Development of systems thinking

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This diagram had been developed over a number of years in an attempt to represent the development of systems thinking and complexity and some of the areas in which these developments contribute to ethical discourse.

There are isolated reactions to the 17th century mechanistic view of the world propounded by Descartes and Newton, most notably among the philosophers of the romantic movement.

The turn of the 18th century sees the first steps towards ecology and complexity being taken by Humboldt and Gauss respectively. In the 19th century Haeckel, Bernard, Poincaré, and Suess make significant contributions to subjects which will be developed in the 20th century.

Poincaré, in particular brings back the visual representation of mathematics after centuries of concentration on algebra and arithmetic at about the same time as Florence Nightingale is developing the graphical representation of statistics. Both in their own ways contribute to the development of visual representations of complexity.

The foundations of systems thinking in the West are laid largely by the organicists who first define many common systems terms — system, emergence, hierarchy and open system. The baton is then taken up by the cyberneticists who develop the concepts of feedback, redundancy and network as well as establishing the mathematical basis for information theory and the development of systems analysis in information technology.

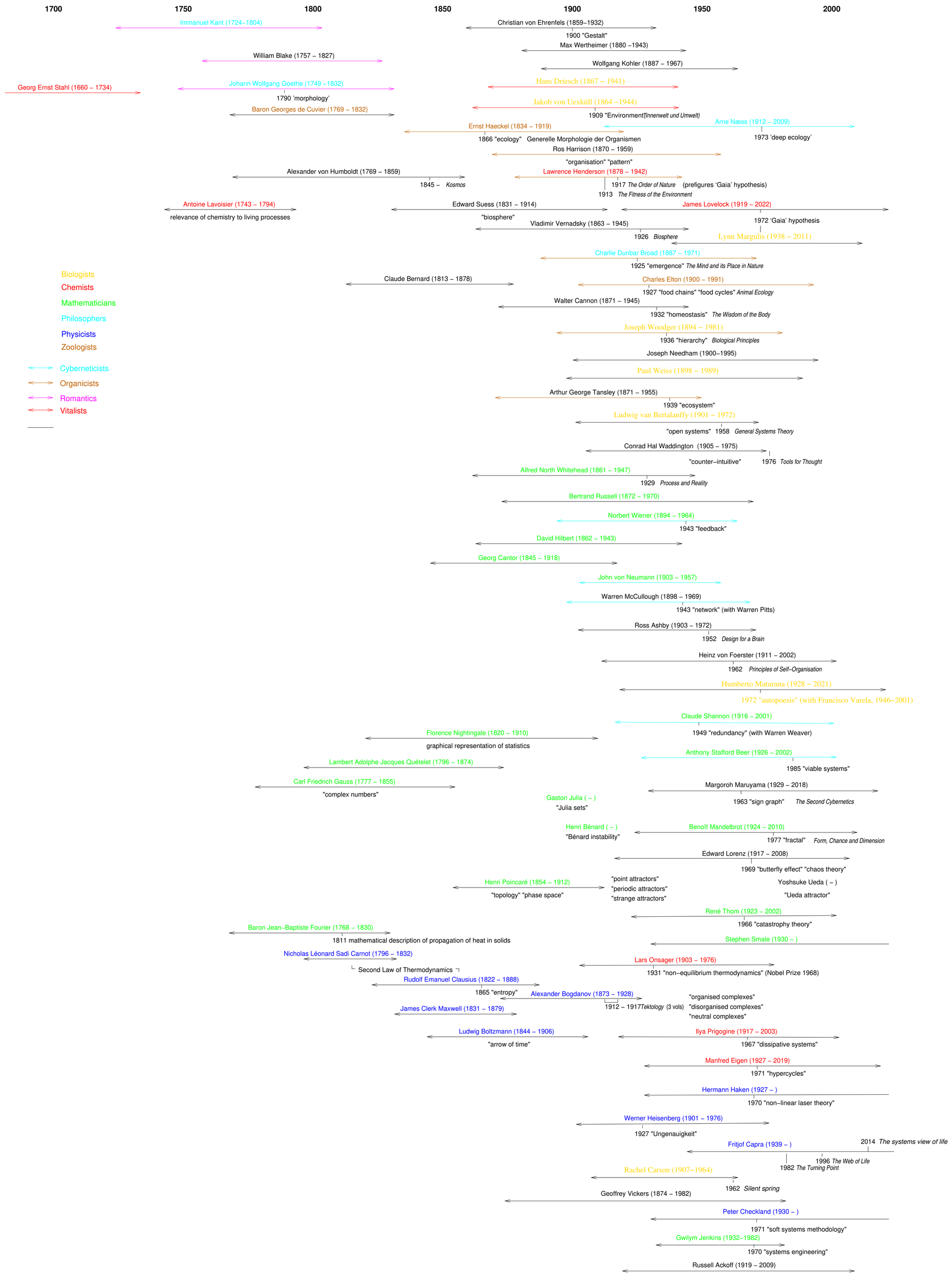
The biologist, Ludwig von Bertalanffy, tries to unite all the many disciplines, from the life sciences, mathematics and engineering, who are now using systems ideas but the attempt fails, in part because many members of these disciplines are still wedded to a mechanistic view of the world which progressive biologists have abandoned.

