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“Cold Fusion” May Be Part Of A Scientific Revolution

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Paradigm shifts in physics have occurred at about 80-year intervals for the past 500 years. The periodicity of the paradigm shifts is due to the constraints of inhibition of apprehension and the difference between theoreticians and technicians, so that there is a three-generation periodicity. The various phenomena called “cold fusion” and associated physical anomalies are the grounds for another scientific revolution. If the historical pattern of paradigm development continues into the future, we can make predictions about this new physics and its economic effects. The Fluid Theory, Field Theory, and Q.M-Relativity Theory paradigms each led to an industrial revolution that happened about 55 or 80 years afterward.

1 Introduction

Scientific revolutions in physics of the type described by Thomas Kuhn [1] occurred at about 80-year intervals[2]. Two constraints on the development of physics and the time required for scientists to mature establish the 80-year periodicity. The phenomena of “cold fusion” and other recently discovered physical anomalies are a part of the basis for a revolution in physics theory. The pattern of paradigm shifts relates to the pattern of industrial revolutions and productivity growth in the most advanced economies. If this theory is accurate and physics and economies develop as in the past, we can make predictions about the future development of the field of cold fusion and about its technological and economic consequences.

There have been six scientific revolutions in physics:

- the Copernican, about 1506;
- the Galilean, about 1593;
- the Newtonian, 1664;
- the Fluid paradigm originally formulated by Franklin, about 1745;
- the Classical Field theory paradigm, rudimentarily formulated by Faraday in 1820 and developed by Maxwell;
- and the Quantum Mechanics (Q.M.) and Relativity theory paradigm formulated by Einstein, about 1905.

There are major changes in the basic postulates of physics during the scientific revolutions. From 1506 to 1905, six groups of postulates were formulated. The major physics theories of the past can be classified according to the six groups of postulates or as mixtures of the six groups. The revolutions happened about every 80 years. In fact, the period 1506–1905 is 399 years, or about 5 x 80 years. See Figure 1.

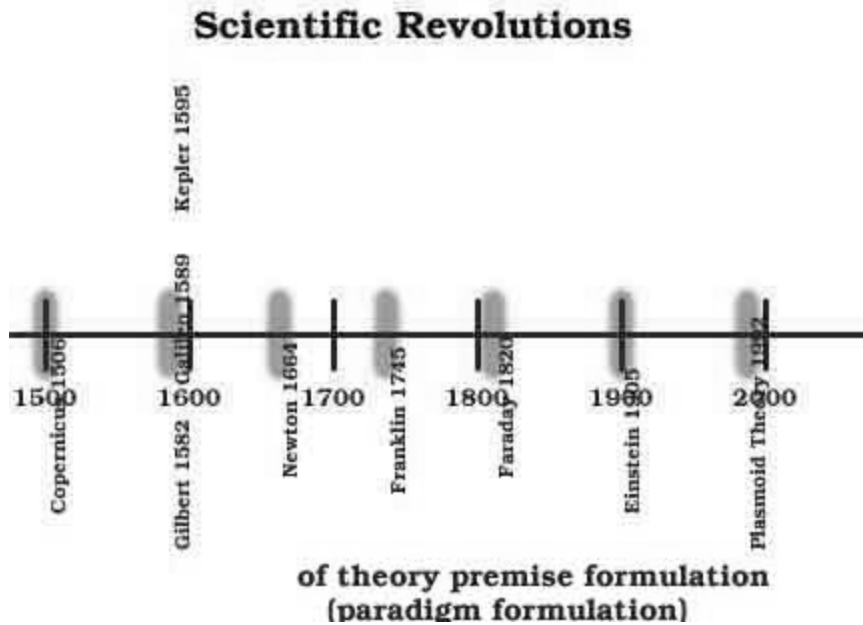


Figure 1. Chart of scientific revolutions in physics after 1500. The chart clearly shows an approximately 80 year periodicity [2].

In each of the scientific revolutions, there was a change of the basic set of postulates of physics. Each of the paradigms contained a different basic hypothesis about the force or energy that caused matter to move. There were also several differences in the basic conception of the atom.

