Rosies: The Female Computers of WWII

STUDY GUIDE

In war, math may be the most secret weapon of all.

INTRODUCTION

In 1942 a secret US military program was launched to recruit women to the war effort. But unlike the efforts to recruit Rosie to the factory, this search targeted female mathematicians who would become human 'computers' for the US Army. From the bombing of Axis Europe to the assaults on Japanese strongholds, women worked six days a week, around-the-clock creating ballistics tables that proved crucial to Allied success. Rosie made the weapons, but the female computers made them accurate. When the first electronic computer (ENIAC) was developed to aid the Army's calculation efforts, six of these women were tapped to become its first programmers.

Top Secret Rosies incorporates the stories of four very different women who worked as human computers at the University of Pennsylvania from 1942-1946, but does more than simply document the factual lives of a literally 'dying breed'- the participants of the WWII era. Through image and sound, the project attempts to capture the opportunities and exhilaration of the times but also the moral dilemma inherent in this work as these human 'computers' labored night and day to create the mathematical computations that made every Allied bomb and bullet more deadly.

Top Secret Rosies: The Female Computers of WWII shares a story of the women and technology that helped win a war and usher in the modern computer age.

HOW TO USE THIS STUDY GUIDE

This study guide is targeted to educators and written to offer discussion suggestions organized around the chapters of the film. The film can be screened in its entirety (56 minutes) or can be screened in three segments, each approximately 20 minutes in length.

The film's subject matter is suitable for middle school through college-aged students and applicable to the following subject areas:

- History, particularly the Great Depression and the WWII era

- Mathematics, particularly meaningful for the study of differential equations

- Engineering, specifically the invention of ENIAC

- Computer Science, particularly the history of human computing and ENIAC

- Women's Studies, an inspirational 'lost' story of female accomplishment

- Film and Media production

OBJECTIVES

At the conclusion of the film and following group discussion, students will:

- Have a clear understanding of the crucial role mathematics played in the successful outcome of WWII.

- Understand the history of human computing and its contribution to the development of the first general purpose, electronic computer, ENIAC.

- Understand the important contributions of women to the successful conclusion of WWII and the development of the first computer.

- Have a personal understanding of the moral implications of war related work and technology.

Instructors may choose to screen the entire film and then lead a discussion, based on specific curricular interests, but the documentary can also be screened in three separate parts, described by chapters below and including possible discussion questions.

Graduation photos of Marlyn Wescoff, Doris and Shirley Blumberg and Betty Jean Jennings

PART I: approximate runtime 16 minutes
- Prologue
- 1936

Discussion Questions:
The chapter *1936* introduces the four women we will follow throughout the documentary. Marlyn, Doris, Shirley and Betty Jean come from very different backgrounds, yet all end up working for the Army as part of the Philadelphia Computing Section.
- Discuss the link between class and educational opportunities during the Great Depression.

Dr. Nathan Ensmenger states in the documentary that in the 1920s and 30s, women made up half of all college students, yet there were quotas keeping women out of studies in the hard sciences.
- Research archival newspaper want ads and discuss the limited career choices for women in 1930s America.

