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Dr. Paul Dickler
Paul Dickler, a Senior Fellow of The Foreign Policy Research Institute's Wachman Fund for International Education, has taught History and International Relations at Neshaminy High School in Langhorne, PA. He has been an Adjunct professor at the University of Pennsylvania, and is a Consultant whose clients have included Penn's Annenberg School for Communication, The College Board, The Educational Testing Service, Camden County College, Nebraska-Wesleyan University, La Salle University, the West Virginia Center for Professional Development, and the Pittsburgh Public Schools. He received his Bachelor's Degree in Economics from The Wharton School and his doctorate in education from The University of Pennsylvania.

Lesson Title: **German Innovation and Technology**

Grades: 9-12

Objectives: To examine Germany's reputation as a country known for innovation and technological advancements.
To learn about Germany's Nobel Prize history.
To understand the on-going role of innovation in Germany today.

Time: Four to five days, 45 minute periods.

National Standards for World History:
Standard 2 The Search for community, stability, and peace in an interdependent world.
Standard 2A The student understands how population explosion and environmental change have altered conditions of life around the world.
Standard 2E The student understands major worldwide scientific and technological trends in the second half of the 20th century.
World History Across Eras:
Standard 1 Long-term changes and recurring patterns in world

history.

Background:

The future we want has to be invented, otherwise we get the future that we do not want. –Josef Beus

Today every invention is received with a cry of triumph which soon turns into a cry of fear. -Bertolt Brecht

Historically speaking, Germany has been a leader in innovation and technology, and boasts an impressive record of inventions and Nobel Prize winners. Magnetic levitation trains are a German invention as is the over-the-counter pregnancy test. So too are the applications of ThyssenKrupp Titanium, found in Airbus planes and toothpaste, among other places. Used in paints, this application of titanium certainly makes the world a more colorful place. Nevertheless, recent innovations merely scratch the surface of German History. Listed below are some of the most famous innovations, inventions, or discoveries that have long given Germany its reputation. The list below comes from
About.com http://german.about.com/library/blerfinder.htm?nl=1

Erfinder und Entdecker The list below is a sampling of German, Austrian and Swiss inventors and researchers. It emphasizes people who developed practical and significant technologies, companies or devices that either still exist today or that represent important scientific and technological milestones. To learn more about an inventor, click on any name link below. The years for discoveries (as opposed to inventions) are marked in red.

Inventor	**Jahr** Year	**Erfindung** Invention
Alois Alzheimer	1906	**die Alzheimer Krankheit** Alzheimer's disease (discovery)
Selmar Aschheim	1928	**Schwangerschaftstest** first scientific pregnancy test
Martin Leo Arons	1892	**Aronssche Röhre**, **Quecksilberdampflampe** Arons tube, mercury vapor lamp
Karl Benz	1885	**Kraftwagen** automobile (Daimler-Benz)
Emil Berliner	1887	**Grammophon**, **Mikrophon** gramophone, microphone
Karlheinz Brandenburg	1995	**MP3** MPEG Level 3, Fraunhofer Inst.
Karl Ferdinand Braun	1897	**Braunsche Röhre** cathode-ray tube (Nobel Prize 1909)
Wernher von Braun	1940	**V2- und Redstone-Raketen** V2 and Redstone