Copernicus postulated indivisible atoms. Copernicus's heliocentric viewpoint contained a postulate about impetus, which was that everything strived to position itself to its natural place. In contrast, Galileo, Kepler, and Gilbert more or less independently postulated the tendency of bodies to rest and outside forces as the reason for motion, and magnetism as the reason for the fall of bodies. Newton postulated that corpuscles of matter are the seat of forces and also *aether* to explain magnetic and electric phenomena. The ideas of a pervading aether and of corpuscles that were the goal or point of departure of forces were postulates of all theories of the Newtonian paradigm. Franklin retained Newton's conception of atoms and gravity but postulated both the "matter" of heat and the "matter" of electricity. He may have postulated about a fluid of magnetism. Franklin's postulate of heat was quite different from the theory of heat of the Newtonians: To Franklin, heat was a basic kind of matter, a cause, but to the Newtonians heat was an effect of something else. The French called the matter of heat *caloric*. Aepinus developed the theory of the fluid of magnetism. Faraday postulated that atoms were "point atoms" and not hard corpuscles as did Franklin. He postulated about lines of force; and Maxwell extended these ideas by developing Classical Field theory. Einstein postulated the quantum of energy and space-time.

Each change of premise led to an advance of technology, as will be described.

2 Theory

The periodicity happens because of two constraints on human achievement that impede the progress of development of a paradigm during the "crisis period" stage, the theoretical formulation stage, and the stage of theoretical development. The term *crisis period* was used by Thomas Kuhn [1] to refer to the 10- or 20-year period of time just before a scientific revolution in which fundamentally significant anomalies to the established paradigm are recognized by experimenters. These constraints are as follows:

- (I) Older, more experienced people learn new ideas slowly or not at all, especially when the ideas are very different from their own[1]. I call this constraint the *inhibition of apprehension*.

- (II) Theoreticians are not usually the best experimenters or technicians, and vice versa[3]. I call this constraint *the difference between theoreticians and technicians*.

Both of these constraints were described by Kuhn: “Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change[1].” It is important to try to understand why this constraint happens. He also wrote:

what scientists never do when confronted by even several and prolonged anomalies. Though they may begin to lose faith and then to consider alternatives, they do not renounce the paradigm that has led them into crisis ... anomalies are seldom just an increment to what is already known. [Their] assimilation requires the reconstruction of prior theory and the re-evaluation of prior fact[1].

2.1 Formulation of Basic Postulates

Constraint I impedes progress at the crisis period stage. During a crisis period, experimental physicists who are middle-aged find anomalies that contradict the basic premise of their theory of physics. Neither they nor other experienced scientists in their generation can formulate a new premise because of this constraint. So a younger person in the generation following or less-experienced person in their own generation (such as Franklin) formulates a new basic theory to understand the anomalies.

The postulates of a formulator’s paradigm are inherent in the anomalies themselves. This is because such anomalies are simply the way reality contradicts the postulates of a previous paradigm to our senses. For this reason, several individuals, such as Galileo, Gilbert, and Kepler, may more or less independently formulate similar premises for the same paradigm.

2.2 Development of the Theory of Each Paradigm

The formulator of the premise has never been able to complete the development of the theory of a paradigm by himself. Since those of his generation already accept the older paradigm, the work of developing theory to an advanced level has been carried out by the younger people of the next generation, again because of Constraint I. For example, Coulomb (b. 1736), Aepinus (b. 1724), LaPlace (b. 1749), Lavoisier (b. 1743), and Watt (b. 1736) were among the second-generation physicists, chemists, and scientists who developed the theories of the Fluid theory paradigm.

The developers of the Field theory paradigm were mainly a few British men such as Maxwell (b. 1831) and Thomson (b. 1824). Field theory was not accepted by most Continental scientists until the late 1800s. They accepted a modified form of Fluid theory that was developed to account for the anomalous phenomena. Maxwell developed most of Classical Field theory by himself by the year 1865 around the age of 40.