However, unbeknown to the West, Alexander Bogdanov has already formulated a theory of systems or 'complexes' which prefigures the work of late 20th century mathematicians and chemists while Gaston Julia has drawn the first fractals without knowing it.

By 1980 the fruits of Gauss's work on complex numbers and Poincaré's work on topology have led to the development of a whole new field of dynamical equations which enable Mandelbrot, Prigogine, Thom, Lorenz, Ueda, Haken and Eigen to describe the behaviour of systems which had not been understood, and in some case not recognised, fifty years earlier.

Stephen Smale had already shown how dynamical equations can be applied to ecological systems and the stage is therefore set for further advances in the study of 'systems' or 'complexes' using the insights born of the new concepts of nonlinear mathematics and far from equilibrium behaviour in a permanently unstable world where random behaviour is an integral part of the survival of many systems.

It is intended to develop the diagram to draw out further some of the associations which are obscured by the current layout, to add further information about the development of systems thinking in engineering and management and to extend its coverage to deep ecology and ecofeminism.


1700
1750
1800
1850
1900
1950
2000
Immanuel Kant (1724–1804)
Christian von Ehrenfels (1859–1932)
1900 "Gestalt"
Max Wertheimer (1880 –1943)
William Blake (1757 – 1827)
Wolfgang Kohler (1887 – 1967)
Georg Ernst Stahl (1660 – 1734)
Johann Wolfgang Goethe (1749 –1832)
1790 'morphology'
Hans Driesch (1867 – 1941)
Jakob von Uexküll (1864 –1944)
1909 "Environment"(Innenwelt und Umwelt)
Baron Georges de Cuvier (1769 – 1832)
Arne Næss (1912 – 2009)
Ernst Haeckel (1834 – 1919)
1866 "ecology" Generelle Morphologie der Organismen
1973 'deep ecology'
Ros Harrison (1870 – 1959)
"organisation" "pattern"
Alexander von Humboldt (1769 – 1859)
Lawrence Henderson (1878 – 1942)
1845 – Kosmos
1917 The Order of Nature (prefigures 'Gaia' hypothesis)
1913 The Fitness of the Environment
Antoine Lavoisier (1743 – 1794)
Edward Suess (1831 – 1914)
James Lovelock (1919 – 2022)
relevance of chemistry to living processes
"biosphere"
1972 'Gaia' hypothesis
Vladimir Vernadsky (1863 – 1945)
1926 Biosphere
Lynn Margulis (1938 – 2011)
Charlie Dunbar Broad (1887 – 1971)
1925 "emergence" The Mind and its Place in Nature
Biologists
Claude Bernard (1813 – 1878)
Charles Elton (1900 – 1991)
Chemists
1927 "food chains" "food cycles" Animal Ecology
Mathematicians
Walter Cannon (1871 – 1945)
Philosophers
1932 "homeostasis" The Wisdom of the Body
Physicists
Joseph Woodger (1894 – 1981)
Zoologists
