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## **AC 2011-992: CREATING INTEREST IN TECHNOLOGICAL LITERACY BY REINTRODUCING PAST TECHNOLOGIES**

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# **Creating Interest in Technological Literacy by Reintroducing Past Technologies**

## **Abstract**

Students understand and use today's technologies. They are so familiar with their operation and capabilities that many cannot imagine living without them. Most of them, in fact, would be lost and not have a clue what to do. They are part of the new technology generation. However, technologies of all types have existed since the beginning of time. Those technologies were less sophisticated, typically simple, and in many ways crude but they served their purpose. Ideas were turned into inventions, dreams became innovations, and problems were solved. These technologies changed the way people lived and worked. They made life easier, better, safer, and in many ways more comfortable. Ironically, few students recall, study, or even know much about many of these past technologies. It is this ability to understand past technologies and connect them to current ones that is important. To address this issue, a series of lectures and presentations were created that explore the historical perspective of technological development in a global context. They show how technologies are inter-related and how cultural factors affect the acceptance or rejection of technologies. The intent was to enhance the student's understanding of how technologies were developed and why. The material covered also helps the student to understand and recognize our dependence on technology and its invasive nature into our lives. The lectures and presentations were designed to be interactive utilizing images, pictures, representations, and recreated artifacts. This historical material has been presented multiple times to groups of students from various levels with positive reactions of intense interest, curious questions, and thoughtful comments. The objective was to better prepare students for the technological challenges they will encounter in the future by enhancing and extending their understanding of past technologies and their related issues. This series of lectures and presentations, described in this paper, has made an important contribution toward that end.

## **Introduction**

"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<sup>1</sup>, 2010). This statement describes the difficulty encountered by engineering faculty today. The pace of technological change has accelerated and this trend will continue with no end in sight. However, in order to understand where technology is going, it is important to understand where it came from. That is, reviewing and reintroducing technologies from the past to people that may have never seen, heard, or even considered them before.

Today technology is everywhere. It is all around us. Most members of modern society constantly utilize technologies without even thinking about them. In many cases, it has become so commonplace that it is taken for granted. Nearly everyone, including small children, know something about today's technologies. But that is where the dilemma begins.

Few people take the time to ponder where that technology came from in the first place. Or how one technology may be inter-related with another. Technology is simply accepted without question. It is just another tool in our arsenal to use. However, it is important to clearly understand the roots of these technologies in order to appreciate the long journey that they have travelled. Current technologies have been improved, refined, enhanced, reduced in size, made more powerful, and lowered in cost making them accessible by almost everyone. It is this progression or transition that is imperative. It is all about the significance of technological literacy and the realization of the importance of past inventions and innovations on our modern life and society. As a result, there are many technology and engineering concepts that can be easily understood by all people.

These objectives for technical literacy became the vision and driving force behind this initiative. It all started with a course titled Technology in World Civilization (Loendorf<sup>6</sup>, 2010). It was then expanded by collecting and recreating historical artifacts for hands on examination by the students (Loendorf & Geyer<sup>8</sup>, 2010). Pictures graphics, and videos are utilized to show how old technologies looked, and worked. This added another dimension to the learning process because "seeing is not simply a process of passive stimuli but also involves active construction of meaning" (Felten<sup>4</sup>, 2008).

It has evolved further into a series of lectures that are used for mock classes, guest presentations, and recruiting events. The reintroduction of past technologies has awakened a new interest in where technologies originated, how they are used, and where they are going. These lectures trace the evolution and history of past technologies along with connecting technologies together.

### **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<sup>2</sup>, 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<sup>9</sup>, 2008). "Technological literacy is the ability to use, manage, assess, and understand technology" (International Technology Educational Association<sup>5</sup>, 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<sup>7</sup>, 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<sup>11</sup>, 2001).

As the second decade of the 21st Century begins, students need to gain knowledge and insight about the nature of the tools, technologies, and processes that have shaped society since the beginning of time. This is particularly important because many of those tools and technologies along with many new ones will shape societies of the future. "Only through this kind of projection, can we hope to avoid social calamities which may result from the sudden emergence of powerful mechanisms of control without previous preparation or understanding of the implications of their use" (David & Truxal<sup>2</sup>, 1967).