The developers of the Q.M.-Relativity paradigm were born around the year 1905, and they also finished their most important contributions by about the age of 40. These men included Heisenberg (b. 1901), de Broglie (b. 1892), Dirac (b. 1902), Schrodinger (b. 1887), Tomonaga (b. 1906), Schwinger (b. 1918), and Feynman (b. 1918). Two kinds of well-developed theories for Q.M. emerged. Some, such as Dirac and Schrodinger, developed theories that had a premise that was more like Einstein's, whereas others such as Heisenberg developed a Q.M. that included the concept of the “uncertainty principle.”

2.3 Third-Generation Stage of Experimentation

The generations of theoretical developers have never been able to produce the anomalies that led to the next paradigmatic formulation. This is because of Constraint II. Theoretical developers of the second generation often don’t perform experiments or develop technical skill. The work of developing the technology, instrumentation, and experimental skills necessary for characterizing fundamental anomalies has been carried out by technically orientated people who discover anomalies at about age 40. Researchers in the third generation work to achieve the results of verifying the existing prevalent theory and finding experimental contradictions.

Constraint II explains why most of the experimenters in the cold fusion field were middle-aged when they made their discoveries. They were born around the 1940s and were taught Q.M. and Relativity theory when they were young. After about 20 years of developing their technical and research skills, they reached their most productive years in the 1970s, 1980s, and 1990s. For example, Martin Fleischmann (b. 1927) and Stanley Pons (b. 1943) began doing a series of experiments in the mid-1980s to investigate the phenomena of bursts of heat during electrolysis

with palladium electrodes. Fleischmann said he noticed this phenomenon in the 1960s, but he didn't do his best experimental research until he had grown in expertise in studying this anomalous area.

In the crisis period of the 1880s, 1890s, and the early 1900s, the important experimenters who found fundamental anomalies include John Thomson (b. 1856), Michelson (b. 1852), Morley (b. 1838), and Lenard (b. 1862). In 1881 Michelson invented the interferometer. Michelson and Morley showed that light travels at a constant speed in all inertial frames of reference. This anomaly was a part of the basis for Relativity theory. This generation of experimenters was born about the year 1865 and accepted Field theory. The anomalies formed the basis for Einstein's premise.

During the prior crisis period of the late 1790s, 1800s, and 1810s, Benjamin Thompson (b. 1753) in 1798 showed that heat was not a fluid but a form of mechanical energy. Together with Davy (b. 1778), he helped to found the Royal Institution, where Faraday worked as an assistant. There, Faraday noted several anomalous effects that showed him that Fluid theory was false, and that laid the basis for his conceptions of the point atom and lines of force. In 1820 Oersted (b. 1777) showed an experimental relationship between magnetism and electricity that contradicted the then-current idea that these were distinct fluids.

During a crisis period or a little afterward, third-generation experimenters also validate the premise and predictions of the dominant theory. For example, during the last crisis period, in 1971, J. C. Hafele (b. 1933) measured the effect of altitude on cesium clocks and validated Relativity theory. Other verifications included the measurement of the relativistic treatment of the Lamb shift in 1976, the measurement of the positron anomaly in 1981, and the measurement of the electron anomaly in 1985.

2.4 The Generational Pattern from Copernicus to Franklin

From 1506 to 1745, physics developed in an 80-year, three-generation pattern. Copernicus was born in 1473. As Copernicus grew up, he learned about the anomalies and the problems of the established physical theories of his time. In 1506, when he was 33, he started to circulate letters describing his heliocentric ideas. He described a general theory to explain the known phenomena of planetary motion, meteorological phenomena, lodestones and rubbed amber, and the fall of objects. The hypothesis of impetus was his explanation for the cohesion of the earth and fall. He thought everything on and in the earth had an innate drive to move to the center of the earth. The young people who accepted his ideas developed the Copernican paradigm in the two routes of astronomy and earth-based physics when they reached middle age (about 1546).

Some, including Rheticus (b. 1514) and Reinhold (b. 1511), focused on studying Copernican astronomy. Rheticus met Copernicus in 1539, and Reinhold met him in 1541. Both men were impressed by his ideas and contributed their best work in their 40s. Rheticus published *Narratio Prima*, which was about *De Revolutionibus*, in 1540 when he was 26. In 1551, when he was 40, Reinhold published a set of astronomical tables that were computed by the mathematical methods developed by Copernicus.

