDV containing the Stone Age tools (shown in Figure 2) was painted in a camouflage pattern to distinguish it. Additional collections of technologies followed including the EDV containing the Pioneer Days technology (shown in Figure 3) had two weathered wooden posts attached to the cart and barbed wire attached to those posts, along with a turn of the century (1900s) meat grinder (Loendorf & Geyer[15], 2010). The EDV also serves as an excellent display platform for the lectures and exhibitions. In fact, the height of the old AV carts is ideal for use in the front of the classroom allowing even the students sitting in the back of the room to observe everything that is occurring.

Figure 2. Educational Delivery Vehicle 1 (EDV 1).

Figure 3. Educational Delivery Vehicle 2 (EDV 2).

Artifacts that are more modern are found in relative abundance. A collection of plastic based technology was a relatively low cost endeavor. By searching through local second-hand stores the process of building a collection of Plastic's technology (shown in Figure 4) proceeded (Loendorf & Geyer[15], 2010). As the collection grew, the focus shifted to two areas; items that could be found in the food isles of grocery stores and items that were non-food related.

Figure 4. Plastic's Technology (EDV 5).

Over the years innovative visual content (Loendorf[11], 2011) was continually added to the lectures. The method used to develop these lectures was based on tracing the historical impact of a technology from its humble roots all the way through to its modern day counterpart. It becomes a journey that the particular technology made over time, perhaps hundreds of years. During this journey many changes, improvements, and enhancements were made. In many cases, the modern version of the technology displays very little resemblance to the original technology.

The session begins with a brief introduction to technological literacy and its importance in our modern society. The focus then shifts to a particular technology previously selected for the occasion. The technology is presented in chronological order starting with its initial design and form and progresses up to the current version. Each step of the transformation process is displayed visually, either in pictures or as artifacts, and clearly described.

Stories that describe the historical aspects of technology are embedded directly into every lecture in order to gain and keep the students attention and boost their interest (Loendorf[12], 2012). The sources of these stories are quite varied ranging from historical texts and personal experiences. Some of the stories are well scripted while others are not. But it is the verbal presentation of these stories that really makes an impact upon the students. That cannot, in most cases, be duplicated by the written word alone.

A wide variety of historical artifacts have been recreated for this course as demonstration exhibits. They were reconstructed using the same materials, tools, and techniques that were originally utilized centuries ago. However, typically these objects were small, no bigger than a foot or so. The challenges that would be encountered to recreate the much larger artifacts, due to their size, were almost insurmountable. Nevertheless, that did not detract from their importance. In order to rectify this situation, a project was started over three years ago to build scale models of these very large relics for demonstrations (Loendorf, Geyer, & Richter[16], 2013). Now they are part of the many collections of ancient artifacts routinely utilized in the classroom.

A series of scale models were initially built to test the feasibility of the project. The methods and materials utilized to construct these examples were similar in every way to the original items used. Even the same types of ancient tools, though recreated as well, were utilized. A few examples of these scale models were an ancient battering ram (shown in Figure 5) as it attempts to breach the walls of a castle, a mobile battering ram with a shield that can protect the soldiers to some extent, an Egyptian Chariot, and a working scale model of a trebuchet. Each of these scale models represents the beginning of the learning process during which every attempt was made to accurately replicate in size and function the original ancient machine. Much of what was accomplished can be attributed to the trial and error method of discovery. In fact, this aspect accurately depicts how they were originally built centuries ago and is perhaps the most interesting aspect of the scale model reconstruction phase.

Figure 5. Scale Model of an Ancient Battering Ram.

Over the years, the number of collections has increased with new ones being added almost every year. These collections range from recreated ancient artifacts (i.e., armor technology), antique items (i.e., Pioneer technology), and scale models, to cell phones, computers, plastics, and a wide assortment of other items. As a consequence the number of EDVs has also grown to 12 causing a storage problem for them as well. However, that is a good outcome.