New technologies have brought ubiquitous and irreversible changes (Duncan<sup>3</sup>, 2010). In order to meet the unknown challenges of the future, renewed focus is required on both preparation and inspiration. As a result, educators must place additional emphasis on two complementary goals. First, all students must be prepared to be proficient in science, technology, engineering, and mathematics (STEM) subjects. Second, students must be inspired and motivated to learn STEM subjects and pursue STEM Careers (Prepare to Inspire<sup>10</sup>, 2010). The bottom line is in order to be adequately prepared for the future; the past (tools, technologies, processes, and events) must be clearly understood.

## **Method**

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.

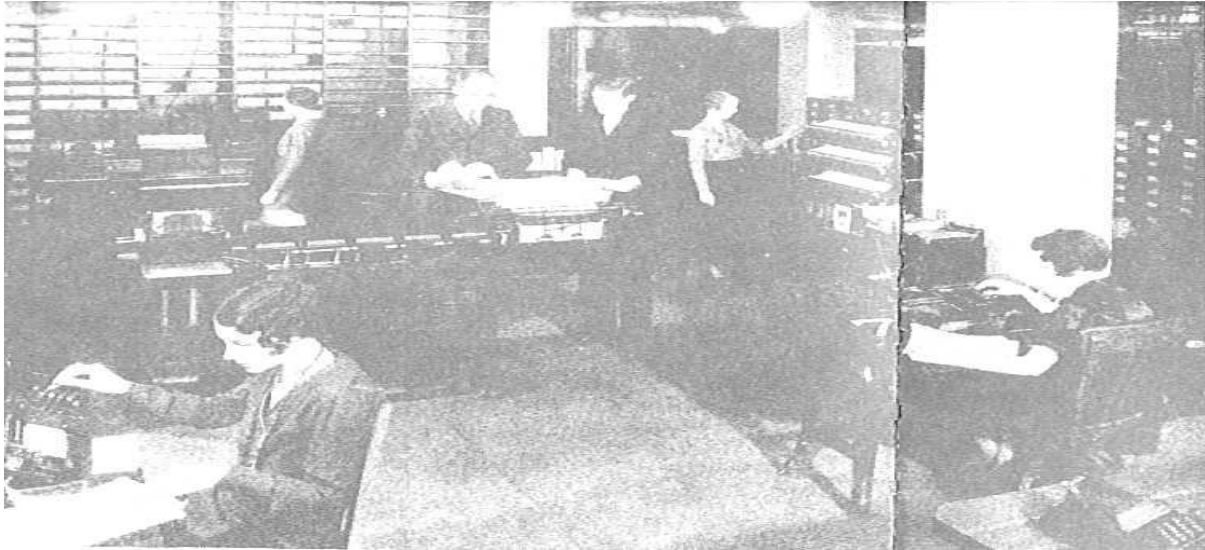
The session begins with a brief introduction to technological literacy and its importance in our modern society. The focus then shifts to a particular technology previously selected for the occasion. The technology is presented in chronological order starting with its initial design and form and progresses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

Perhaps the best way to show how this process works is through an example. This is an abbreviated example with only what would be 10 PowerPoint slides. The pictures and text have been condensed and reformatted in order to be properly displayed on this document. Therefore, as you read on, imagine a PowerPoint presentation conducted in an entertaining manner.

