Preface

Introduction

Societal dynamics is the pattern of change and stability in societies – alternating crisis and stasis. Societal dynamics is both history and contemporary news. For example at the time this preface was written, the news then was the "Arab Spring." In January 2011, the Arab world abruptly changed. Beginning in Tunisia, as Roula Khalaf summarized: "In the most dramatic display of people power witnessed in the region's post-colonial age, the Arab street has risen from its torpor. This Arab awakening has already pushed out one long-time ruler – Tunisia's Zein al-Abidine Ben Ali – and has proved that the color of change need not be Islamist, as leaders had claimed in their pursuit of lifetime power." (Khalaf 2011)

A despotic and corrupt government suddenly fell: "In Tunisia, the protests continued long after Mr Ben Ali's departure, ensuring that corrupt members of his family were rounded up, the ruling party was weakened if not destroyed and the transitional government was to their liking." (Khalaf 2011)

Popular revolts spread next from Tunisia to Egypt. After 2 months of mass protests in the Cariro's Tahrir square, President Mubarak left office and the Egyptian Army took control of the country. They altered the constitution to limit the terms in office of a president and scheduled elections for a new parliament and president in the fall of 2011.

In Libya, a civil war erupted when the eastern half of the country rebelled and drove out Muammar el-Qaddafi's government and army from Benghazi, the second major city in Libya, The UN condemned the army's attack upon civilians; and NATO bombed Qaddafi's army to prevent their taking back Bengazi. In October 2011, Qaddafi's government finally fell. Qaddafi was killed, and Libyans were free from his dictatorship. In Yemen, protestors pushed their long-term "president," Ali Abdullah Saleh, from office. In Syria, demonstrators protested against the minority Alawite (Shite) rule of Bashar al-Assad; and his government responded by shooting and arresting people and sending tanks to wipe out some Sunni villages.

The issues we are to examine are: (1) how to analyze the complexity in such societal events and (2) how to relate this complexity to theories about society? These are two fundamental issues in the methodology of historical studies and of social science studies.

Methodologically, how can one base social science theory construction upon the empiricism of historical studies?

Methodologically, how can one integrate the social science disciplines to theoretically understand all of a society (instead of only disciplinary slices through society)?

But before we begin our examination of history/science methodology, we review two ideas in scientific method – "scientific paradigm" and "scientific perceptual space." These are central to modern methodology.

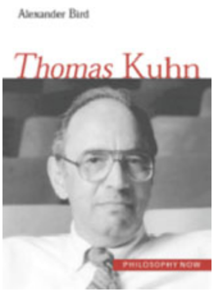
Scientific Paradigm

In modern science, a "scientific paradigm" is an intellectual framework in which each science discipline observes nature and formulates scientific theory. Thomas Kuhn, in 1962, introduced this term into the philosophy of science. (Kuhn 1996). A scientific paradigm does not describe the "details of research" at the cutting edge of disciplinary specialties. Instead, a paradigm describes the meta-theory, the larger framework, in which the research details (experimental formulation and theory) are constructed. A paradigm is an intellectual framework within which the scientists observe, describe, and explain nature. A paradigm is a "meta-logic" to theory.

As examples of paradigm changes in science, Kuhn used the two paradigm shifts in physics in the beginning of the twentieth century: (1) from Newtonian physics to special relativity and (2) from classical mechanics to quantum mechanics. Both shifts, he argued, were accepted within the physics community as "generational changes," with younger scientists more easily making the intellectual change than many older scientists. (Kuhn 1996).

Kuhn's book had a major impact upon sociologists because it introduced the idea of group consensus as a methodological issue in science. Kuhn argued that scientific consensus in a community was not always easily nor smoothly attained. Instead, consensus depends upon how big an intellectual leap was being conceptually proposed as "progress in science." Kuhn argued that science does not always progress by a steady accumulation of knowledge but sometimes makes large conceptual leaps in the forms of a paradigm shift.

Thomas Kuhn (1922–1996) was born in Ohio, USA. In 1943, he received a bachelor's degree from Harvard University and then a PhD in 1949 in physics. From 1948 to 1956, he taught a history of science course at Harvard. In 1957, he went to the University of California at Berkeley to join there both the philosophy department and history department. In 1964, Kuhn moved to Princeton University and then to MIT in 1991. In 1962, Kuhn had published his seminal book in the sociology of science, The Structure of Scientific Revolutions.