As the project continues, it is likely that new collections of historical technologies will emerge and be collected. The project has grown in popularity and taken on a life of its own. Word of the project promoting technological literacy has spread and many people have come forward volunteering to donate items for the collections. Since there no money is allocated to purchase historical technologies that still exist; the challenge was finding them at a reasonable cost. In many cases, the faculty that taught the course simply bought them and donated them to the project. It is certain that many of the contributed items will lead to additional collections that expand further the ability to display, explain, and expose students to technologies from the past.

Theoretical or Conceptual Support

Theodore J. Gordon of the Rand Corporation stated "As scientific research progresses we gain greater control over our environment. Yet the power of these tools which give us this control, in the hands of an unprepared or indifferent people, faced with social pressures of unprecedented magnitude, may result not in greater control but self-extinction" (David & Truxal[2], 1967). This statement, made over 40 years ago is still relevant today. To understand and function effectively in the future, people must first understand the past and its technologies.

This reawakening and understanding of past technologies is directly related to enhancing the student's technological literacy level. "Technological literacy can be thought of a comprising three interrelated dimensions that help describe the characteristics of a technologically literate person... (1) knowledge; (2) ways of thinking and acting; and (3) capabilities" (National Academy of Engineering[20], 2008). "Technological literacy is the ability to use, manage, assess, and understand technology" (International Technology Educational Association[6], 2007). All of these definitions point to the knowledge and understanding of technologies.

"Common elements of technological literacy include knowledge about individual technologies, the process of technology development, the historical and cultural aspects of technology, and adaptability based on creative thinking" (Loendorf & Geyer[14], 2009). Four competencies are required: "(a) accommodate and cope with rapid and continuous technological change, (b) generate creative and innovative solutions for technological problems, (c) act through technological knowledge both effectively and efficiently, and (d) assess technology and its involvement with the human life world judiciously" (Wonacott[29], 2001).

Technological literacy education enables students to understand, utilize, and manage technology. Teich[25] (2000) related how knowing the development of technology, its impact on society, and the environment builds a foundation from which future decisions can be made. These concepts, systems, processes, and procedures can then be applied to challenging new problems that today are not even being considered. Israel[7] (1995) stated that "a student who has completed a technology education program should be able to participate as an active citizen by expressing their positions on technological issues, making wise consumer choices such as selecting, using, and disposing of technical artifacts, and making informed career choices." Technological literacy, according to Wiens[28] (1995), "is essential to the political and economic empowerment of the citizen."

An important aspect of technological literacy is not only to understand its consequences to some extent, but to also visualize the technologies. That is where the displaying of artifacts comes in. "Since their inception, museums have been important, albeit too often elite, sites for the ordering and reordering of knowledge through the display of an array of things, be they cultural artifacts or natural specimens (Foucault[4], 1994). "Museums, galleries, and the objects within them both shape and represent knowledge. As study collections, they form the basis of research that transforms the material into the intellectual; as spaces of display, they interpret the intellectual through the material" (Petrov[22], 2012).

"Since early modern collectors began arranging their collections for the purpose of being seen by visitors, an interest in display was apparent" MacGregor[17], 2007). "Designed to present collections and tell stories about the significance of the objects contained within them, museum exhibitions are typically seen as providing opportunities to see 'treasures' from times long gone, or as useful educational aids for informing the public" (Moser[19], 2010). "Archaeologists have begun to address how exhibitions define past societies, demonstrating that museum displays have a significant role in the formation of disciplinary knowledge" (Scott[23], 2007). "As active agents in the production of knowledge, museum displays are increasingly being recognized as documents of significance to the history of scholarly disciplines and the evolution of ideas" (Moser[19], 2010).

The use of this old method of exhibiting ancient items and at the same time protecting them from harm has effectively transferred knowledge. It also allows large numbers of people to view and read about relics from the distant to recent past. With these concepts in mind, display cases were used to exhibit a recently discovered collection of electrical artifacts.

Historical Background

Since the Technology in World Civilization course was first introduced in the 1999 – 2000 academic year, the Engineering & Design Department has experienced significant growth and a couple of name changes. The growth was so dramatic that the Department quickly out grew its current facility. In order to meet the increased student demand, additional classrooms and laboratories were located in the nearby Science Building.