### The History of Computers

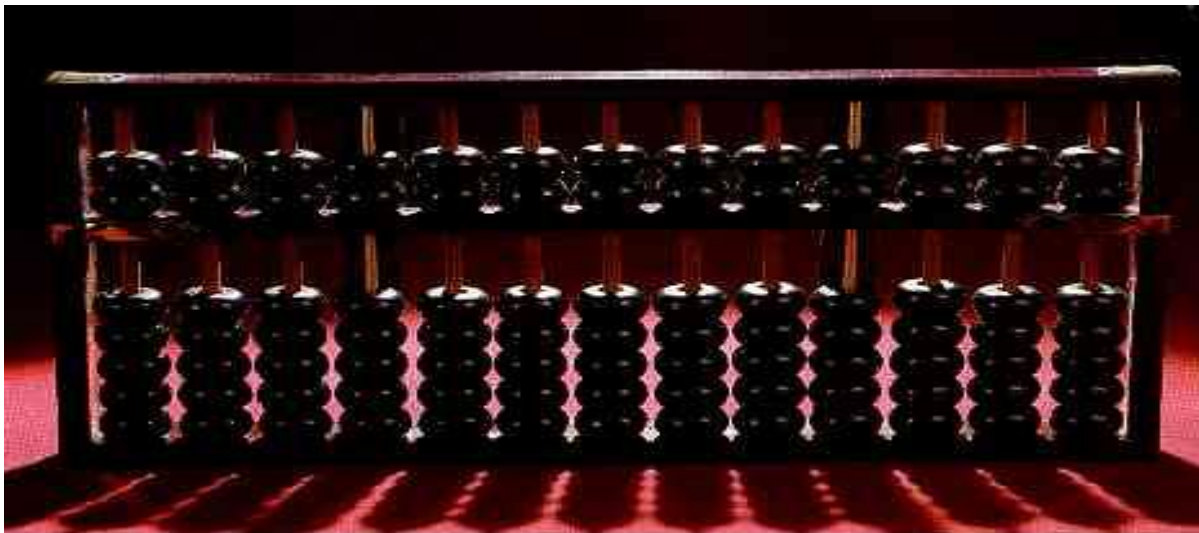
For well over 60 years, the ultimate tool for doing calculations has been the electronic digital computer. However, where did computers come from and how were they created? It all started with the basic concept of using mechanical devices to perform arithmetic. This process can be traced back thousands of years. It began with numbers and the ability to count using objects like sticks, stones, and fingers.

The first computers were people! Electronic computers (and the earlier mechanical computers) were given this name because they performed the work that had previously been done by people. "Computer" was originally a job title: it was used to describe those human beings (predominantly women) whose job it was to perform the repetitive calculations required to compute such things as navigational tables, tide charts, and planetary positions for astronomical almanacs.



A typical computer operation back when computers were people.

The abacus was an early aid for mathematical computations. Its only value is that it aids the memory of the human performing the calculation. A skilled abacus operator can work on addition and subtraction problems at the speed of a person equipped with a hand calculator (multiplication and division are slower).



A modern abacus

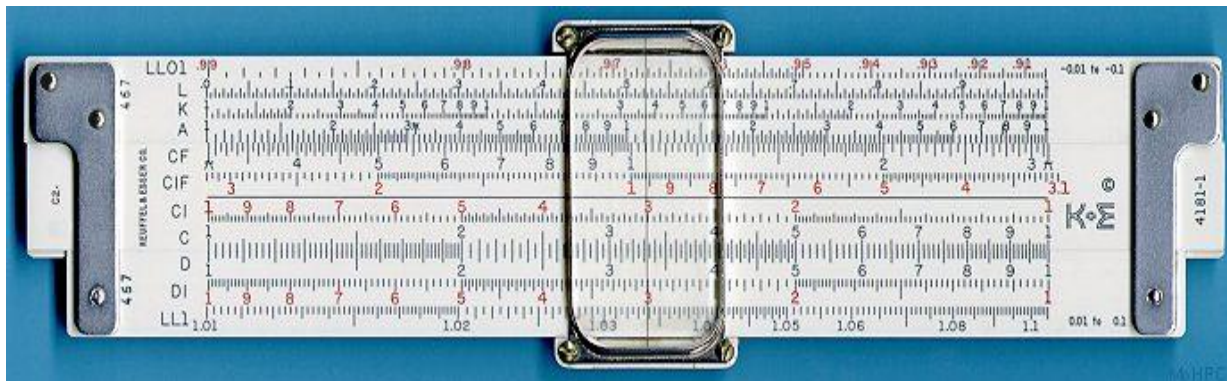
Note how the abacus is really just a representation of the human fingers: the five lower rings on each rod represent the five fingers and the two upper rings represent the two hands.

In 1617 an eccentric Scotsman named John Napier invented logarithms, which are a technology that allows multiplication to be performed via addition. The magic ingredient is the logarithm of each operand, which was originally obtained from a printed table. But Napier also invented an alternative to tables, where the logarithm values were carved on ivory sticks which are now called Napier's Bones.



A modern set of Napier's Bones

Napier's invention led directly to the slide rule, first built in England in 1632 and still in use in the 1960's by the NASA engineers of the Mercury, Gemini, and Apollo programs which landed men on the moon.



A 1960s slide rule

Slide rules added logarithms to perform multiplication and contained up to 22 different scales that were used for various mathematical functions like square root, sine, cosine, etc.