Thomas Kuhn (http://en.wikipedia.org, Thomas Samuel Kuhn, 2007)

History: Kant's Critique of Pure Reason

To understand how a scientific paradigm works in science, one again needs a little philosophical background (Kuhn was a philosopher of science). Philosophically, a scientific paradigm provides a meta-logical framework to scientific research (a larger intellectual framework for scientific theory). To understand this, one can go back to the historical case in philosophy wherein this concept of a "meta-logic" first appeared. This was Immanuel Kant's book, *Critique of Pure Reason.* (Kant 1965)

Kant was interested in how a mind worked. He proposed that any mind must have two capabilities before the mind can reason (process experience into ideas): "transcendental aesthetics" and "transcendental logic." A mind must have these two kinds of a priori capabilities before any sensory experience can be perceived; and such capabilities must be built into a mind.

For example, in physiology of the brain, there must exist certain capabilities in the brain before the experience of vision is possible. People must be born with physical eyes, optical nerves, and optical processing portions of the brain. These brain mechanisms must be "a priori" – existing before – any visual experience in the brain. People born blind can never see; and people whose eyes are damaged lose the capability of vision. All sensory experience by the human mind requires prior existing mechanistic capabilities of the body. Thus in the case of sight, eyes provide the transcendental aesthetic for vision and the brain provides the transcendental logic to assemble visual sensations into visual images.

To further understand what Kant meant by these terms, now we can compare the structure of a modern computer to Kant's "a priori" structure for mental reasoning, as sketched in Fig. 1. In a computer with Von Neumann architecture, before any computation the computer first needs to have two prior capabilities: (1) a prior *format* recognized in the computer for formatting the input data and (2) a prior *stored program* in the computer as instructions for processing the formatted data. Similarly, Kant had argued that for the human mind to display pure reason, such mind must have a prior *transcendental aesthetics* and a *transcendental logic*. Thus Kant's term of "transcendental aesthetics" is equivalent to a computer's "data format" and his term of "transcendental logic" is equivalent to a computer's stored program instructions.

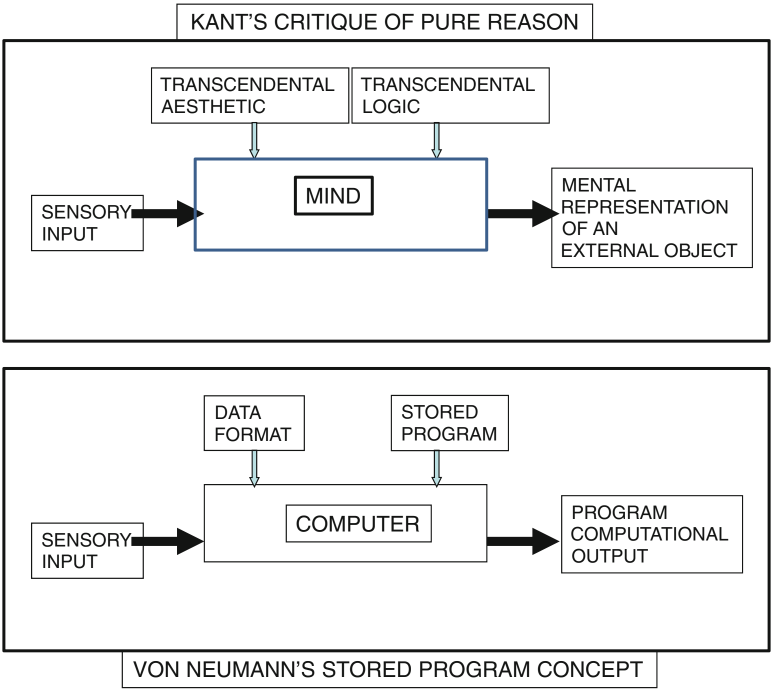


Fig. 1 Kant and Von Neumann

The modern term "data format" is equivalent to Kant's older term of "transcendental aesthetics."

The modern term "stored program" is equivalent to Kant's older term of "transcendental logic."