By the early 1550s, other theoreticians of their generation developed much of the physics of earth motions of that paradigm. For example, Benedetti (b. 1530) developed a physics of motion on the earth and statics according to Copernican-type ideas. He published *Demonstratio* in 1554.

Men of the next generation performed the important experiments that tested the theory. One of these men, Tycho Brahe (b. 1546), was not a Copernican. He espoused a theory that was a mixture of Copernican ideas and earlier ideas. His theory could be regarded as a mixture of two or more sets of postulates. Brahe used the tables that Reinhold published as a guide or template for testing Copernicus's theory to discern several important anomalies, such as the extra-lunar orbit of comets and the incorrect predictions about planetary motion.

Simon Stevin (b. 1548) believed and taught Copernican theory and verified Benedetti's prediction that objects of the same substance but of different weights would fall at the same rate in vacuum. Sarpi (b. 1552), along with many others who in the late 1500s accepted Copernican ideas, believed that the earth was a magnet, based on their study of magnets and the discovery of the magnetic dip by Norman (date of birth unknown) as described in 1581 in *The New Attractive* and by Georg Hartmann (b. 1489). They understood that magnetism originated in the earth, that the earth drew objects, and that the reason for the orientation of compasses was not extraterrestrial. These ideas contradicted Copernicus's idea of impetus. There was thus a crisis period in physics during the late 1500s.

In the late 1500s, Gilbert, Galileo, and Kepler formulated similar sets of hypotheses based on the experimental work of the preceding generation of experimenters. Galileo and Kepler were enthusiastic about Gilbert's theory when they read the *De Magnete*, which was published in 1600. They agreed with him about much of his description because their premises were already similar. Galileo and Kepler were communicating at least by 1600, and agreed with each other about the major points of theory.

Gilbert (b. 1544) formulated his premise in about 1582. In the preface to the *De Magnete*, Edmund Wright wrote that Gilbert had held back his magnetic philosophy for almost 18 years. Gilbert postulated what he called *magnetic form* and *electrical effluvia*. This classification of phenomena was a basis for physics in this paradigm for the succeeding 80 years.

Gilbert thought that the earth coacervates (heaps) or is brought together and held together electrically, positioned and revolved magnetically, and coheres magnetically in its interior. However, he also thought that water and other large-scale features of the earth were influenced to stay on the earth magnetically and were influenced by the moon magnetically. It is important to note that Gilbert thought that the cohesion and aggregation of the earth was both electrical effluvia and magnetic form, not magnetic form only. In this respect, his theory differs from Galileo's theory.

In 1589, at age 25, Galileo (b. 1564) formulated his first postulates of motion. He laid a foundation of a physics of motion of that time, but Descartes and others completed this theory. Galileo postulated magnetism as the cause for fall, the vacuum, the tendency of bodies to rest, and outside force as the cause of motion.

Kepler (b. 1571) attended the University of Tübingen where Maestlin, who taught a theory similar to Copernicus's, taught and performed experiments. Around the year 1595, Kepler formulated a heliocentric theory for astronomy. Later, he understood that the planets follow elliptical orbits. There is evidence that he hypothesized that planets had a tendency to rest about 1604 or 1605. He thought that objects on the earth had a tendency to rest as well[4]. By 1600 he thought that the sun emanated a magnetic vigor that caused the planetary rotations. He idealized outside force, the tendency of bodies to rest, and fall as a magnetic phenomenon.

Those of the next generation who developed similar theories of this genre include Gassendi (b. 1592), Mersenne (b. 1588), Desargues (b. 1591), Descartes (b. 1596), Roberval (b. 1602), Etienne Pascal (b. 1588), Castelli (b. 1578), and Cavalieri (b. 1598). They defined gravity as magnetic effluvia or form, or electric effluvia, or as a vortex of particles. Descartes developed a highly influential philosophical physics that was nearly impossible to test and published his ideas in the early 1640s.