Differential mathematics was used to develop ballistics data for Army weapons.
- Discuss the role math and computing machines played in the war effort.
- Discuss the 'job' of human computing, as described by the women.
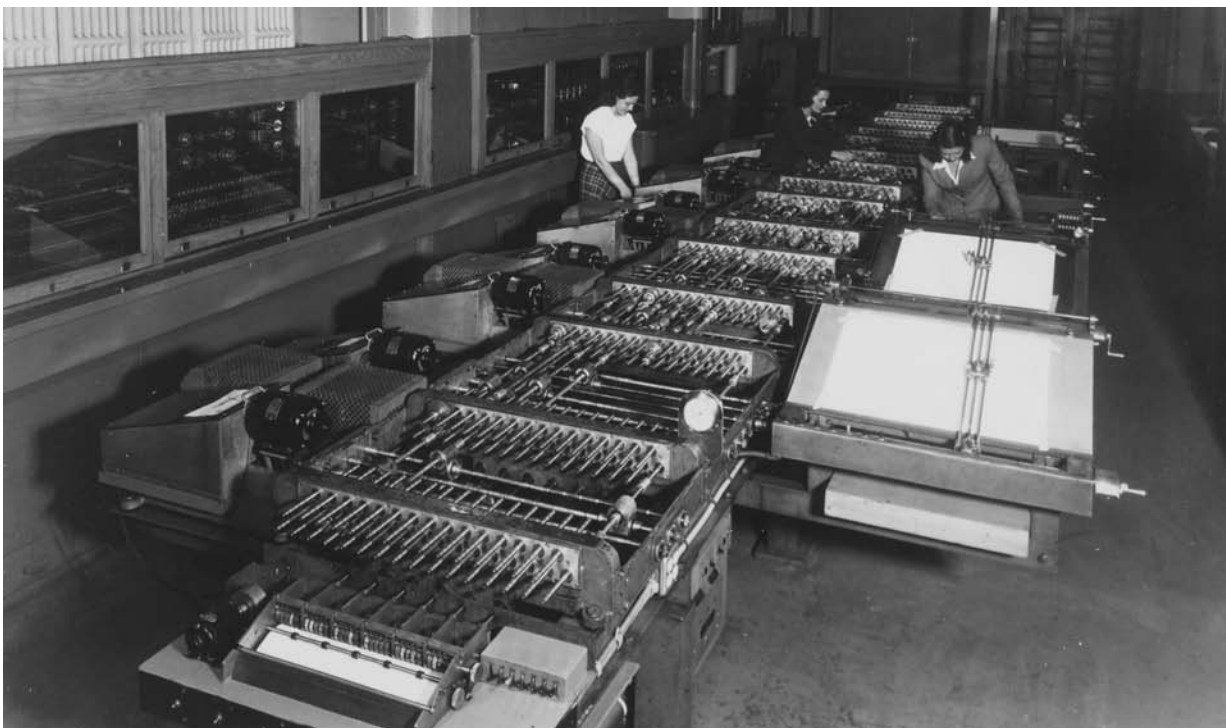
three women programming the Differential Analyzer, courtesy of the Smithsonian Institute

PART II: approximate runtime 21 minutes
- The Sky was full of Us
- There is a Place for Everything

Discussion Questions:
The chapter *The Sky was Full of Us* introduces two veterans, Doug Mickle and Ed Sage, who used ballistics tables developed by the home front human computers.
- The Norden Bombsight was an analog computer on board lead airplanes. Discuss how math was used to aim aerial bombs.
- Ballistics calculations were not always perfect. Discuss problems with such calculations and the devastating results.

ENIAC was commissioned for development by the Army in 1942.
- Discuss the Army's hopes for the machine and who it would replace.

The chapter *There is a Place for Everything* begins by describing the pay, after hours activities and camaraderie of the female computers.
- WWII actually gave women opportunities they would never have had. Discuss these opportunities and their larger impact on society