Immanuel Kant (1724–1804) was born in Konigsberg in Prussia and entered the University of Konigsberg in 1740. There he read philosophical works – including the new mathematical physics of Newton which then was being taught in the natural philosophy faculties of German universities in the 1700s. Newton's idea of a space/time descriptive framework for physics would influence Kant in his ideas in his major philosophical work, *Critique of Pure Reason*, published in 1781. From Newton's perceptual space of modeling the Copernican solar system, Kant generalized the notion as space/time as a transcendental aesthetic – a framework prior to measuring any physical phenomena. Thus Kant's philosophical work was the first philosophy to be congruent with the new science of physics – providing the first "model" of mind (pure reason) matching to the new research techniques of Newtonian mechanics. Later in 1788 and 1790, Kant published two more books, *Critique of Practical Reason* (as a book on ethics) and *Critique of Judgment* (as a book on aesthetics).

Immanuel Kant (http://en.wikipedia.org, Immanuel Kant, 2007)

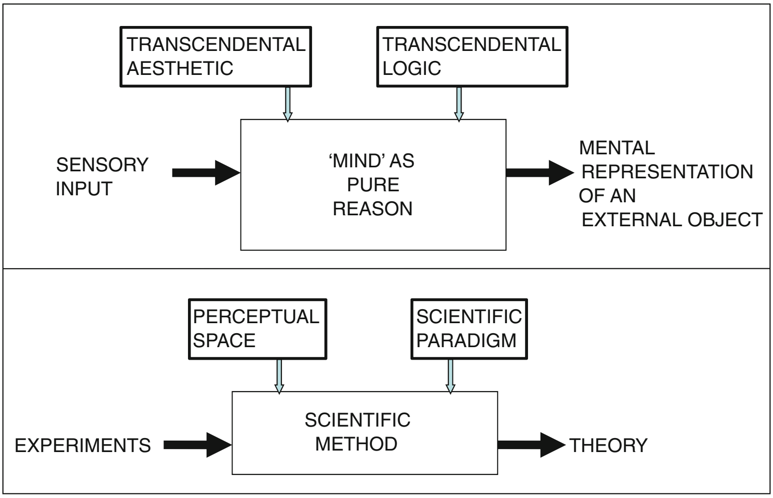


Fig. 2 Scientific perceptual space and paradigm in Kant's philosophical terminology

We can use this Kant-Computer metaphor to help explain the role of *scientific paradigms* and *scientific perceptual spaces* in scientific method. This is sketched in Fig. 2. A scientific paradigm provides the a priori logical framework for theory construction in science. A scientific perceptual space provides the a priori framework for observing natural phenomena in science.

> In scientific method, the concept of a "Scientific Paradigm" is equivalent to Kant's idea of a "Transcendental Logic."

> In scientific method, the concept of a "Scientific Perceptual Space" is equivalent to Kant's idea of a "Transcendental Aesthetic."

Scientific Paradigms and Scientific Disciplines

What kinds of paradigms provide meta-frameworks for modern science? Kuhn did not elaborate upon the different kinds of paradigms that are used in science, but later the author described four kinds of paradigms used in modern science: *Mechanism Paradigm, Function Paradigm, System Paradigm, Logic Paradigm*. (Betz 2011)

Mechanism is a paradigm for viewing all things in nature as physical objects and processes – gravitational-electro-mechanical mechanisms in a world of matter and forces. *Function* is a paradigm for viewing the relevance of things in nature to living beings – functions such as nutrition, respiration, motion, etc. *System* is a paradigm for viewing an object in nature as a dynamic totality – systems such as the solar system, an atomic system, a biological system, etc. *Logic* is a paradigm for viewing things in the world as conceptual objects – logical ideas expressed in language.

Modern science is divided into disciplines, and different disciplines use different paradigms. Thus scientists in disciplines see the world of nature differently from each other – using different paradigms. The disciplines of modern science have been organized as: (1) departments in a modern university and (2) disciplinary scientific societies. One can classify all the science disciplines into those of the physical sciences, biological science, mathematical sciences, and social sciences, as shown in Fig. 3. This classification groups the disciplinary fields of nature into: (1) inanimate (without life), (2) animate (living), (3) cognitive (thinking), and (4) societal (human groups).

