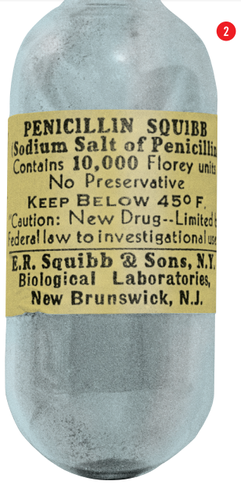
THE WAR THAT CHANGED THE WORLD

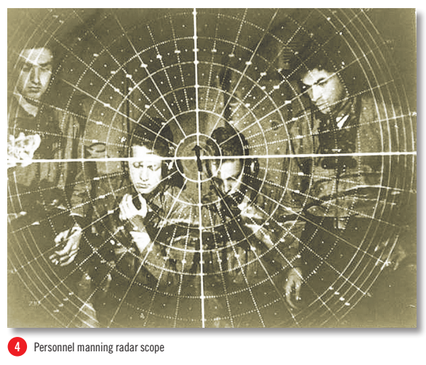
How the Science and Technology of World War II Influences Your Life Today

1 British naval personnel prepare a depth charge / Allied chart of German U-boat activity in the North Atlantic



2 Schenley Laboratories, Inc. penicillin magazine advertisement / Penicillin vial

3 Bell & Howell film projector magazine advertisement / U.S. Army and Navy technical manuals



4 Personnel manning radar scope

5 Auschwitz death camp gate / Canister of Zyklon B poison

6 Manhattan Project patch / Atomic explosion over Nagasaki, Japan

7 British Colossus computer / 3-rotor German Enigma machine

8 U.S. soldier being dusted with DDT

9 Norden bomb site / B-29 bomber

10 SCR-536 Handie-Talkie radio

11 Messerschmitt Me 262 turbojet fighter

12 V-2 *(Vergeltungswaffe 2)* Rocket

WWII science and technology not only effected how that war was fought and won, but continues to influence our technology, politics, economics, and even education today. Here are some of the most important ways:

1 Organizing a Complex War
Operations Research (OR) is the mathematical study of problems of organization, logistics, and deployment. OR helped the Allies hunt German U-boats in the Atlantic and organize complex logistical needs—like the organizing of D-Day. These methods, using statistics and probability, became the underlying principles of today's businesses, from airline scheduling to delivery of goods from around the globe to your local Wal-Mart.

2 A Life-Saving Medical Advance
Throughout history, more people died in wars from diseases than from weapons. The use of penicillin began to change that during WWII, as using it on a large scale helped protect soldiers from bacterial infections. The success of penicillin led to the search for and discovery of the antibiotics we routinely use today. Because of WWII, today an ear infection almost never turns into a life-threatening illness.

3 Winning the War: 101
Complicated new weapons are no good if soldiers don't know how to use them. WWII saw great advances in training methods, including the use of animated films, technical manuals, and even simulators to recreate combat conditions in a laboratory setting to aid in training. Today's interactive white boards and video games are their descendants.

4 Blip, Blip, Blip
Radar (radio detection and ranging) in WWII was used to track attacking bombers, for airplane-to-airplane combat, to guide bombers to their targets, to direct gunfire, even to follow mortar shells back to their sources. Radar required a new kind of electronics that processed high-speed electronic pulses. This technology was critical in the development of digital computers, satellite communication, and television.

5 Factories of Death
The Nazis used the latest techniques in industrial organization, manufacturing, and accounting to systematically murder six million Jews and millions of others during WWII. These activities showed the world that simply being advanced in science and technology did not necessarily lead to civilized actions. The world today needs to remember and learn from the Holocaust, and commit itself to the ideal, "Never Again."

6 The Destroyer of Worlds
The only atomic weapons ever used in an actual war were dropped by the U.S. on the Japanese cities of Hiroshima and Nagasaki in August of 1945. The result of a massive scientific and industrial effort, these weapons changed the nature of warfare and international relations up to the present day. For the remainder of the 20th Century, the "Cold War" was characterized by a nuclear standoff between the U.S. and the Soviet Union. Today the threat of terrorists or "rogue states" acquiring and using nuclear weapons has become a new global reality.

7 Cracking Impossible Codes
Aided by wartime innovations in radar, electronics, and mathematics, by late in the war scientists and engineers began building electronic digital computers, primarily for ballistics and code breaking applications. While originally built to solve military and scientific calculations, no invention has had more effect on our daily lives in the past sixty years than the electronic digital computer.