War has moral consequences and the veterans and human computers featured in Top Secret Rosies share their personal feelings.
- Discuss the moral questions raised in this section by the documentary subjects.
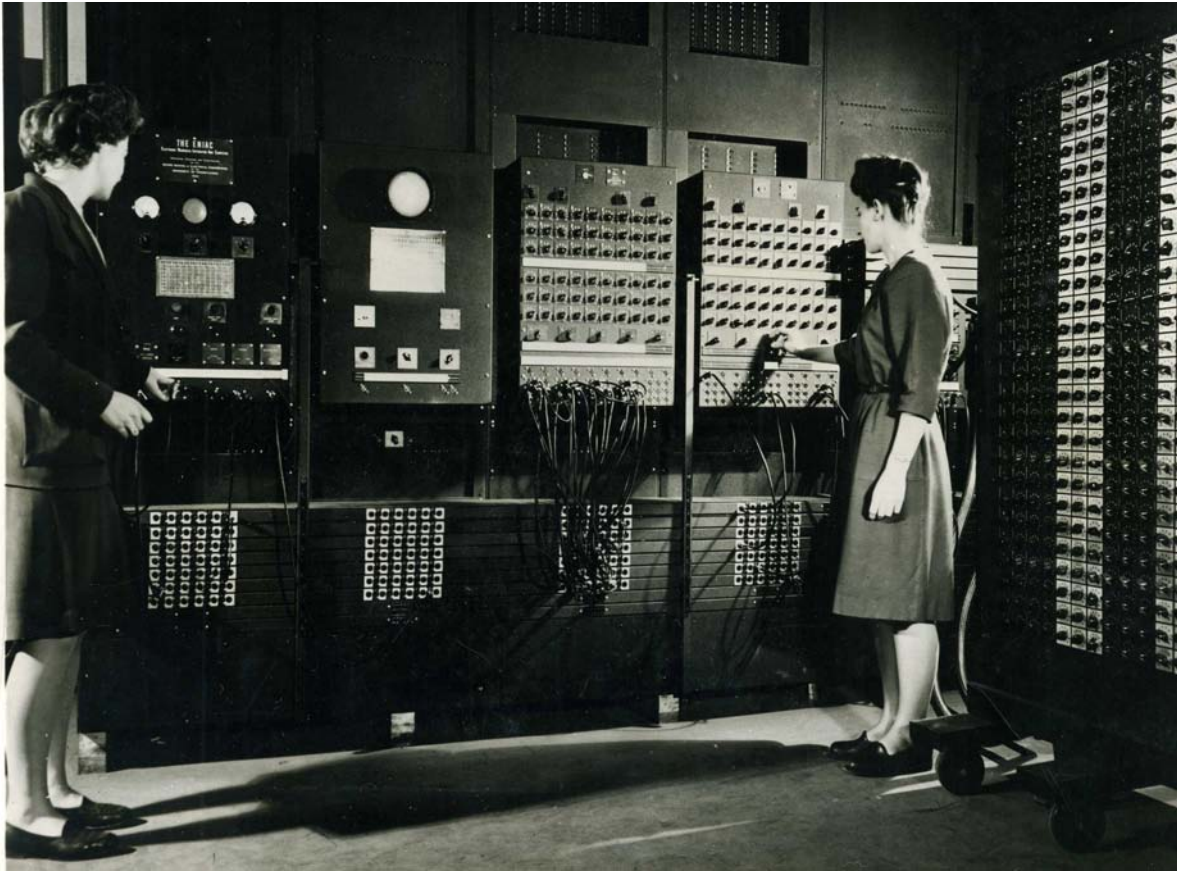
Betty Jean Jennings and Fran Bilas programming ENIAC, courtesy of the Smithsonian institute

PART III: approximate runtime 19 minutes
- Computer, Conclusion
- Epilogue, Credits

Discussion Questions:
When ENIAC was nearing completion, six of the female human computers were chosen to serve as the programmers.
- Discuss the work of the first electronic computer programmers- what did the women contribute to ENIAC's development; how did their programming work differ from modern computer programming?
- What was the practical use of the test trajectory in the computing work of ENIAC?
- Discuss the 'disappearance' of women from the history of ENIAC.