INANIMATE	ANIMATE	COGNITIVE	SOCIETAL
PHYSICAL SCIENCES	BIOLOGICAL SCIENCES	MATHEMATICAL SCIENCES	SOCIAL SCIENCES
PHYSICS APPLIED PHYSICS CHEMISTRY ASTRONOMY EARTH SCIENCES	MOLECULAR BIOLOGY CELL BIOLOGY SYSTEMIC BIOLOGY POPULATION BIOLOGY ECOLOGY SOCIO-BIOLOGY	MATHEMATICS COMPUTER SCIENCE	ECONOMICS SOCIOLOGY ANTHROPOLOGY PSYCHOLOGY POLITICAL SCIENCE MANAGEMENT SCIENCE
MECHANISM SYSTEM	MECHANISM SYSTEM TECHNOLOGY	LOGIC SYSTEM	LOGIC SYSTEM TECHNOLOGY

Fig. 3 Disciplines of science

Inanimate: Physical Sciences

Physics describes the non-living objects in nature as matter existing in a framework of space and time and moving over time through space. Interactions between material objects occur due to forces that alter the energy of the material object. At molecular scales, chemistry is a physical discipline that elaborates upon atomic and molecular interactions as chemical interactions. At the planetary scale, environmental sciences is a physical discipline that elaborates upon the physical systems in planetary processes. At a celestial scale, astronomy is a discipline that elaborates upon the physical systems in stellar processes.

> The disciplines of the physical sciences (physics, chemistry, earth sciences, astronomy) differ from each other by specialization on spatial scale – all using scientific paradigms of Mechanism and System.

Animate: Biological Sciences

The biological science is also arranged partly by spatial scale, studying the molecular level of life to the cell level to the organism level to the population level: molecular biology, cellular biology, physiology, ecology. Modern biology is unified by the principles of gene theory, cell theory, homeostasis, and evolution:

Gene theory – A living organism's traits are encoded in DNA.
Cell theory – All living organisms are composed of cells.
Homeostasis – Physiological processes enable an organism to sustain living chemical processes by means of taking in energy from an environment.
Evolution – Genetic mutations enable functional change in generations of a species, providing variation in a species with increased chance of survival in a specific environment.

> The specialties of biological science provide a description and explanation of living forms based upon carbon-based chemistry – using scientific paradigms of Mechanism, Function, and System.

Cognitive: Mathematics and Computer Sciences

Mathematics is the logic and language of quantitative inference. In mathematics a "set" of things is defined as a collection of things that share a 'similar property.' A 'similar property' is called the 'quality' of the things; and the those things in the set is called the "quantity." Traditionally, mathematics began with numbers – counting similar things and expanded into algebra (quantitative expressions among variables). And traditionally mathematics also began with abstraction of spatial forms and their similarities – the topic of geometry. Modern mathematics still deals with numbers and structures of numbers as: groups, algebras, vector spaces, etc. Modern mathematics still deals with special forms as: geometry, trigonometry, differential geometry, topology, fractal geometry. Now modern mathematics also deals with change (as calculus, dynamical systems, chaos theory) and with mathematical logic (set theory) and statistics (inductive inference).

Computer science is a new scientific discipline providing a science base for the development of computer and information technology – which was invented in the second half of the twentieth century. It focuses upon the theoretical foundations for dealing with computation and information in computer systems. Its theories include foci upon mathematical foundations of computation, computational theory, algorithms and data structures, programming languages and compilers, computational procedures and architectures, artificial intelligence, and computer graphics.

Mathematics and computer science focus upon linguistic expression of quantity – providing quantitative and calculation languages and logics – for expressing quantities and performing inference and calculations about quantities – using the scientific paradigms of Logic and System.

Societal: Social Sciences and Management

The social sciences all focus upon societal phenomenon in the human species but are divided into different perspectives of what they see in a society – the perspectives of economics, sociology, anthropology, political science, and psychology – observed "slices" of a society.

Economics looks at exchange of utility in societal interactions – economic interactions;
Sociology looks at social interactions in industrial cultures – social interactions;
Anthropology looks at cultural patterns in pre-industrial cultures – cultural interactions;
Political science looks at governmental patterns in industrial societies – political interactions;
Psychology looks at individual behaviors in societies – individual interactions;
Management science looks at the decisions and control of organizations – decision interactions;

The disciplines of the social sciences view social nature in disciplinary perspectives as observational slices through society – using the scientific paradigms of Function, System, and Logic.