8 Killing More than Just Insects
The pesticide DDT was very effective in controlling the spread of tropical diseases during the war. Sometimes entire cities were dusted from the air. DDT has massive environmental impact. It is highly toxic to many animals and somewhat toxic to humans. Public reaction against heavy DDT use in the U.S. in the 1960s helped ignite the modern environmental movement.

9 Civilians in the Firestorms
Advances in aeronautics, optics, and engineering led to advances in both precision bombing (hitting a bridge or specific building) and strategic bombing (destroying the enemy's capacity for making war). More people—mostly civilians—died in WWII from aerial bombardment than from any other weapon. Today people and politicians continue to debate the morality of killing civilians during indiscriminant warfare.

10 "Roger That—Over and Out"
The electronic components, batteries, and new materials, like plastics, that went into making Handie-Talkies and other radios allowed soldiers to communicate across a Pacific atoll or across an ocean. Never before were the headquarters and the front lines so well connected. The cell phone in your pocket can look to these WWII-era devices as important ancestors.

11 Jetting into the Future
Like much technology of WWII the jet aircraft was invented before the war, but only became practical during the war. The first jet aircraft to fly was the Heinkel He 178, which took to the air in 1939, though the first operational fighter was the Messerschmitt ME-262, which entered service in 1944. After WWII the "jet age" truly began, and within fifteen years civilian jet airliners, based on military transport designs, were regularly crossing the Atlantic.

12 From Destruction to Discovery
During WWII the Germans developed liquid-fueled rocket weapons that were used to attack civilians in London and throughout southeast England. American engineers developed smaller, but tactically more effective, solid fuel rockets. These technologies, along with German, American, and Russian engineers, made the period after WWII into "the Space Age" that continues to this day. The rockets that flew to the moon were in some ways an updated version of the German V-2 rocket bomb.

To continue exploring the science and technology of WWII, visit the companion website www.ww2sci-tech.org, created by The National WWII Museum.

THE NATIONAL WWII MUSEUM

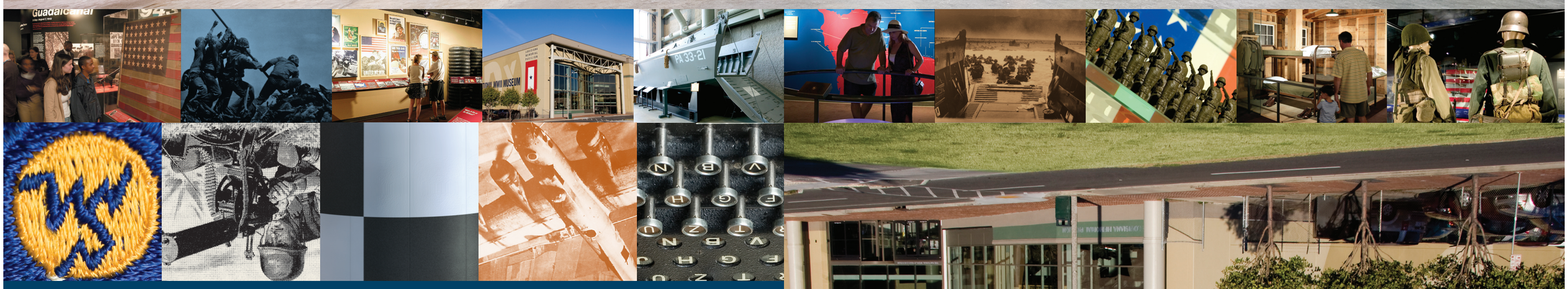
Funds for this project were generously provided by GE Foundation

THE NATIONAL WWII MUSEUM - A NATIONAL TREASURE

Dedicated in 2000 as The National D-Day Museum and now designated by Congress as the country's official WWII museum, The National WWII Museum tells the story of the American Experience in *the war that changed the world* – why it was fought, how it was won, and what it means today – so that all generations willl understand the price of freedom and be inspired by what they learn.

For all the role of science, mathematics, and new inventions in earlier wars, no war had as profound effect on the technologies of our current lives as WWII. And no war was as profoundly affected by science, math, and technology as WWII. Through a generous grant from The GE Foundation, The National WWII Museum has created this poster and a companion website exploring the importance of science and technology during and after WWII.

For more information on this topic, visit www.ww2sci-tech.org.