		rockets
Gottlieb Daimler	1885	**Kraftwagen** automobile (Daimler-Benz)
Adolf (Adi) Dassler	1920	**Sportschuh** (adidas) athletic shoe
Rudolf Diesel	1885	**der Dieselmotor** diesel engine
Paul Ehrlich	1910	**Salvarsan** syphilis treatment, Nobel Prize 1908
Albert Einstein	1905	**Relativitätstheorie** Theory of Relativity
Daniel Gabriel Fahrenheit	1709	**Alkoholthermometer** alcohol thermometer
Heinrich Geissler	1850	**Geissler Röhre** Geissler (flourescent) tube
Edmund Germer	1900	**Neonlampe** flourescent lamp
Bernhard Grill	1995	**MP3** MPEG Level 3, Fraunhofer Inst.
Johannes Gutenberg	1440	**Buchdruckerkunst** movable type
Peter Henlein	ca. 1510	**die Unruh** balance spring (clockwork)
Heinrich R. Hertz	1888	**elektromagnetische Wellen** electromagnetic waves
Felix Hoffmann (Bayer AG)	1899	**Aspirin** Aspirin®, aspirin*
*In Germany and many other countries, aspirin is a registered trademark belonging to Bayer AG, the company that invented the name "aspirin." In 1995 Bayer (*pron.* BYE-er) bought back the US rights to the Bayer Aspirin brand in North America, but aspirin is still not a trademarked name in the US. **About Link**: History of Aspirin from Inventors @ About.		
Robert Koch	1876	**Milzbrand-Bakterium** anthrax bacterium, Nobel Prize in Medicine 1905
Hedy Lamarr	1942	**Wechselspektrum** spread spectrum technology Web > Hedy Lamarr
Otto Lilienthal	1896	**Segelflugzeug** glider
Zitat: **Opfer müssen gebracht werden.** - *Last words of Otto Lilienthal after his glider crashed, following several successful flights in 1896.*		
Karl von Linde	1876	**Kühlschrank** ammonia refrigerator
Ernst Mach	1877	**Mach'scher Zahl** Mach number (speed of an object relative to speed of sound) Web > Wikipedia - Mach
Paul H. Müller	1939	**DDT** DDT
Walther Hermann Nernst	1920	**Nobelpreis** Nobel Prize, thermochemistry
Paul Nipkow	1884	**Nipkow-Scheibe** Nipkow scanning disk (TV)
Nikolaus August Otto	1877	**Viertakt-Verbrennungsmotor** four-stroke internal combustion engine
Emil Rathenau	1884	**Allgemeine Elektrizitätsgesellschaft** (AEG)
Philipp Reis	1861	**Telefon** telephone prototype
Zitat: **Ein Pferd frißt keinen Gurkensalat** - *Words spoken by Philipp Reis while testing his new telephone in 1861.*		
Wilhelm C. Röntgen	1895	**Röntgenstrahlen** X-rays (discovery), Nobel Prize in Physics 1901

Ludwig Roselius	1906	**Entkoffeinierung** - Decaffeination of coffee
Ernst Ruska	1931	**Elektronenmikroskop** electron microscope, Nobel Prize in Physics 1986
Charles Proteus Steinmetz	1902	**Wechselstrom**, **Blitzforschung** alternating current, lightning research
Levi Strauss	1853	**die Jeans**, blue jeans, Levi's
Werner von Siemens	1867	**Dynamo** dynamo generator
Felix Wankel	1954	**Kreiskolbenmotor** rotary cylinder engine
August Paul von Wassermann	1906	**Wassermann-Test** for syphilis
Graf Ferdinand von Zeppelin	1900	**Zeppelin-Luftschiff** rigid airship
Bernhard Zondek	1928	**Schwangerschaftstest** first scientific pregnancy test
Konrad Zuse	1941	**Z1-Z4-Rechner** Z1-Z4 computers - The Z3 was the first programmable computer

More than a hundred recent German discoveries, applications, and innovations are cited in 365 IDEAS FROM GERMANY- THE ESSENTIAL GUIDE (cited in the Sources for Information section of this lesson). Much more information can be accessed through the web searches also recommended in the Sources for Information section.

As for Germany's Nobel Prize winners, the list is most impressive, including 21 in Physics (2nd most), 27 in Chemistry (2nd most), and 16 in Physiology and Medicine (3rd most). Note the list below of ALL GERMAN Nobel Prize winners, cited by Wickipedia:

1. Gerhard Ertl, Chemistry, 2007
2. Peter Grünberg, *(then Protectorate of Bohemia and Moravia, now Czech Republic)*, Physics, 2007
3. Theodor W. Hänsch, Physics, 2005
4. Robert Aumann*, Economics, 2005
5. Wolfgang Ketterle, Physics, 2001
6. Herbert Kroemer*, Physics, 2000
7. Günter Blobel*, Physiology or Medicine, 1999
8. Günter Grass, *(then Free City of Danzig, now Poland)*, Literature, 1999
9. Horst L. Störmer*, Physics, 1998

10. Christiane Nüsslein-Volhard, Physiology or Medicine, 1995
11. Reinhard Selten, Economics, 1994
12. Bert Sakmann, Physiology or Medicine, 1991
13. Erwin Neher, Physiology or Medicine, 1991
14. Hans G. Dehmelt*, Physics, 1989
15. Wolfgang Paul, Physics, 1989
16. Johann Deisenhofer, Chemistry, 1988
17. Robert Huber, Chemistry, 1988
18. Jack Steinberger*, Physics, 1988
19. Hartmut Michel, Chemistry, 1988
20. J. Georg Bednorz, Physics, 1987
21. John Charles Polanyi*, Chemistry, 1986
22. Ernst Ruska, Physics, 1986
23. Gerd Binnig, Physics, 1986
24. Klaus von Klitzing, Physics, 1985
25. Georges J.F. Kohler*, Physiology or Medicine, 1984
26. Georg Wittig, Chemistry, 1979
27. Henry Kissinger*, Peace, 1973
28. Ernst Otto Fischer, Chemistry, 1973
29. Karl Ritter von Frisch, *(then Austria-Hungary, now Austria)*, Physiology or Medicine, 1973
30. Heinrich Böll, Literature, 1972
31. Gerhard Herzberg*, Chemistry, 1971
32. Willy Brandt, Peace, 1971
33. Bernard Katz*, Physiology or Medicine, 1970
34. Max Delbrück*, Physiology or Medicine, 1969
35. Manfred Eigen, Chemistry, 1967
36. Hans Albrecht Bethe*, *(now France)*, Physics, 1967