The presentation goes on to display and describe Jacquard's loom, Babbage's "analytical engine," calculators that utilized telephone relays, the ENIAC (the first computer based on electronic rather than mechanical or electro-mechanical technology), the UNIVAC (The first commercial computer), along with many other technologies including the vacuum tube, transistor, core memory, and integrated circuits. The journey through the historical development of computers ends with our present day technologies.

This same format has been used to create a number of other presentations focusing on other aspects of technologies. The completed presentations include Looking Back, Memorable Moments, Important New Inventions, Greatest Gadgets, Curious Technologies, and Eureka Moments. It is inevitable that additional presentations along similar themes will be created.

## **Implementation**

The first audience for these technology literacy lectures and demonstrations was a group of incoming freshman students with undecided majors. They were then used as mock classes for the University Experience, Advantage, and First Step Programs. The audience was then expanded to include high school and middle school students. Presentations were also made at university recruiting events and as part of MESA competitions.

A representative class session runs for 50-minutes, in a similar fashion to typical university classes. An open format is used where the students are encouraged to join the discussion as well as ask questions. At the end of the presentation, additional time is allocated for a question and answer period. Many of the questions at this point are related to specific technical majors and programs.

In some cases, a single 50-minute session is simply not enough time to adequately cover a topic. In order to resolve this issue, a number of 50-minute sessions, usually two or three held on consecutive days, are grouped together to form a type of short course or mini course. These are often included as an integral part of an existing course in order to add depth and breadth to the subject matter. The presenter is introduced to the audience as a guest lecturer or invited lecturer. This format offers flexibility, variety, and a change of pace for the class or audience.

## **Evaluation and Assessment**

At the end of the session or group of sessions when applicable, an evaluation form is distributed to the audience in order to assess its effectiveness. The attendees have the opportunity to provide feedback about the session or short course. The evaluation process is simple and takes only a few minutes to complete. The instrument contains four questions along with an area for comments. The four questions utilize a 5-point scale where 5 = excellent, 4 = good, 3 = average, 2 = poor, and 1 = very poor. The four questions used are:

1. The session or short course as a whole was...
2. The session or short course content was...
3. The instructor's contribution to the session or short course was..., and
4. The instructor's effectiveness in teaching the subject matter was....

The results from this assessment process for five sessions or short courses are shown in Table 1. All of these sessions or short courses were conducted during the Winter, Spring, or Summer Quarters of 2010. The number of participants along with the average scores for each question is displayed by session or short course. In addition, the average score of the four questions per session or short course is also revealed. Finally, the overall average score for all five sessions or short courses is presented.

Table 1  
*Results of the Session or Short Course Assessment*

	Winter 2010	Spring 1 2010	Spring 2 2010	Spring 3 2010	Summer 2010
Attendees	31	35	19	26	21
Question 1	4.73	4.46	4.58	4.65	4.43
Question 2	4.70	4.29	4.68	4.62	4.52
Question 3	4.83	4.77	4.90	4.89	4.71
Question 4	4.71	4.71	4.68	4.85	4.67
Average	4.74	4.56	4.71	4.75	4.58
Total Average					4.67

As of this writing, 132 attendees have participated in these sessions. All of the average assessment scores by session or short course for all four questions exceeded the good criteria and approached the excellent category. Since an overall average of 5 for excellent is highly unlikely, average scores of 4.56 and above along with a total average score of 4.67 is very good. It reflects that this project promoting technological literacy is meeting its objectives and succeeding.

The evaluation tool also offered the opportunity for inputting comments on the session or short course. A number of pertinent comments were received offering further insight into the way the sessions were held, material covered, and possible ways to make improvements. These included:

1. The course was widely informative and was presented very well. I very much enjoyed the PowerPoint's.
2. Instructor used his experience in engineering to relate real-life examples.
3. Excellent instructor and a great subject to learn about technology.
4. Good content and interesting contributions.
5. Instructor did an excellent job of keeping the class engaged, interested and enlightened while learning.
6. I gained a lot from this course while enjoying it.
7. Instructor had interesting and relevant stories to tell.
8. He made this class really enjoyable and created involvement.
9. I thoroughly enjoyed this course.
10. Excellent course and excellent teacher.
11. Very enjoyable and learned a lot.



