An Overview Of Thomas Kuhn's *The Structure Of Scientific Revolutions*[1]

This review examines Kuhn's *The Structure of Scientific Revolutions* (SSR) very broadly, with the aim of understanding its essentials. As you can gather from the title of Kuhn's book, he is concerned primarily with those episodes in history known as "scientific revolutions." During periods of this sort, our scientific understanding of the way the universe works is overthrown and replaced by another, quite different understanding. According to Kuhn, after a scientific discipline matures, its history consists of long periods of stasis punctuated by occasional revolutions of this sort. Thus, a scientific discipline goes through several distinct types of stages as it develops.

I. The Pre-Paradigmatic Stage

Before a scientific discipline develops, there is normally a long period of somewhat inchoate, directionless research into a given subject matter (e.g., the physical world). There are various competing schools, each of which has a fundamentally different conception of what the basic problems of the discipline are and what criteria should be used to evaluate theories about that subject matter.

II. The Emergence Of Normal Science

Out of the many competing schools that clutter the scientific landscape during a discipline's pre-paradigmatic period, one may emerge that subsequently dominates the discipline. The practitioners of the scientific discipline rally around a school that proves itself able to solve many of the problems it poses for itself and that holds great promise for future research. There is typically a particular outstanding achievement that causes the discipline to rally around the approach of one school. Kuhn calls such an achievement a "paradigm."

A. Two Different Senses Of "Paradigm"--Exemplar And Disciplinary Matrix

Normal science is characterized by [nearly] unanimous assent by the members of a scientific discipline to a particular paradigm. In SSR, Kuhn uses the term paradigm to refer to two very different kinds of things.

1. Paradigms As Exemplars

Kuhn at first uses the term "paradigm" to refer to the particular, concrete achievement that defines by example the course of all subsequent research in a scientific discipline. In his 1969 postscript to SSR, Kuhn refers to an achievement of this sort as an "exemplar." Among the numerous examples of paradigms Kuhn gives are Newton's mechanics and theory of gravitation, Franklin's theory of electricity, and Copernicus' treatise on his heliocentric theory of the solar system. These works outlined a unified and comprehensive approach to a wide-ranging set of problems in their respective disciplines. As such, they were definitive in those disciplines. The problems, methods, theoretical principles, metaphysical assumptions, concepts, and evaluative standards that appear in such works constitute a set of examples after which all subsequent research was patterned. (Note, however, that Kuhn's use of the term "paradigm" is somewhat inconsistent. For example, sometimes Kuhn will refer to particular parts of a concrete scientific achievement as paradigms.)

2. Paradigms As Disciplinary Matrices

Later in SSR, Kuhn begins to use the term "paradigm" to refer not only to the concrete scientific achievement as described above, but to the entire cluster of problems, methods, theoretical principles, metaphysical assumptions, concepts, and evaluative standards that are present to some degree or other in an exemplar (i.e., the concrete, definitive scientific achievement). In his 1969 postscript to SSR, Kuhn refers to such a cluster as a "disciplinary matrix." A disciplinary matrix is an entire theoretical, methodological, and evaluative framework within which scientists conduct their research. This framework constitutes the basic assumptions of the discipline about how research in that discipline should be conducted as well as what constitutes a good scientific explanation. According to Kuhn, the sense of "paradigm" as a disciplinary matrix is less fundamental that the sense of "paradigm" as an exemplar. The reason for this is that the exemplar essentially defines by example the elements in the framework that constitutes the disciplinary matrix.

B. Remarks On The Nature Of Normal Science

1. The Scientific Community

According to Kuhn, a scientific discipline is defined socially: it is a particular scientific community, united by education (e.g., texts, methods of accreditation), professional interaction and communication (e.g., journals, conventions), as well as similar interests in problems of a certain sort, and acceptance of a particular range of possible solutions to such problems. The scientific community, like other communities, defines what is required for membership in the group. (Kuhn never completed his sociological definition of a scientific community, instead leaving the task to others.)

2. The Role Of Exemplars

Exemplars are solutions to problems that serve as the basis for generalization and development. The goal of studying an exemplar during one's scientific education is to learn to see new problems as similar to the exemplar, and to apply the principles applicable to the exemplar to the new problems. A beginning scientist learns to abstract from the many features of a problem to determine which features must be known to derive a solution within the theoretical framework of the exemplar. Thus, textbooks often contain a standard set of problems (e.g., pendulums, harmonic oscillators, inclined plane problems). You can't learn a theory by merely memorizing mathematical formulas and definitions; you must also learn to apply these formulas and definitions properly to solve the standard problems.

[1] This summary was downloaded from a university web site. The citation was lost in the process of preparing it for redistribution. My apologies to the author, whoever it is.

This means that learning a theory involves acquiring a new way of seeing, i.e., acquiring the ability to group problems according to the theoretical principles that are relevant to those problems. The "similarity groupings" of the mature scientist distinguish her from the scientific neophyte.

3. Normal Science As "Puzzle-Solving"

According to Kuhn, once a paradigm has been accepted by a scientific community, subsequent research consists of applying the shared methods of the disciplinary matrix to solve the types of problems defined by the exemplar. Since the type of solution that must be found is well defined and the paradigm "guarantees" that such a solution exists (though the precise nature of the solution and the path that will get you to a solution is often not known in advance), Kuhn characterizes scientific research during normal or paradigmatic science as "puzzle-solving."

III. The Emergence Of Anomaly And Crisis

Though the paradigm "guarantees" that a solution exists for every problem that it poses, it occasionally happens that a solution is not found. If the problem continues to persist after repeated attempts to solve it within the framework defined by the paradigm, scientists may become acutely distressed and a sense of crisis may develop within the scientific community. This sense of desperation may lead some scientists to question some of the fundamental assumptions of the disciplinary matrix. Typically, competing groups will develop strategies for solving the problem, which at this point has become an "anomaly," that congeal into differing conceptual "schools" of thought much like the competing schools that characterize pre-paradigmatic science. The fundamental assumptions of the paradigm will become subject to widespread doubt, and there may be general agreement that a replacement must be found (though often many scientists continue to persist in their view that the old paradigm will eventually produce a solution to the apparent anomaly).

IV. The Birth And Assimilation Of A New Paradigm

Eventually, one of the competing approaches for solving the anomaly will produce a solution that, because of its generality and promise for future research, gains a large and loyal following in the scientific community. This solution comes to be regarded by its proponents as a concrete, definitive scientific achievement that defines by example how research in that discipline should subsequently be conducted. In short, this solution plays the role of an exemplar for the group--thus, a new paradigm is born. Not all members of the scientific community immediately rally to the new paradigm, however. Some resist adopting the new problems, methods, theoretical principles, metaphysical assumptions, concepts, and evaluative standards implicit in the solution, confident in their belief that a solution to the anomaly will eventually emerge that preserves the theoretical, methodological, and evaluative framework of the old paradigm. Eventually, however, most scientists are persuaded by the new paradigm's growing success to switch their loyalties to the new paradigm. Those who do not may find themselves ignored by members of the scientific community or even forced out of that community's power structure (e.g., journals, university positions). Those who hold out eventually die. The transition to the new paradigm is complete.