A new facility for the Department along with Computer Science (the Computing and Engineering Building or CEB) was completed in time for use during the Fall Quarter of 2005. The facility (93,000 gross square feet and 60,000 assignable square feet) included 15 classrooms (three of which are wired for distance education) and 21 laboratories, more than doubling the usable space previously available for students in high-technology disciplines.

The Department continued to grow as the new facility was being constructed. By the time it was completed, it was already too small. As a result, more space was required and funds were secured to remodel and repurpose the old building. In 2006, Cheney Hall (the E&D

Department's old home) was completely renovated (with 30,000 assignable square feet) to include five additional laboratories and eight enhanced classrooms.

During the move from the Science Building Laboratories into the new building and the refurbished old building, cabinets full of boxes were discovered in an unused storage room. They were covered with dust, forgotten, and had not been opened for years or perhaps even decades. Initially all of these items were simply moved and placed in another storage area to be dealt with at some later time.

However, curiosity drove the author to open them. Inside was a treasure trove of antique artifacts dating back many decades. Almost all of them were connected to engineering with the majority associated with electrical engineering. It became an important discovery that was simply too historically significant and interesting to leave in boxes. There had to be some way to display them so they could be shared with today's students, faculty, and visitors.

Displaying Historical Artifacts

The solution was found in the remodeled building on the first floor where two twelve foot wide display cases were barely being used. In fact, they contained a very old display that was outdated and had been neglected for years. It was even impossible to determine and locate who was responsible for these showcases. With no group or individual identified, action was taken to gain control of these display cases.

These showcases were located on the east and west sides of the first floor main hallway that many students, faculty, and visitors to the campus routinely used. After gaining permission to use them, they were repaired, painted, and shelves added. They were also secured with improved sliding locking glass fronts to protect the items on display. Since these display cases were just outside the electrical engineering laboratories, it was logical to put the antique electrical items into them. Finally, a new home was created for the long lost but recently rediscovered artifacts.

The items displayed in these showcases are frequently changed and rearranged because there simply was not enough room for everything. If space allowed, items of a similar nature were placed close together. Descriptions or explanations of the items and their use were also written and placed nearby.

The east wall showcase is shown in Figure 6 with a northern view and in Figure 7 with a southern view. Together they give a good picture of the items on display. The items include a Packard-Bell Transistor Radio Demonstrator, a variety of other types of circuit demonstrators, PROM Programmers, Capacitor Checker, Frequency Generator, Oscilloscope, Tube Tester, Multi-meters, CRT Tube, Vacuum Tubes, Bread Board Simulator, and many other items.

The west wall showcase is shown in Figure 8 with a northern view and in Figure 9 with a southern view. The items on display include a Packard-Bell Radio Demonstrator, Generator Simulators, Video Analyzer, Signal Generators, Hard Drive, Oscilloscope, Tube Tester, Multi-meters, Panel Meters, Numeric Keypads, Switches/Pushbuttons used in Laboratory Experiments, Circuit Simulators, and a set of Television Rabbit Ears.