37. Nelly Sachs*, Literature, 1966
38. Feodor Felix Konrad Lynen, Physiology or Medicine, 1964
39. Konrad Bloch*, Physiology or Medicine, 1964
40. Karl Ziegler, Chemistry, 1963
41. Maria Goeppert-Mayer*, Physics, 1963
42. J. Hans D. Jensen, Physics, 1963
43. Rudolf Mössbauer, Physics, 1961
44. Werner Forssmann, Physiology or Medicine, 1956
45. Max Born* *(1933-1953 in exile in Britain - became a British subject)*, Physics 1954
46. Walther Bothe, Physics, 1954
47. Hermann Staudinger, Chemistry, 1953
48. Fritz Albert Lipmann*, *(then Germany, now Russia)*, Physiology or Medicine, 1953
49. Hans Adolf Krebs*, Physiology or Medicine, 1953
50. Albert Schweitzer*, *(now France)*, Peace, 1952
51. Otto Diels, Chemistry, 1950
52. Kurt Alder, Chemistry, 1950
53. Herman Hesse*, Literature, 1946
54. Ernst Boris Chain*, Physiology or Medicine, 1945
55. Otto Hahn, Chemistry 1944
56. Otto Stern*, Physics, 1943
57. Adolf Butenandt, Chemistry, 1939
58. Gerhard Domagk, Physiology or Medicine, 1939
59. Richard Kuhn, *born in Austria* Chemistry 1938
60. Carl von Ossietzky, Peace, 1935

61. Hans Spemann, Physiology or Medicine, 1935
62. Werner Karl Heisenberg, Physics, 1932
63. Otto Heinrich Warburg, Physiology or Medicine, 1931
64. Carl Bosch, Chemistry 1931
65. Friedrich Bergius, Chemistry, 1931
66. Hans Fischer, Chemistry, 1930
67. Thomas Mann, Literature, 1929
68. Adolf Otto Reinhold Windaus, Chemistry, 1928
69. Ludwig Quidde, *(then Bremen)*, Peace, 1927
70. Heinrich Otto Wieland, Chemistry, 1927
71. Gustav Stresemann, Peace, 1926
72. Richard Adolf Zsigmondy, *(then Austrian Empire, now Austria)*, Chemistry, 1925
73. James Franck, Physics, 1925
74. Gustav Ludwig Hertz, Physics, 1925
75. Otto Fritz Meyerhof, Physiology or Medicine, 1922
76. Albert Einstein, Physics, 1921
77. Walther Nernst, Chemistry, 1920
78. Johannes Stark, Physics, 1919
79. Fritz Haber, Chemistry 1918
80. Max Karl Ernst Ludwig Planck, *(then Denmark)*, Physics, 1918
81. Richard Willstätter, Chemistry, 1915
82. Max von Laue, Physics, 1914
83. Gerhart Hauptmann, *(then Prussia, now Poland)*, Literature, 1912
84. Wilhelm Wien, *(then Prussia)*, Physics, 1911
85. Otto Wallach, Chemistry, 1910

86. Albrecht Kossel, Physiology or Medicine, 1910
87. Paul Johann Ludwig Heyse, *(then Prussia)*, Literature, 1910
88. Karl Ferdinand Braun, Physics, 1909
89. Wilhelm Ostwald, *today Latvia*, Chemistry, 1909
90. Rudolf Christoph Eucken, *(then Hanover)*, Literature, 1908
91. Paul Ehrlich, Physiology or Medicine, 1908
92. Eduard Buchner, Chemistry, 1907
93. Albert Abraham Michelson*, *(then Prussia, now Poland)* Physics 1907
94. Robert Koch, Physiology or Medicine, 1905
95. Philipp Lenard*, *(then Austria-Hungary, now Slovakia)*, Physics, 1905
96. Adolf von Baeyer, Chemistry, 1905
97. Hermann Emil Fischer, Chemistry, 1902
98. Theodor Mommsen, *(then Denmark)*, Literature, 1902
99. Emil Adolf von Behring, Physiology or Medicine, 1901
100. Wilhelm Conrad Röntgen, *(then Prussia)*, Physics, 1901

The Nobel Prize website, http://nobelprize.org/nobel_prizes/lists/all/ lists all winners of all Nobel Prizes, some 797 through 2007. It is quite evident that Germany has especially excelled in the sciences and technology.