Experimenters of the next generation such as Torricelli (b. 1606), Boyle (b. 1627), Hooke (b. 1635), Von Guericke (b. 1602), and Blaise Pascal (b. 1623) found some important anomalies during the crisis period of 1640-1664. Von Guericke put Descartes' "plenist" theory, which denied the existence of the vacuum, to the test. He devised and constructed various models of pumps to produce a vacuum. Boyle helped to invent the vacuum pump and taught Newton about important anomalies. The anomalies that were discovered, such as the vacuum and that sound did not travel through a vacuum, were important for Newton's formulation of new hypotheses about the nature of matter and motion.

Their contemporaries in the mid-1600s, such as Borelli (b. 1608) and Huygens (b. 1629), tried to comprehend the anomalies, but it was Newton who formulated the set of postulates for the next paradigm. But the development of theories of this earlier genre did not end with Newton. In Continental Europe, scientists such as Leibniz, the Bernoullis, Euler, Nollet, and Dufay continued development of ideas based on theories similar to those of Galileo and Descartes. These theorists described gravity, electricity, and magnetism as vortices, the mechanical motion of tiny invisible objects. Most educated Continental Europeans accepted a theory of this genre until the mid-1700s, but the Newtonian paradigm was accepted mainly in Britain. There was a similar divergence in thinking in the mid-1800s among theoreticians in Britain and the Continent as is described in this article.

In 1664, at the age of 22, Newton (b. 1642) formulated the basic premise of his theory. He attempted to lay a uniform theoretical foundation for the whole of known phenomena. His work proved successful for mechanics and gravitation, but he failed to adequately explain electrical or magnetic phenomena known during the 1700s. He resolved anomalies such as the elasticity of air by postulating corpuscles of matter as being the seat of forces. He postulated that there was a repulsive force that made corpuscles springy; and at least later, if not at first, that there was an attractive force, gravity, between them.

After 1664, there followed a two-generation process that required about 80 years to complete. People of the next generation who developed the theories include Boerhaave (b. 1668), Hauksbee (b. 1666), Gravesande (b. 1688), Stephen Gray (b. 1666), and Desaguliers (b. 1683). When they reached middle age in the early 1700s, they taught others who verified predictions of Newtonian theory or found anomalies in this paradigm.

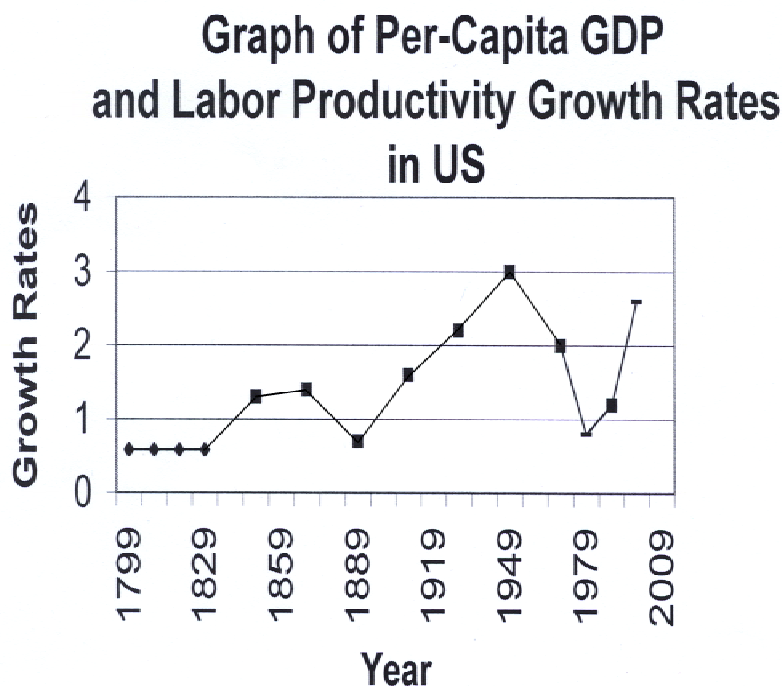
During the crisis period of 1725-1745, Martine (b. 1702), Van Musschenbroek (b. 1692), and Von Kleist (b. 1700) made discoveries of electrical and heat anomalies that led to Franklin's fundamental theoretical formulation. George Martine showed experimental anomalies of the Newtonian premise concerning heat. In 1745 and 1746, Von Kleist and Van Musschenbroek independently produced the anomalous Leyden jar to store electricity generated from Hauksbee-type machines.