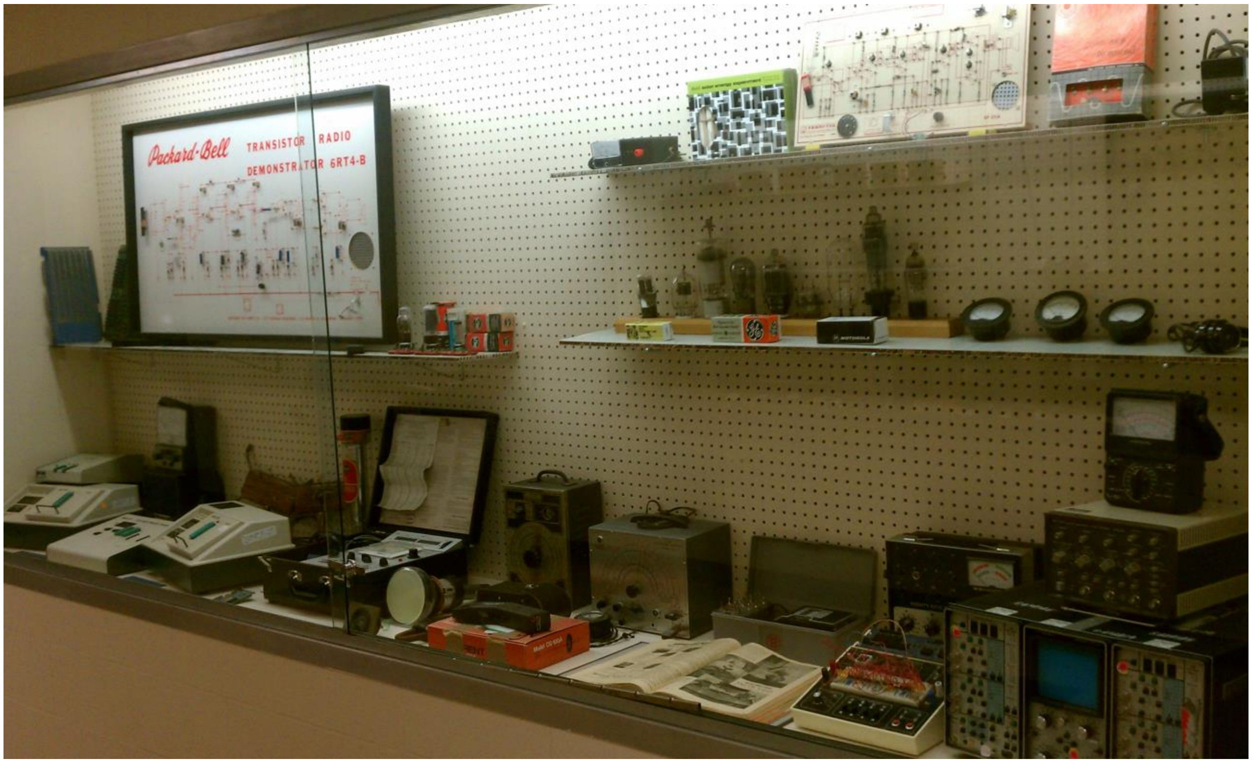

Figure 6. East Wall Display Case Northern View.

Figure 7. East Wall Display Case Southern View.

Figure 8. West Wall Display Case Northern View.

Figure 9. West Wall Display Case Southern View.

Many of these items can be traced back as far back as the 1940s when they were actually used in laboratories for student experiments. They accurately depict the equipment used at the time laying the foundation for today's electrical test equipment. Together they offer a historical perspective for students that was almost lost forever.

A number of these items were donated from the lead authors own personal collection. They represent two generations of items that were used to build and test Amateur Radio devices and other equipment. Placing them along with the antique equipment discovered in the forgotten storage room in the showcases is a fitting way to have them noticed and remembered.

Student Experience

It is one thing to put displays of antique artifacts together and quite another to judge their effectiveness. One easy way to determine the impact of the showcases was to take a census of the people passing by and count the number that paused and looked at the items inside. This process, to some extent, would indicate the interest generated by the display cases.

The showcases were monitored for three straight days a couple of months after they were completed. The selected days were from the middle of the week in order to minimize weekend effects. Since the Quarter System was used, Fridays are usually a light day for class scheduling but the laboratories are utilized every day of the week. A delay in taking the census allowed for the initial newness to dissipate. The results would also be a more accurate indication of the attention given to the display cases.

Each day the number of students, faculty, and visitors passing by the showcases were counted along with those stopping to take a closer look. Since some students could likely pass by multiple times in one day, each occurrence was counted. The results are shown in Table 1 below.

Table 1. Results of the Display Case Census.

Day of the Week	Number Passing By	Number Stopping to Look
Tuesday	1,123	137
Wednesday	1,389	151
Thursday	1,245	148
Average	1,252	145

It should be noted that during the weekdays the number of visitors to the campus was likely to be small. The University had approximately 11,230 students attending class and roughly, 550 faculty members were working during the period of the census. That means approximately 10.6% of the entire student and faculty population may have passed by during the test days. However, the actual percentage may be higher due to the possible and likely multiple counts of the same students and faculty passing by.