   In the Epilogue chapter brief bios of the four women discuss their post WWII work.
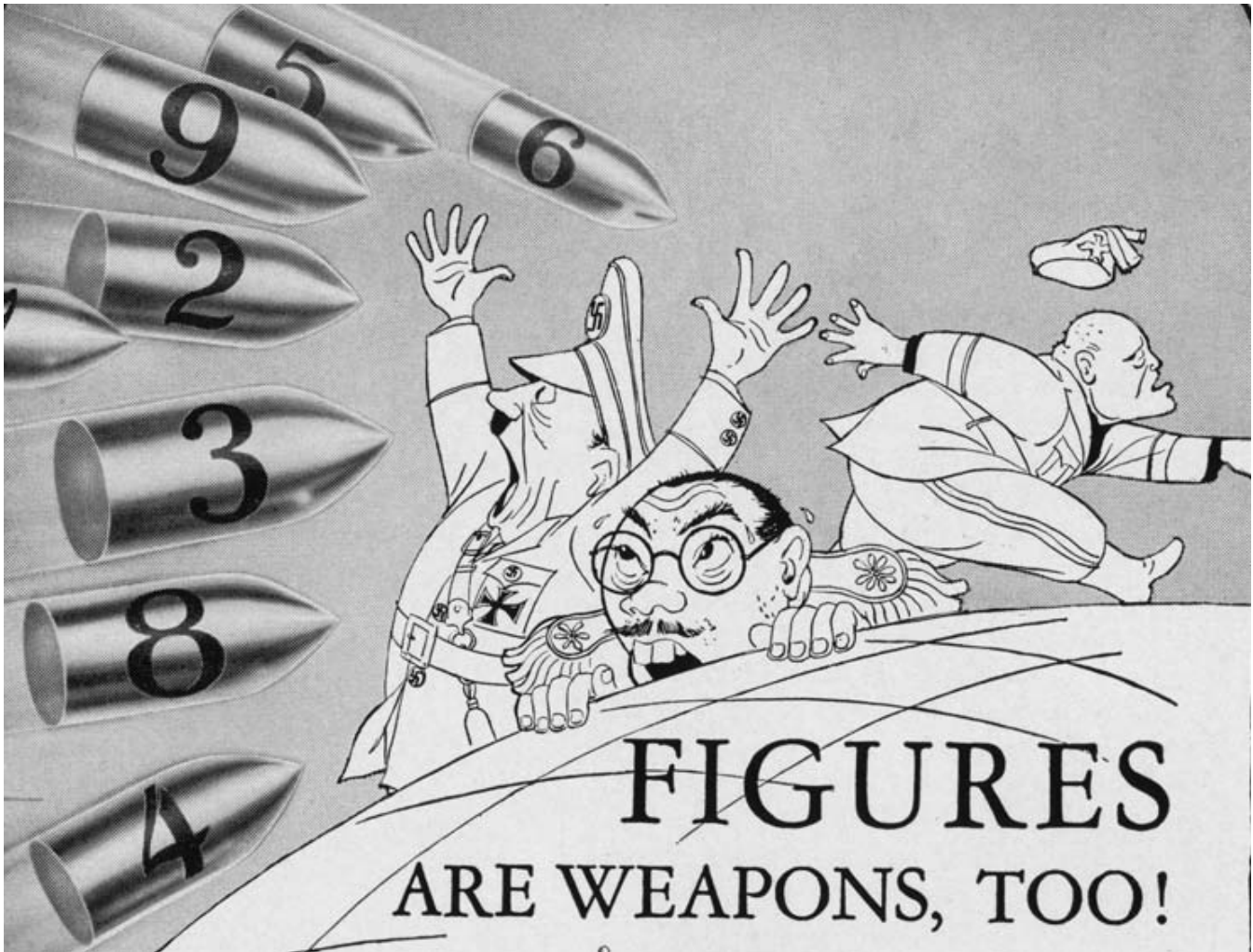- What surprised you about the choices the women made?

Final Thoughts:
Women were on the ground floor of the development of the modern computer age, yet were pushed out very quickly. Did viewing *Top Secret Rosies,* a story of women, math, technology and war, change your ideas about women and computer careers?

Math, Science and Computer Science classes

Marchant Calculator Ad, courtesy of the Smithsonian Institute

Mathematics, Computer Science and other science classes often focus on the fundamentals of each discipline but the history of these areas of study offer opportunities to engage students on a different plane. For example, as they memorize theorems, complete equations and take tests, students often feel that math is an activity with no practical application to their lives. Yet mathematics is crucial to the development of new technologies and inventions, to the advancement of scientific investigations and, in the case of the *Top Secret Rosies,* the successful execution of war.