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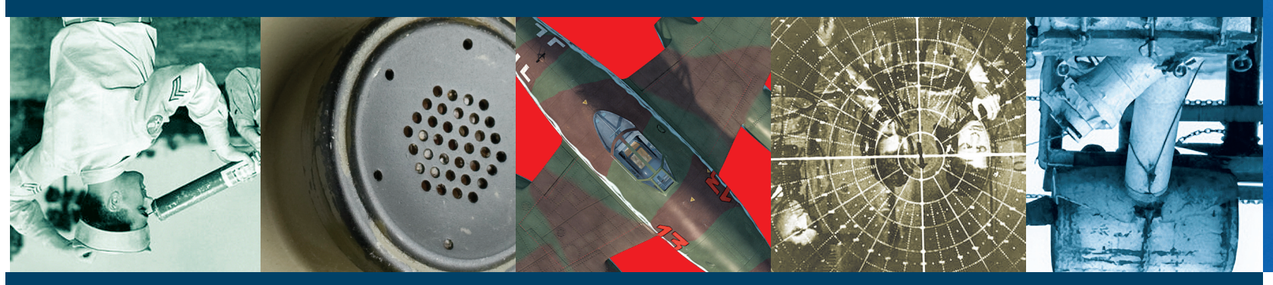

The Science and Technology of WWII

www.ww2sci-tech.org

The National WWII Museum

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QUOTES ABOUT WWII SCIENCE AND TECHNOLOGY

"I think there's a world market for about 5 computers."
–Thomas J. Watson,
Chairman of the Board, IBM, circa 1948

"I am become death, the destroyer of worlds."
–J. Robert Oppenheimer, quoting from the sacred Hindu text *Bhagavad Gita*, on witnessing the successful test of the first atomic bomb at the Trinity test site, outside Alamogordo, NM, July 16, 1945.

"Ours is a world of nuclear giants and ethical infants. We know more about war than we know about peace, more about killing than we know about living. We have grasped the mystery of the atom and rejected the Sermon on the Mount."
–Omar Bradley, U.S. Army five-star general and first Chairman of the Joint Chiefs of Staff

"I don't know how the third world war will be fought, but I do know that the fourth one will be fought with sticks and stones..."
–Albert Einstein

"If civilization is to survive, we must cultivate the science of human relationships—the ability of all peoples, of all kinds, to live together, in the same world at peace."
–Franklin D. Roosevelt

"Where a calculator on the ENIAC is equipped with 18,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps weigh 1.5 tons."
–unknown, *Popular Mechanics,* March 1949

"If they can make penicillin out of moldy bread, they can sure make something out of you."
–Muhammad Ali

"If only I had known, I should have become a watchmaker."
–Albert Einstein, *reflecting on his role in the development of the atom bomb.*

"When you see something that is technically sweet, you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb."
–J. Robert Oppenheimer, chief scientist for the Manhattan Project

Making "Synthetic Rubber"

Rubber was an essential product for many wartime needs during WWII—from tires, to life rafts, to engine gaskets. But when most of the world's natural rubber supply fell into the hands of the Japanese, the government turned to scientists. The shortage of natural rubber led to experiments with synthetic or artificial rubber. Try this recipe for a gooey version of synthetic rubber.

WHAT YOU WILL NEED:

- Liquid starch
- White glue
- Food coloring
- 2 small plastic or paper cups
- A ruler and a marking pen
- Popsicle stick or other strong stirrer
- Paper towels (for clean-up)
- Plastic sandwich bag

The recipe for this version of ooey-gooey synthetic rubber is one part liquid starch to two parts white glue. You only want to make as much as you can easily hold in your hands.

DIRECTIONS:

1. On your first cup, draw a mark one inch from the bottom of the cup. Carefully pour in white glue up to that mark. Do not overpour.
2. On your second cup, draw a mark one-half inch from the bottom. Carefully pour liquid starch up to that mark. Do not overpour. *(You can find liquid starch in the laundry detergent aisle of the grocery store.)*
3. Choose the color you want your ooey-gooey rubber to be. Drop only one or two drops of food coloring on top of your glue. *(Food coloring can stain clothing, so be careful.)* Slowly pour the liquid starch into your glue cup.
4. With your stirrer, carefully begin to mix your rubber together. Do not let it spill out of the cup. As the glue and starch mix together, you can stir more vigorously for about 30 seconds.
5. The rubber will collect on your stirrer. Remove the stirrer from the cup and scrape the mixture into your hand. Place the stirrer back in the cup.
6. Begin to work the rubber together between your hands. It will feel very gooey and sticky. Work the mixture for at least two minutes. If the rubber continues to be very sticky, add a dollop more of starch directly to the mixture in your hand. *(As the scientist, you can experiment with different amounts of each material and different methods of mixing them together.)*
7. Once your rubber has the right consistency (pliable, but not too wet), place it in a plastic bag. Keep the putty in the bag when you are not playing with it or it will dry out.
8. Throw away your cups and stirrer. Wash your hands. Clean up any mess around your work area.