It should also be noted that on the weekends, even though no classes were in session the building was still open. Many students typically have friends and family visit them on the weekends and the students like to show them where they are taking classes. These groups were often seen standing in front of the display cases and discussing the contents.

As expected, the time spent looking at the items on display varied from just a few seconds to minutes. Many groups of two or more students stopped by and discussed the items inside. However, the duration of the viewing was not recorded nor was the items logged that were discussed.

However, the comments made by the students were overheard and written down. Many of the comments were actually questions seeking additional information. They ranged from amazement to curiosity and included:

- I cannot believe that engineers actually used this equipment.
- What are all of the knobs and dials used for?
- Where is the keyboard and computer?
- It is interesting to see how a transistor radio works.
- What were vacuum tubes used for?
- Why do you need a tube tester?
- Where are the digital readouts?
- I am happy that I do not need to know how to use any of this equipment.
- I think I will change my major so I can understand how to use equipment like this.

There were times, while the census was being taken, that the observer was asked questions about the items on display. Some of these were captured and included in the list above. In some cases, the response led to a short discussion outlining the historical significance of the item. Other times faculty members were talking to their students about the items, creating a real teaching moment.

Since these showcases are located right outside of the electrical laboratories, they offered a convenient storage location for these old technologies. Faculty members frequently open the display cases and bring them into the laboratory to demonstrate how they were used perhaps many decades ago. Then their modern versions are demonstrated and the differences in capabilities discussed. As a result, the students experience a hands-on opportunity to utilize technologies from the past. It presents an involvement for students to use old technologies in the laboratory that they otherwise may never have had expanding their knowledge.

Assessment of Student Learning

Learning is assessed by performance or how students apply what they have learned. The Course Learning Outcomes (CLOs) are clearly stated in the syllabus with the appropriate ones listed on the writing assignments and exams (Loendorf[9], 2004). The overall objectives of this process are to improve student learning and ensure that learning is taking place by evaluating the concepts, skills, and knowledge gained. In order to accomplish this goal, evidence of student learning is systematically collected and analyzed throughout the course. Students are evaluated through their performance by writing original essays and taking exams that demonstrate learning and the application of knowledge.

A series of four written essays based on the readings, lectures and discussions are assigned. Representative topics have included history's most important innovation or invention, the historical development of a technology, a technology's most beneficial and harmful effects, and society's choices about what technologies to accept or reject. The projects challenge the students to identify and apply the knowledge obtained from the course to both historical and today's technologies. The students are expected to be creative and innovative in their solutions to the problems and scenarios presented to them.

Over the years, multiple formats for the exams were used ranging from essay, short answer, true or false, fill in the blank, matching, and multiple choice. Various combinations of these methods were also tried with varying degrees of success. However, the large amount of material covered in the course caused a problem for many students. Each of the four exams covers between six to eight chapters from the textbooks along with all of the material discussed in class. In order to overcome this issue, a combination of short answer and multiple-choice questions were used. The average exam scores using this assessment method improved from the low 70s to the mid-80s.

The student's final grade is derived from their scores on the four exams and four essays. The exams and essays each determine half of the student's final grade. That is, each exam or essay represents one-eighth (12.5%) of their final course grade. Overall, eight graded assignments are utilized to calculate the final grade. As a result, a single poor grade on an exam or essay does not significantly detract from an otherwise good performance.

Class participation is encouraged and considered in the final grade where close decisions are required. Attendance is taken daily by using a sign in sheet with penalties imposed to discourage absences. Anything discussed in class (including the content of videos) is fair game to be included on the exams.

Lessons Learned

What began as a small project to introduce students to technological literacy in one college class has become so successful that it is continually being expanded. Many lessons have been learned while integrating recreated artifacts, collected retro technologies, graphic images, pictures, and videos into the class sessions along with utilizing display cases in the hallways. All of these lessons learned have been implemented, in one form or another, right into the classroom experience. As a result, what began as purely lecture sessions have been transformed into lecture, discussion, demonstration, and hands-on activity periods.