2.5 Conclusion of Theory Section

The development of a paradigm in physics is a three-generation process working through two constraints. There is a drive to develop physics as quickly as possible given these two constraints and the maturation of the scientists. Scientific revolutions would happen at regular intervals of time under the right conditions. In fact, they have happened at about 80-year intervals. This suggests that the age of maturity in the performance of the work of theoretical development and experimentation is about 40. This seems to be so in the history of physics.

3 Economic Effects

The periodicity of technological development has caused a periodicity of productivity growth in the most advanced economies. Physics is knowledge about the environment and how to manipulate it, so paradigm shifts in physics change our ability to manipulate the environment. In the third generation of the development of each paradigm, experimenters, inventors, and technicians invent new technologies that become the basis for important industries. The first generation of the work force to accept a new paradigm implements the inventions of the technicians, invent the kinds of products that are possible, and build the new industries, and the second generation perfects process innovation, that is, the establishing of oligopolies, automation, and economies of scale; this results in the 80-year periodicity of productivity growth rates (see Figure 2) in the most advanced economies since 1790.



This figure for the rate of increase of GDP is from a table in a working paper by Paul M. Romer. "Table 2, Per Capita Growth in the United States," in Paul M. Romer, "Increasing Returns and Long Run Growth," Working Paper, Oct, 1985. The raw data he uses is from Maddison (1979).



The figures for productivity growth rates in the U.S. economy which were used here are from a chart from a paper by Paul M. Romer: "Capital Accumulation in the Theory of Long-Run Growth," in Robert J. Barro, ed., **Modern Business Cycle Theory**, (Cambridge, 1989): 51-126 (p. 58).



The figures for productivity growth for 1979 and 1999 that were used here are my estimates for the 10 year period 1974-1984 and the 8 year period 1996-2004.

Figure 2. 80-Year Periodicity of Productivity Growth Rates in the United States. This graph uses statistics from articles by Paul Romer in 1985[5] and 1989[6] and my own estimates. In Romer's working paper from 1985, the graph of per capita growth in the United States in the early 1800s shows an increasing straight line.

The young people entering the work force in 1800, 1900, and 1982 thought according to the Franklin, Faraday, and Einstein paradigms, respectively. By the time they reached middle age, they had depleted the potential of the three paradigms for the innovation of kinds of products. Jobs (b. 1955) and Wozniak (b. 1950) are examples of the "Baby Boomer" generation's experience. They created the Apple I and started the personal computer industry in 1977. They and many other baby boomers built the Q.M.-based large industries that now dominate the economies of the most technologically advanced countries.

But by the years 1820, 1920, and 2000, when the first generation reached middle age, they had introduced almost all the basic kinds of products that were possible to invent. For example, the American commercial radio broadcasting industry started in 1920[7], and radio was the last important industry developed during the 1920s. Similarly, no large industry-creating kind of product is expected to be introduced in the new few years. At these times of technological acceleration and productivity growth acceleration, the middle-aged workers switched their emphasis from product innovation to process innovation. The focus of competition within each industry shifted from product introduction to refining fashion and style; increasing labor productivity by automating production; decreasing labor employment; increasing capital expenditure and corporate debt; and gaining market share by forming oligopolies. This is why technological acceleration periods happened in the 1820s in Britain and the 1920s in the U.S.[7], and another started about the year 2000 in the U.S.; and why there were productivity growth accelerations, high corporate debt levels and a great increase of unemployment. In the early 1800s, the U.S. was a technological follower of Great Britain, and this explains why the technological acceleration period in the U.S. lagged the one in Great Britain by a few years.

The second generation entered the workforce about 1937 and 1837 and further perfected process innovation during those times, and by middle age they depleted the technological potential of the respective paradigms. Due to depletion, the shift of resources to new industries, and foreign competition, there were the productivity growth slumps. See Figure 3.