Recognizing these different paradigms in different science disciplines is important to understand the differences in methodology between the physical sciences and the social sciences.

"Mechanism" is a principle paradigm of the physical sciences; but the social sciences do not use the paradigm of "Mechanism."

Consequently while there are explanations of cause and effect (causality) in the physical sciences, there are no causal explanations in the social sciences.

Accordingly, this is one of the methodological issues we will address to integrate history and social sciences explanation. Beyond "causality," what other kinds of explanations are there in science?

Perceptual Spaces and Scientific Method

In addition to the idea of a "paradigm," modern scientific method also uses the basic concept of a "perceptual space." Science uses this as an a priori framework for observation and description (perception as a transcendental aesthetic).

> A scientific perceptual space provides an "a priori" frame for the scientific observation, description and measurement of a natural object.
>
> There are two different perceptual spaces in science: one for the physical/biological sciences and one for the social sciences.

Perceptual Space for Observing Physical Nature

Physical space/time provides the observational framework for perceiving (describing) physical existence. Physical space is the methodological concept of how material objects can coexist in nature at the same time. Physical time is the methodological concept of how material objects can occur at different positions in space as a sequence of temporal events. Historically, Newton formulated his calculus for describing *instantaneous motion* in space (using the mathematical framework of Descartes' Analytical Geometry). This is illustrated in Fig. 4, with three mutually perpendicular axes, *X*, *Y*, *Z*, and a fourth dimension of TIME.

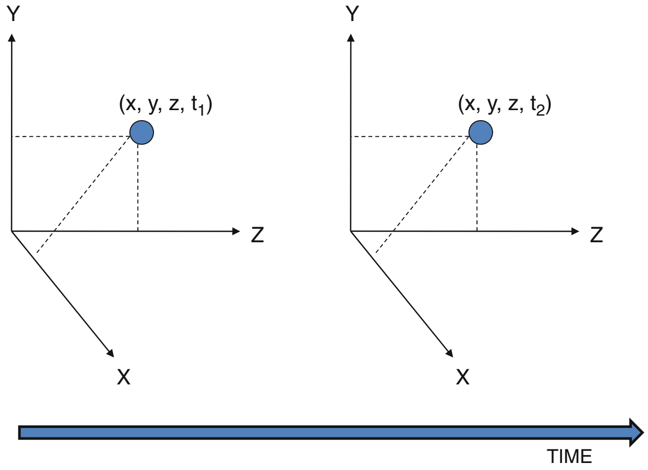


Fig. 4 Three-dimensional geometric physical space and a fourth dimension of time

Each position of an object in space can be mathematically described by three position numbers and a time label (x, y, z, t). This set of numbers (x, y, z, t) is mathematically called a vector (v). A space–time framework described by such vectors is called a *vector space*. In Newtonian mechanics, we live in a three-dimensional vector space (length, width, and depth), separate from a separate time dimension. In relativistic physics, we live in a connected four-dimensional vector space (three dimensions of space and a fourth dimension of time).

> All physical things (matter) in a material universe are individuated from each other in a spatial and temporal framework.
>
> Two physical objects in material nature are said to be different because they can exist at different points of space at the same time.
>
> Any object phenomenally observed in a space at a specific time can be mathematically described as to its position by a set of spatial coordinate numbers (x,y,z) upon a reference frame (X,Y,Z) of the space.
>
> Description of position and of motion is the first step in any mechanistic representation of physical things in nature.

Perceptual Space for Observing Societal Nature

But here is the methodological challenge. The social sciences do not use the perceptual space of physical space-time.

> What kind of perceptual space is useful to describe societal nature – a “transcendental aesthetic” for the history and for the social sciences?
>
> We will call this a “societal perceptual space.”

Methodologically, it is important because it enables an intellectual integration across history and the social sciences. Historically, the intellectual integration of the physical and biological sciences occurred because they shared the common *physical perceptual space of Mechanism*. In contrast, the lack of intellectual integration of the social sciences occurred because they did not have a common perceptual space of society.

> What kind of societal perceptual space (a priori transcendental aesthetic) can the social sciences and historical studies share?

This is what we will construct in this book: a general societal perceptual space for analyzing historical events in any society. In this methodological framework, one can construct a *natural history of society*. Now our preface ends and our methodological journey begins – across society and history and social science.

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