Doing something different both in and outside the classroom to break the routine is welcomed and appreciated by the students. As a result, additional activities and surprises are planned. Many will occur unannounced and without prior warning offering new opportunities to experience old and new technologies.

In the classroom, this active learning environment created a heightened interest in the subject even to the point where test and essay grades improved. This was a somewhat unanticipated consequence resulting from the project. However, it was one of the best possible outcomes from the experiment.

The interest generated for the science, technology, engineering, and mathematics (STEM) programs is very encouraging. It comes at a time when America needs more engineers, scientists, and technically trained people. This course has opened new career possibilities for many students into new fields that were previously not considered by them. The majority of these students simply never considered an engineering or technical career path and now they do.

The use of two refurbished display cases to promote technological literacy has been considered a success. They have created interest and dialog in a subject area that is all too often forgotten and overlooked by today's students. Rescuing old relics and artifacts, while using another old way to display them in showcases, has given them a new opportunity to inspire new generations of engineers and technologists.

The display case experiment was so effective that additional showcases are planned. A search is underway to find more underutilized or forgotten display cases in buildings across the campus that could be refurbished to promote technological literacy. Some good candidates have been located in very busy hallways in a few buildings that could be used. Permission to utilize them is in progress and approval is expected. These new showcases will be used to promote both technological literacy and the "TECH393: Technology in World Civilization" course. It is likely that this effort will steer additional students into the course as well.

Conclusions, Reflections, and the Future

The study of past technologies utilizing recreated artifacts, collected objects, graphic images, pictures, videos, and display cases has enhanced the student's knowledge of technological literacy. The relationship between people and technology is now better understood in terms of its social, cultural, political, and economic aspects. The problem solving ability of previous generations of humans along with their desire to invent and develop new tools, techniques, and processes are also more appreciated. The objective to increase the student's awareness of past technological issues in order to better prepare them to solve the technological challenges they will encounter in the future has been met.

Reflecting back, 14 years ago this course began with one instructor and only one section with 20 students. At the time, it was quite a gamble to offer a course related to Technological Literacy. Gradually over the years, as new creative ways to present the material were implemented, the popularity of the course rapidly increased resulting in expansion of the number of sections offered and instructors participating. Each of the courses facilitators follows a common syllabus that incorporates all of the presentation methods developed during the past 12 years. Every quarter four or more sections containing over 45 students each are run with an additional two sections run during the two summer sessions. In total, over 14 sections are offered each academic year with over 700 students taking part in the learning process. Since its inception, well over 7,500 students have been exposed to technological literacy because of this course and the interest continues to grow. What seemed to be a gamble has paid off in more ways than were ever expected or anticipated.

Future plans include adding more collections with additional artifacts obtained either through donation or recreation. Artifacts for the new collections are currently being made using the tools and techniques from the past, just as engineers and technologists from generations ago did. Donations for other new collections are also being accepted with the items being added to the collections as well. It is clear that the project is by no means complete, but rather just in its beginning stages. There is a lot more that can and will be done using these and new techniques to promote technological literacy.