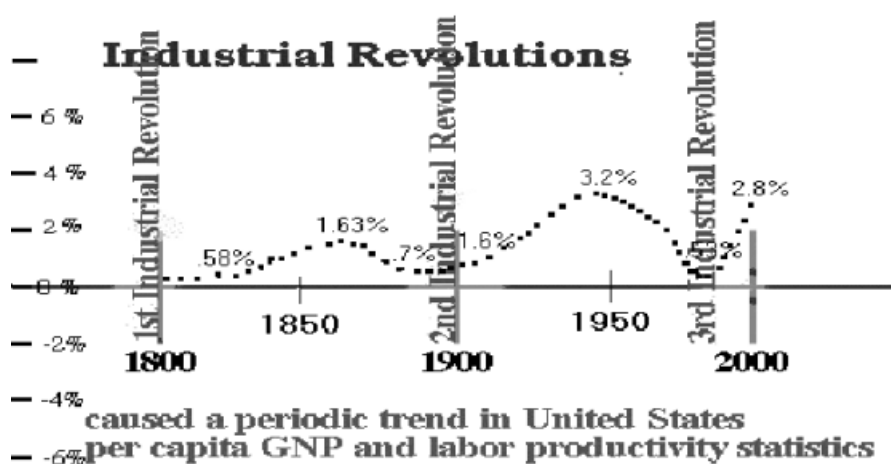


Figure 3. The three industrial revolutions resulted in an 80-year periodicity of productivity growth in the United States. The industrial revolutions are the times of the lowest productivity growth.

The Franklin paradigm entered the stage when the young work force accepted the basic ideas of the paradigm earlier than did the Faraday and Einstein paradigms, 55 years compared to about 80 years for the other two. This may have been because Franklin was a good writer and his theories were internationally published and studied only a few years after 1745. By the 1770s, he was widely recognized as one of the world's greatest scientists, and he was a popular political figure internationally as well.

Franklin's ideas of fluids of heat and electricity enabled innovation in furnace and steam engine design, chemical technology, and the control and use of electricity. The lightning rod saved cities and ships from destruction. Franklin estimated that his stove design required only a half or a third as much wood. Rittenhouse (b. 1644) and Thompson (b. 1753) improved furnace design as well. Watt (b. 1736) and his associates Black (b. 1728), Robison (b. 1739), and others who accepted Fluid theory developed the theory of latent and specific heats and improved steam engine design in the mid-1760s. Their knowledge of the fluid of heat enabled the invention of the steam engine because they thought of heat as a conserved substance.

"Caloric" chemistry enabled mass production of important chemicals such as litharge for glass making, sulfuric acid for use as a bleach for making textiles, and soda for making soap. The chemistry developed by people who believed the Franklin paradigm enabled the mass production of many consumer products.

Starting about 1800, hundreds of thousands of steam engines replaced human labor in factories. By 1833 there were almost 100,000 steam powered looms operating in the textile industry in Britain. In the 1820s and 1830s, the steam engine and automated production disemployed hundreds of thousands of British laborers but enabled an acceleration of the growth of British industrial output and labor productivity. Recently published statistics show that output per capita grew at a 0.5% flat rate from 1700 to about 1820. But in the 1820s and afterwards, Britain achieved growth in real output of 2% per year[8].

The Field Theory paradigm required 80 years to reach the stage when the entering work force accepted the theory, perhaps because Faraday did not publish much about his theory until old age. His paradigm was not accepted by most scientists until the 1880s, when crucial experiments by Hertz (b. 1857) and others who accepted the Faraday paradigm showed the superiority of the paradigm over the Fluid-based theories.

Faraday and Maxwell explained the structure of matter and space and the relationship between electric, magnetic, and chemical effects. This led Faraday and others to invent motors, generators, metal alloys, glass, and other products that became the basis for many industries around 1900. Faraday invented prototypes of the electric motor and the electric generator. He invented several kinds of steel alloys and glass, and he was called the founder of scientific metallurgy. These inventions were incorporated in automobiles and in electrical products of many kinds. Hertz's discoveries led to the invention of radio, television, and radar.