The comments presented here are representative of all the comments received from the five sessions or short courses. In totality, they were all very positive focusing on the material, presentations, and the instructor. Incidentally, the instructor for all five of the sessions or short courses discussed here was the author of this paper. Although many of the comments were about the instructor, an equally large number of comments concerned the presentation methods and material covered. It is planned to train and add additional instructors in the near future in order to keep up with the demand for presentations.

According to the recruiting and advising staff in the School of Computing and Engineering Sciences, 26 students have either selected or changed their major to a STEM field as a result of the lectures from these sessions or short courses. It is likely that other attendees have selected STEM fields, as well, but were not counted. This is because the School of Computing and Engineering Sciences consists only of the Department's of Engineering & Design and Computer Science. Many other STEM departments in the fields of science and mathematics exist on campus and may have attendees declaring their majors as well. In addition, the total impact on the middle and high school students that have attended the sessions is unknown at this time.

The results from the evaluation and assessment are very encouraging. They are taken seriously and are used to improve the effectiveness and impact of these sessions or short courses. The results indicate that the project is having a positive impact and shedding new light on technological literacy in a very interesting and informative manner. However, new innovations will be tried to improve the effectiveness and reach of the project. After all, it is a continuous improvement process.

## **Lessons Learned**

What began as a project to produce a couple of technological literacy presentations for use in mock college classes has become so successful that it is continually being expanded. Additional opportunities to use the lecture materials and presentations are constantly surfacing. Frequently new requests occur to speak in front of groups and gatherings that were simply never thought of as potential audiences. It is with great enthusiasm that all of these speaking opportunities are welcomed and granted.

The use of pictures, graphics, collected technologies, and recreated artifacts has expanded the students learning experience. Instead of just reading and imagining about past technologies, they actually become alive right in front of their eyes. Students can visually see, hear and in many cases touch technologies that were either recently forgotten or ones from ancient times. These methods have rekindled an interest in where our modern technologies originated and how they were transformed, over time, into our current versions.

The series of lectures has also had an impact on recruiting students into the science, technology, engineering, and mathematics (STEM) programs. This aspect of the project was anticipated and not unexpected. However, the level of interest has greatly exceeded all expectations. Many students simply had never seriously considered a technical major before the presentation but were interested afterward.

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. These lectures have opened new career possibilities for many new freshman students into new fields that were previously not considered by them. It is also interesting to note that many of the students, at the middle and high school levels, never considered a technical career path or in some cases a college education.

The range, depth, and breadth of questions were very intriguing, fascinating, and stimulating. The actions of the audiences reflected interest, curiosity, and excitement. As a result, the discussion became a lively exchange of comments, questions, and ideas. The most frequently question asked was, why? Of course, that question is often times the hardest to answer.

Many students stayed around after the presentation was over to ask more questions and explore educational possibilities. Many even asked if a college course was offered that further investigated technologies and their impact on society. At that point, a brief marketing commercial for the Technology in World Civilization course is made. Other students asked if additional lectures and discussions on related topics are planned and how they could sign up to attend.

The bottom line and the most important lesson learned is that young people are interested in technologies from the past. In many cases, the students are seeing these old technologies for the first time. In fact, many of the tools and gadgets discussed were unfamiliar to the students and they knew nothing about them. The progression of how specific technologies evolved over time amazed many of the audiences. The inter-relationship between technologies and how one technology led to another was another area of fascination.

### **Conclusions, Reflections, and the Future**

The intent of this lecture series was to create interest in technological literacy by reintroducing past technologies. This goal has not only been easily met, but actually exceeded. It has achieved its objectives of increasing the awareness and understanding of past technologies and their social, political, economic and cultural impact on society.

Reflecting back on the lectures reintroducing past technologies, they were a joy to facilitate. The lectures were intended to be very dynamic and interactive resulting in presentations that were never the same. In the end, each lecture and presentation became unique addressing areas in many ways suggested by the audience.

The makeup of this lecture series continues to change, expand, and evolve. New subjects and focus for lectures are being constantly considered. This is as it should be because technology and its influence on society changes at a rapidly accelerating pace. Hopefully, this series of lectures reintroducing past technologies and creating interest in them can keep a step ahead or at least in step with technology and its effects on all of society. Foremost, it will continue to create interest in science, technology, engineering, and mathematics.

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