An ideal use of the documentary *Top Secret Rosies* in math, science and computer classrooms would be to couple a screening and discussion of the film with a hands-on activity where students can put their math skills to use.

Suggested math, computer and science activities:

4- 6 grades: Build and use an Abacus

The ancient Abacus is a hand calculating machine that is still in use today in parts of Africa and Asia. Each student will build his/her own Abacus and use it to complete mathematical problems. More elaborate projects could be created in conjunction with an arts program or community woodworking program but even tinker toys and wooden beads can be used to build a working Abacus. Below are links for sites on building and using an Abacus.

Make an Abacus for pennies using cardboard, glue, string and beads.
http://www.galaxy.net/~k12/math/abacus.shtml

Here is a video clip from simplekidscrafts.com on making an Abacus using popsicle and BBQ skewer sticks.
http://www.youtube.com/watch?v=Y1f3zH-7DY4&NR=1&feature=fvwp

How to Use an Abacus- detailed instructions on how to use an abacus to do addition, subtraction, multiplication and division.
http://www.educalc.net/144267.page

PBS Teachers site- Mathline, contains PDFs for teachers and worksheets for students on using the Abacus.
http://www.pbs.org/teachers/mathline/concepts/asia/activity1.shtm

7-9 grades: Using Legos to teach Math, Computers and Engineering

Many of your students have probably grown up playing with Legos. They are fun and easy to use, yet can be the basis for robotic exercises that give students hands on math, computing and engineering experience. Plus, the students will have a cool object at the end!

This site is the clearing house for all things Lego and educational.
http://www.legoengineering.com/

Here's a site about Lego Mindstorms kits.
http://www.nxtprograms.com/

9-12th grades and college: Solving Differential Equations

With older students, a project more directly tied to *Top Secret Rosies* would be for students to devise a ballistics table for a military weapon. Variables affecting the trajectory of a projectile include atmosphere, wind, weight of the projectile, powder magazine, type of ground the weapon rests on, obstacles between the gun and target, and even the curve of the earth. Just like the women in *Top Secret Rosies*, students must work in tandem, completing parts of the equation before combining all the results. Like in the film, the

moral implication of this intersection of math and war would be a good topic to raise and discuss.

This site gives a brief overview of Differential Equations.
http://www.cliffsnotes.com/study_guide/Introduction-to-Differential-Equations.topicArticleId-19736,articleId-19708.html

Note: A PPT lecture on the history of human computing and WWII computing is available for download at www.topsecretrosies.com and includes graphics of actual math work completed by the female human computers working at the University of Pennsylvania during WWII. These documents would be good references for this project.

Professional Mentoring

It is common knowledge that the US suffers from a shortage of young people interested in pursuing careers in the areas of Math, Computer Science, Engineering and other areas of the hard sciences. Particularly problematic is the shortage of girls and minorities working toward college degrees in these areas.

Offering students professional role models in the classroom is a wonderful way to encourage students, particularly girls and minority students, that math, computers and science can be part of their future.

Mentor/Role Models should be introduced as early as 4th grade and continue on through college classrooms. Teachers will need to outreach to their individual communities to identify individuals who could visit their classroom, discussing their own paths to their current career and demonstrating the diversity of jobs available that are based on math, computer and science skills.

Below is a list of professional organizations where teachers might find local chapters and classroom visitors but teachers are urged to engage with their communities, contacting local businesses, corporations and colleges for possible visitors/mentors. A business need not be a high tech firm to produce a possible visitor. The owner of the local bicycle repair shop probably uses math to tool and create replacement parts.   The local museum director undoubtedly has an IT staff organizing the collection, maintaining the museum website and creating digital files for upload. The best strategy is to secure a diverse group of visitors, demonstrating to students the wide variety of career opportunities using math, science and computers.