In conclusion, this theory explains the 80-year periodic timing of industrial revolutions and productivity growth rates in the most advanced economies. Industrial revolutions happened when a generation that accepted a new physical paradigm entered a market. Technological acceleration periods happened when those generations reached middle age and had exhausted the potential of the paradigm for invention of new kinds of products. Productivity growth was lowest during the industrial revolutions and fastest close after the periods of technological accelerations. See Figure 4.

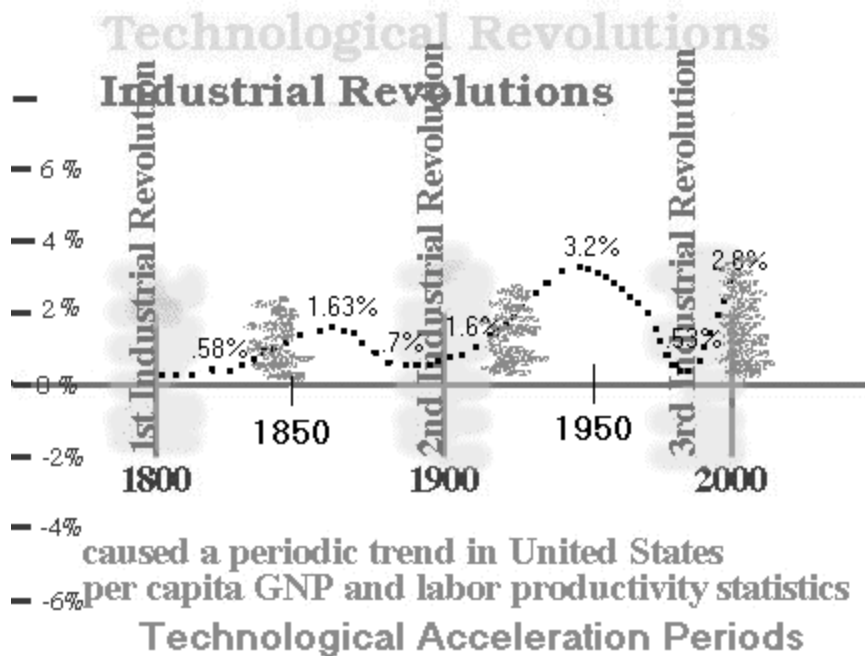


Figure 4. Chart of the periods of technological acceleration (and productivity growth acceleration) after 1800 in the United States. These happened after 1830, 1920 and 1999. These were the times when the industrial competitive emphasis switched from product to process innovation.

4 Evidence and Predictions about the Field of Cold Fusion

This scientific and economic theory was developed in the late 1980s and predicted that a new general theory was formulated sometime about the year 1985. The 1980s and 1990s were clearly a “crisis period” in physics. The cold fusion and ball lightning researchers have elucidated these major anomalies over the past decade. In Russia, the two fields merged somewhat. Also, this theory correctly predicted the timing and nature of the productivity growth acceleration that began about the year 2000.

If this theory is correct, and science and economies develop as in the past, fundamental anomalies were discovered.^a A young or inexperienced person resolved the anomalies to form simple hypotheses. Almost no one middle-aged can understand the new theory. Though there might be profitable inventive work early on, as there was with the invention of the telegraph based on the electro-magnetic effect in the 1830s, which was well before Maxwell’s work in the 1860s, the important inventions within this paradigm won’t be made until the theory is well developed. There will be a fourth Industrial Revolution by about 2035 or 2060.

5 Conclusion

Cold fusion is a part of a scientific revolution in physics. Paradigm shifts happen in an 80-year, three-generation periodicity. Two constraints and the time required for scientists to mature, together with a driving force, have caused this periodicity. This theory explains the economic periodicity described by Schumpeter and Kondratiev[9] in that the “technological acceleration” periods and the industrial revolution periods have been the economic depressionary troughs in the most advanced economies [2].

^a Please see my other article in this ICCF10 Proceedings that is titled, “The Ball Lightning State in Cold Fusion” for information about some ideas about anomalies in “cold fusion” and transmutation experiments.

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