1936 "hierarchy" Biological Principles
Joseph Needham (1900–1995)
Cyberneticists
Paul Weiss (1898 – 1989)
Organicists
Arthur George Tansley (1871 – 1955)
Romantics
1939 "ecosystem"
Vitalists
Ludwig van Bertalanffy (1901 – 1972)
"open systems" 1958 General Systems Theory
Conrad Hal Waddington (1905 – 1975)
"counter–intuitive" 1976 Tools for Thought
Alfred North Whitehead (1861 – 1947)
1929 Process and Reality
Bertrand Russell (1872 – 1970)
Norbert Wiener (1894 – 1964)
1943 "feedback"
David Hilbert (1862 – 1943)
Georg Cantor (1845 – 1918)
John von Neumann (1903 – 1957)
Warren McCullough (1898 – 1969)
1943 "network" (with Warren Pitts)
Ross Ashby (1903 – 1972)
1952 Design for a Brain
Heinz von Foerster (1911 – 2002)
1962 Principles of Self–Organisation
Humberto Maturana (1928 – 2021)
1972 "autopoesis" (with Francisco Varela, 1946–2001)
Claude Shannon (1916 – 2001)
1949 "redundancy" (with Warren Weaver)
Florence Nightingale (1820 – 1910)
graphical representation of statistics
Anthony Stafford Beer (1926 – 2002)
1985 "viable systems"
Lambert Adolphe Jacques Quételet (1796 – 1874)
Carl Friedrich Gauss (1777 – 1855)
"complex numbers"
Margoroh Maruyama (1929 – 2018)
1963 "sign graph" The Second Cybernetics
Gaston Julia (–)
"Julia sets"
Henri Bénard (–)
"Bénard instability"
Benoît Mandelbrot (1924 – 2010)
1977 "fractal" Form, Chance and Dimension
Edward Lorenz (1917 – 2008)
1969 "butterfly effect" "chaos theory"
Henri Poincaré (1854 – 1912)
"point attractors"
"periodic attractors"
"strange attractors"
Yoshsuke Ueda (–)
"topology" "phase space"
"Ueda attractor"
René Thom (1923 – 2002)
1966 "catastrophy theory"
Baron Jean–Baptiste Fourier (1768 – 1830)
1811 mathematical description of propagation of heat in solids
Stephen Smale (1930 –)
Nicholas Léonard Sadi Carnot (1796 – 1832)
Lars Onsager (1903 – 1976)
Second Law of Thermodynamics
1931 "non–equilibrium thermodynamics" (Nobel Prize 1968)
Rudolf Emanuel Clausius (1822 – 1888)
1865 "entropy"
Alexander Bogdanov (1873 – 1928)
"organised complexes"
James Clerk Maxwell (1831 – 1879)
1912 – 1917Tektology (3 vols)
"disorganised complexes"
"neutral complexes"
Ludwig Boltzmann (1844 – 1906)
Ilya Prigogine (1917 – 2003)
"arrow of time"
1967 "dissipative systems"
Manfred Eigen (1927 – 2019)
1971 "hypercycles"
Hermann Haken (1927 –)
1970 "non–linear laser theory"
Werner Heisenberg (1901 – 1976)
1927 "Ungenauigkeit"
Fritjof Capra (1939 –)
2014 The systems view of life
1996 The Web of Life
1982 The Turning Point
Rachel Carson (1907–1964)
1962 Silent spring
Geoffrey Vickers (1874 – 1982)
Peter Checkland (1930 –)
1971 "soft systems methodology"
Gwilym Jenkins (1932–1982)
1970 "systems engineering"
Russell Ackoff (1919 – 2009)