Professional organizations to contact:
AAUW, The American Association of University Women
"Breaking Through Barriers for Women and Girls"
http://www.aauw.org/

Professional organizations, continued

ACM, Association for Computing Machinery
www.acm.org

The Anita Borg Institute for Women and Technology
http://www.iwt.org/

AWC, Association of Women in Computing
http://www.awc-hq.org/

AWM, Association for Women in Mathematics
https://sites.google.com/site/awmmath/

AWS, Association of Women in Science
Assoc of women in science
http://www.awis.org/

BDPA, Black Data Processing Associates
http://www.bdpa.org/

CAARMS, Council for African and American Researchers in the Mathematical Sciences
http://www.math.buffalo.edu/mad/CAARMS/CAARMS.html

CRA-W, Computing Research Assoc- Women
http://www.cra-w.org/

IEEE, Professional Association for the Advancement of Technology
http://www.ieee.org/

NAM, National Association of Mathematicians
http://www.math.buffalo.edu/mad/NAM/

NSBP, National Society for Black Physicists
http://www.nsbp.org/

TERC (Technical Education Research Centers) is a research and development organization whose aim is to "improve mathematics, science and technology teaching and learning."
http://www.terc.edu/

WITI, Women in Technology International
http://www.witi.com/

History, Social Studies, Women's Studies, Language Arts classes:

Two important internet sites for any classroom activities based on *Top Secret Rosies* and WWII are the National Archives site (http://www.archives.gov/) and the Library of Congress site (http://www.loc.gov/). At these two government-sponsored sites, students can research and view archival images, articles, newspapers, posters, film clips and more.

This LOC link outlines a variety of classroom activities of interest to teachers based on the American Folk Life collection. Suggested activities include lesson plans:
http://www.loc.gov/folklife/edresources/ed-classroom.html

Suggested activity:

Art and Propaganda, the Poster project-
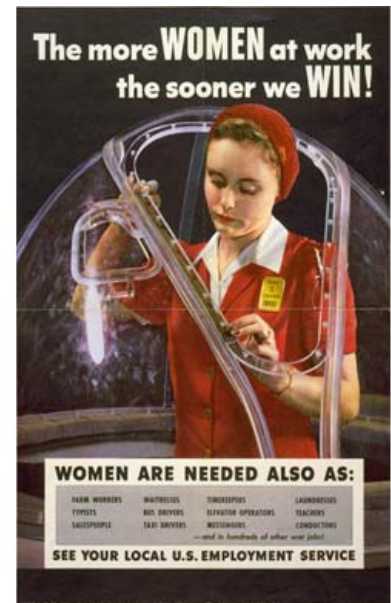
Three recruitment posters, courtesy of the Library of Congress

"We Can Do It" was an iconic poster of the WWII era, a pitch to women to do their bit for the war effort. What role does art and propaganda play in rallying citizens behind a cause? After discussion, students brainstorm a societal 'need' and create a poster on that topic.

Radio programming and propaganda during war-

Commercial Radio has been a staple of American society since the 1920s. In addition to offering entertainment in the form of music, skits and series, radio also played a crucial role in the area of broadcast journalism. Below are links to assist with a discussion of the role of radio in early 20th century life, with emphasis on WWII era broadcasts.

Archive.org houses a large collection of digitized WWII era radio broadcasts
http://www.archive.org/search.php?query=wwii%20radio%20broadcasts

Radio Propaganda, Another Weapon in War
http://radio.about.com/library/weekly/aa121902b.htm

Tokyo Rose and Japanese radio propaganda during WWII-
This is a great website with background information and related links to the story of Iva Toguri D'Aquino, aka Tokyo Rose.
http://womenshistory.about.com/library/bio/blbio_toguri_iva.htm

This website offers background information on Tokyo Rose and mp3 files on CD of Tokyo Rose recordings are available for purchase.
http://www.otrcat.com/tokyo-rose-wwii-japanese-propaganda-p-1933.html

Suggested Activity:
Create a Radio Broadcast-
History or Social Studies students can research a historical event, write commentary and record their own 'radio' show. For literature students, a book currently used in the classroom could serve as inspiration to create a radio broadcast inspired by the plot.