Today, approximately 85% of the research and development moneys in Germany are applied to the chemical, machine tool, and automotive industries. New investments are being made in Information Technology, biotechnology, and nanotechnology. This has resulted in new "high-tech" products being integrated into "medium-tech" products, thus advancing innovation

performance in manufacturing. (Kerstin Rohling and Thomas Multhaup. www.oecdobserver.org) Chancellor Angela Merkel has stated that Germany needs to raise R&D spending to 3% of Gross Domestic product by 2010. Germany continues its desire to reverse the downward venture capital trend of 2001-2004, and reassert its place as an innovation and technology leader.

Germany hopes to boost its standing by attracting foreign brains while the United States impedes their entry. Deregulation of the airwaves has been called for to improve experimentation in mobile services. Intellectual Property recognition needs to be valued by more banks and other financial providers, while on the other hand, some patents such as software ones, may be stifling innovation (Jan hofmann. Jan-p.hofmann@db.com). Yet, from wind energy to all weather autonomous helicopters, new developments continue to arise in Germany. The "Partners for Innovation" program in Germany is pushing the country to succeed.

Procedures:

Students will first be divided into three large groups:

1. History of German Innovation/New Technology.
2. Germany and the Nobel Prize.
3. Innovation in Germany today.

Each group will then subdivide into research teams. Group one could divide by time spans—pre-1900, 1900-1945. 1945-1990. Group two could divide by topics—physics, chemistry, physiology, others. Group three could divide by fields—environmental, industrial, communications and transportation, energy.

Each group will be given a week to gather evidence and draw conclusions about Germany's role in each area. The background and assignment can be taught in a 45 minute class period. Transparencies from GERMANY TODAY or GERMANY IN EUROPE (or CD projections) should be utilized in this introduction. The research itself could be done using one class period in a computer lab/ library, with the remainder being done as an assignment over several days.

The last two or three class periods would be devoted to class presentations and discussion. During the initial background and assignment period, the teacher could determine the length of time for each group's presentation.

The Background Section of this lesson (previous pages) and the Sources for Information section (following this), should give the teacher/class ideas as to specific group content.

Reasonable findings should include the following:

1. Germany has historically been at the vanguard for innovation and new technology.
2. Germany's overall record is second, worldwide, in Nobel Prize prominence (perhaps number one, if figured per capita).
3. Germany today is concerned about restoring its position as the number one or two innovation and technology leader in the world, after a brief, but recent downturn.

Sources for Information"

1. Goethe Institut. www.goethe.de/top
2. GERMANY TODAY, 2007. Jervis, et.al. NCSS (National Council for the Social Studies) or AATG (American Association of Teachers of German) websites.
3. GERMANY IN EUROPE, 2007. Jervis, et. al. NCSS or AATG websites.
4. DW-World.DE, Deutsche Welle, technology sections.
5. DW-World.DE, Deutsche Welle, "German Nobel Prize Winners- A History, 10/10/07.
6. DER SPIEGEL. http://www.spiegel.de/international/ Articles on German innovation and technology.
7. Offshore Energies. www.rostock-business.de
8. **FPRI.org At this site are/will be articles and videos from numerous Innovation experts. Materials will include talks from the Wachman Center Weekend on Innovation October, 2008. Many of the papers from the 2008—"Innovation Weekend" are highly relevant. Many of these writers have numerous works on this subject which are either mentioned in the papers or can be found with a Google search of the authors.**
9. **Airbus. http://www.airbus.com/en/ Aeronautics developments.**
10. **Aker Shipbuilding. http://www.akeryards.com/ Shipbuilding technologies.**
11. **365 IDEAS FROM GERMANY—THE ESSNTIAL GUIDE. Deutsche Bank. www.land-or-ideas.org**
12. **TECHNOLOGY REVIEW (an Massachusetts Institute of Technology publication) http://wwwtechnologyreview.com**
13. Engineering's grand challenges. http://engineeringchallenges.org/
14. **THE ECONOMIST Magazine: search under economic innovation, innovation, invention. See in particular April 28 to May 4, 2007 "When Everything Connects".**

15. A Yahoo or Google search of "German Technologies", " German Innovation", "Invention", and "Technology", will also yield a wide range of sources.
16. Wikipedia entries on Nobel Prizes and Prize Winners plus a wide variety of inventions and innovations (provided that original sources are consulted to verify entries.)
17. http://www.ideafinder.com/history/timeline This website provides an extensive listing of innovations and inventions mixed