Bibliography

1. Alcorn, P. (2003). *Social Issues in Technology: A Format for Investigation*, 4th ed. Upper Saddle River, NJ: Prentice Hall.
2. David, E. & Truxal, J. (1967). The man-made world: A high school course on the theories and techniques which contribute to our technological civilization. Commission on Engineering Education. Washington, DC: Eric ED 019 243.
3. de Vries, M. J., Hacker, M., & Burghardt, D. (2010). Teaching Technology and Engineering. Technology & Engineering Teacher, 70(3), 15-19. Retrieved from EBSCOhost.
4. Foucault, (1994). The Order of Things: *An Archaeology of the Human Sciences*. New York: Vintage Books.
5. Hjorth, L., Eichler, B., Khan, A., & Morello, J. (2003). *Technology and Society: A Bridge to the 21st Century*, 2nd ed. Upper Saddle River, NJ: Prentice Hall.
6. International Technology Education Association (ITEA) (1996). *Technology for all Americans: A rationale and structure for the study technology*. Reston, VA: ITEA.
7. Israel, E.N. (1995). *Technology education and other technically related programs*. In G.E. Martin (Ed.), Foundations of technology education, 44thYearbook of the Council on Technology Teacher Education (pp. 25-117). New York, NY: Glencoe McGraw-Hill.
8. Johnson, S., Gostelow, J. P., & King, W.J. (2000). *Engineering and Society*, Upper Saddle River, NJ: Prentice Hall.
9. Loendorf, W. R. (2004). A Course Investigating Technology in World Civilization. *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Salt Lake City, Utah, June 20-23, 2004.
10. Loendorf, W. R. (2010). The Social, Economic, and Political Impact of Technology: An Historical Perspective. *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Louisville, Kentucky, June 20-23, 2010.
11. Loendorf, W. R. (2011). Creating Interest in Technological Literacy by Reintroducing Past Technologies, *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Vancouver, British Columbia, June 26-29, 2011.
12. Loendorf, W. R. (2012). Using Stories to Promote Technological Literacy, Proceedings of the American Society for Engineering Education (ASEE) Conference, San Antonio, Texas, June 10-13, 2012.
13. Loendorf, W. R., & Geyer, T. (2008). Bridging the Historical Technological Gap Between the Past and the Present in Engineering Technology Curriculum. *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Pittsburgh, Pennsylvania, June 22-25, 2008.
14. Loendorf, W. R., & Geyer, T. (2009). Integrating Historical Technologies and their Impact on Society into Today's Engineering Curriculum, *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Austin, Texas, June 14-17, 2009.
15. Loendorf, W. R., & Geyer, T. (2010). Promoting Technological Literacy by Utilizing Pictures and Recreated Artifacts. *Proceedings of the American Society for Engineering Education (ASEE) Conference*, Louisville, Kentucky, June 20-23, 2010.
16. Loendorf, W. R., Geyer, T., & Richter, D. (2013): Using Scale Models to Promote Technological Literacy, Proceedings of the American Society for Engineering Education (ASEE) Conference, Atlanta, Georgia, June 23-26, 2013.

17. MacGregor. A. (2007). *Curiosity and Enlightenment: Collecting and Collections from the Sixteenth to the Nineteenth century*. New Haven: Yale University Press.
18. Martin, G. E. (2002*). Rationale and structure for standards for technological literacy*. In J.M. Ritz, W.E. Dugger, Jr., & E.N. Israel, Standards for technological literacy: The role of teacher education, 51st Yearbook of the Council on Technology Teacher Education (pp. 47-58). New York, NY: Glencoe McGraw-Hill.
19. Moser, S. (2010). The Devil is in the Detail: Museum Displays and the Creation of Knowledge. Museum Anthropology, 33(1), 22-32. Retrieved from EBSCOhost.
20. National Academy of Engineering (2008). Defining Technological Literacy. Retrieved from http://www.nae.edu/nae/techlithome.nsf/weblinks/CTON-557R5G?
21. Pacey, A. (2001). *Technology in World Civilization* (4th ed.). Cambridge, MA: MIT Press.
22. Petrov, J. (2012). Cross Purposes: Museum Display and Material Culture. Cross Currents, 62(2), 219-234. Retrieved from EBSCOhost.
23. Scott, M. (2007). *Rethinking Evolution in the Museum: Envisioning African Origins*. London: Routledge.
24. Stross, R. (1989). *Technology and Society in Twentieth Century America*, Belmont, CA: Wadsworth Publishing Company.
25. Teich, A. (2000). *Technology and the Future* (11th ed.). Toronto, Ontario, Canada: Thomson Wadsworth Publishing.
26. Voland, G. (2003). *Engineering by Design* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.
27. Volti, R. (2014). *Society and Technological Change* (7th ed.). New York: Worth Publishers.
28. Wiens, A.E. (1995). *Technology and liberal education*. In G.E. Martin (Ed.), Foundations of technology education, 44th Yearbook of the Council on Technology Teacher Education (pp. 119-152). New York, NY: Glencoe McGraw-Hill.
29. Wonacott, M. E. (2001).Technological Literacy. ERIC Digest. (ERIC Document Reproduction Service No. ED459371)