Sample WWII era radio broadcast- The Japanese surrender
http://www.archive.org/details/WWII_News_19450814_Japanese_Surrender_1945
August 14, 1945, amazing amateur recording of a radio broadcast announcing the Japanese surrender. Of particular interest, the announcement that once President Truman declares victory, "censorship will end in this country".

Censorship and National Security-
A classic WWII era censorship case to investigate is the Chicago Tribune's decision on June 7, 1942, to publish information that the US had broken a secret Japanese Code. Below are three internet sites where students can research this incident, sparking discussion of the role of censorship with regard to national security. A contemporary discussion subject would be the WikiLeaks scandal.

PBS site on the issue of National Security and the Role of the Press
http://www.pbs.org/wgbh/pages/frontline/newswar/part1/role.html

WWII timeline January- July 1942
http://history.howstuffworks.com/world-war-ii/axis-conquers-philippines14.htm

American Journalism Review- article "Judgement Calls", October/November 2006
This AJR case includes the original article, making reference to the June 1942 Chicago Tribune article, and includes lesson plans, class assignments and related links.
http://www.jclass.umd.edu/ajr_in_class/10112006.htm

An Oral History Project-

Everyone has grown up listening to family stories. Whether handed down through generations or just occurring yesterday, stories help individuals grasp where they came from and may help them understand where they are going. Oral histories are a wonderful way of capturing everyday events that often hide behind the larger 'history' of our times.

Suggested Activity:
Create your own oral history-

The student will record a family story on audio or video and share it with the class. This can be done professionally with microphones, digital audio recorders and digital video recorders or it can be done inexpensively using computer recording applications or even cell phone recordings.

Sources:
This link offers Library of Congress lesson plans on using oral history as a way to investigate issues of culture, art, history, government and much more.
http://www.loc.gov/teachers/classroommaterials/lessons/index.html

Veteran's History Project, http://www.loc.gov/vets/about.html
"**T**he Veterans History Project of the American Folklife Center collects, preserves, and makes accessible the personal accounts of American war veterans so that future generations may hear directly from veterans and better understand the realities of war."
– Veterans History Project website

This site offers wonderful stories by veterans and would be a great first stop for students to listen and discuss some of the stories before attempting to record their own.

Storycorps, Every Voice Matters- http://storycorps.org/
Students can listen to stories recorded by regular citizens as part of NPR's Storycorps project. After listening and discussing stories on the site, students may want to upload their own recorded family story.

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Robotics consultant.

Below are links to articles that teachers may find informative.

Hands-on projects for students: These ideas are specific to particular communities but they would not be hard to duplicate in your own local city or town.

"Kindergarten Shop Class", This article includes profiles on shop classes for children in NYC, Boston and San Francisco where math is an essential building skill. Is this something you could start in your own school district?
http://www.nytimes.com/2011/03/31/garden/31kids.html?_r=1

"The Hands that Steer are Building the Bikes", This article shares information on the do-it-yourself bike movement, where people work together to custom make bicycles. Math is crucial to this endeavor and any community would have a bike shop where teachers and students could explore this practical application of math.
http://cityroom.blogs.nytimes.com/2011/03/05/the-hands-that-steer-are-building-the-bikes/

"Science and Secrets in New York City Playgrounds", This article discusses unique science-themed playgrounds in the NYC area but every city or town has a parks department where science could be incorporated in to play. Perhaps your students would like to help design such a playground in their own community?
http://www.nytimes.com/2011/04/15/arts/design/extraordinary-playgrounds-in-new-york-city-boroughs.html

Informational articles:

"Why so Few?", This 2010 study investigates why there are so few female scientists and engineers. Downloadable as a pdf from this AAUW website link.
http://www.aauw.org/learn/research/whysofew.cfm

"Women Atop Their Fields Dissect the Scientific Life", an interview with four top female scientists about the challenges and rewards of their career choices.
http://www.nytimes.com/2011/06/07/science/07women.html

The ENIAC, this site is a great, general site for all things ENIAC, including an extensive list of articles explaining how ENIAC worked.
http://the-eniac.com/machine/