

*Book Review*

**The structure of scientific revolutions (Thomas S. Kuhn, 1970, 2<sup>nd</sup> ed. Chicago, London: University of Chicago Press Ltd. 210 pages)**

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## ABSTRACT

This book has thirteen chapters and a postscript developed after seven years of this edition. The organization of the book is disclosed here with. First, the book tried to see the contribution of history to the very existence of science in the different epochs. Secondly, it also considered the route, nature, and puzzle solving role of normal science. Third, the reason why paradigms are considered as the prioritized models in science is briefly treated. Fourth, anomalies as new problems that could not be solved with the known algorithm and the attendant reactions to this situations-discovery are well taken-in. Fifth, the possible responses of scientists about crisis and the attendant outcomes of science- new scientific theories which are realized through discovery are also part of the book. In the end, the book tried to explicate points such as progress, resolution, invisibility, nature and necessity, and how world view is changed by scientific revolution.

Generally, I found the book a high level literary work. I learnt some basic scientific research concepts which I did not come across through any other means so far in my professional as well as student hood years. My level of understanding of the basic thesis of this book triggered me to say that Kuhn is an intellectual “angel” who tried to lift up science from an extreme positivist tradition to the consideration of both- mainly the subjective world. Specifically speaking, the book has the following strengths:

- It tells about the role of history in science-which other research texts give scant consideration,
- It examines the route, nature and role of normal science, which we need to know as would be researchers,
- It enables users of the essay to have a profound understanding about paradigm, which implies the benefit behind framework, and paradigm shift and its causes, such as anomalies and crisis, and
- It provides a unified view of scientific revolutions

Though the strengths over weigh its weaknesses, the critic of this book identified the following limitations:

- Difficulties and misunderstandings created due to the old diction usage of the essay,
- Considering science as mere belief, subjective and non rational enterprise,
- Using one term to convey more than two meanings- example ‘paradigm’,
- The assertion that research can be done without referring a paradigm,
- Equating paradigm shift to revolution,
- The assertion that science has a certain pick time by which it becomes dormant to novelties,
- The assertion that research results in normal science are anticipated before hand,
- The assertion that paradigms guide research in the absence of scientific rules, and
- Piercing the scientist for failure without considering other relevant factors
- Examples provided to elaborate concepts; issues, etc do not serve their purpose. They rather make the Essay complex and ambiguous to users. Even I, as a natural science background as a high school student and mathematics minor in my First Degree, failed to understand most of the examples. As we all know from pedagogical principles, examples are believed to concretize concepts, issues, etc raised by the author. But they failed to realize this purpose that needs revisiting in this essay, and
- The author said nothing about the possible contributing factors to the occurrence of anomalies in the history of science.

## INTRODUCTION

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Generally, the book has its own strengths and weaknesses. This review is made so as to surface these strengths and weaknesses. It is organized vis-à-vis the respective chapters of the book, as indicated in the first paragraph.

## INTRODUCTION: A ROLE FOR HISTORY

In Kuhn's book, there is an attempt to make known the historical upheavals of the study of science. He tried to stress on two epochs about the study of science in history: history of science before historical revolution and history of science after historical revolution. Here the critic will try to discuss their basic considerations and the limitations of the author vis-à-vis the major thesis of this section.

History of science before revolution epitomizes the very concept of peace meal process in the development of science. But such emphasis of the different periods of science is limited in many respects. Of which historians may be challenged in the process of identifying the scientific components of past observations and beliefs from what their predecessors had readily label "errors" and "superstition" (Kuhn, 1962:2).

In order to counteract the above draw backs of studying science in the pre-revolution period, it is a must to inter into revolution about the historical study of science (Kuhn, 1962:3). The author calls such a revolution historiography revolution in the study of science. It is believed to resolve difficulties encountered in the pre-revolution attempt of investigating science so as to differentiate science from non-science. In support of this point, Kuhn (1962:3) professed that "rather than seeking the permanent contributions of an old science in present vantage, they attempt to display the historical integrity of that science in its own time". He further asserted that investigations in different scientific epochs are "scientific"; however, the difference lies in their way of viewing reality.

*From my repeated readings of this section, I came to recognize that the author tried to see ideas about the role of history in the study of science. But my little understanding triggers me to say that the assumption "the scientific community knows what the world is like" (Kuhn, 1962:5) can possibly be a point of criticism. It is simply bearing in mind the social and natural world something orderly, regulated, merit oriented, etc. It is also based upon the assumption that human nature can be studied in the same methods by which we study nature. But as far as my experience to the social world is concerned, there are both ordered, regulated, merit oriented events as well as soft/hidden events that requires to be studied as participant observers and which latter lead us to multiple truths/realities. Therefore, I do not think it is time to accept the given assumption relevant. For example, if we see a man and a woman in a room and the man lighting a candle. This action is open to a number of interpretations. I think this example implies the fact that the human world can not be investigated the same way as the natural world. Another limitation focuses on the historical revolution in the study of science. Historians believed that scientific achievements should be evaluated within the context of their respective epoch. But do not we have some scientific rules and procedures that cross the different historical epochs in the study of science? I think this point would have been considered so as to make his assertion more full-fledged than what it is now. Still another limitation is related to considering science as mere belief. Kuhn might be triggered to say so due to the unproved assumptions/axioms that abound science. But as far as my knowledge is concerned, this is exaggerating minute aspects at the cost of the empirical nature of scientific research.*

## THE ROUTE TO NORMAL SCIENCE

In Kuhn's work, an attempt is made to unearth the processes of arriving to normal science. After providing a brief summary of this journey, some basic limitations came up by the reviewer of this thesis will be explicated.

Kuhn uncovered the fact that the route to normal science follows sensing of the existence of anomalies in doing research following the basic commitments of the existing paradigm. Then anomalies mushroom the prevailing research tradition and lead it to crisis. When scholars sense crisis in the field- especially young members of the community, strive towards investigating more complex, promising and well fitting scientific theories. These theories will be transpired through different media such as textbooks, monographs, classics of science, etc. It is all this ups and downs which finally lead to a mature science or Normal science.

*Generally, realizing a general consensus upon commitments of normal science is believed to have been extraordinarily an arduous task. However, the reviewer needs to communicate limitations of his attempts as given below. First his assertion "... there can be a sort of scientific research without paradigms."(Kuhn, 1962:11) is somehow confrontational. Do we ever have scientific research made without using a certain framework? I do not assume so. To my knowledge, it is qualitative research which is supposed to use a little theoretical base than its counterpart. But, even the extreme qualitative research employs grounded theory which possibly bridges the gap between theory (context free) to practice. Another area of reflection in Kuhn's assertion is his view that paradigm shift is equated to revolution. The critic could not share this point due to the fact that paradigm shift does not occur all of a sudden. It rather takes a long period of time to negotiate, argue, and make tradeoff among members of the scientific community and thereby to trigger scientists with the old paradigm see the worth of the new model and cling to it.*

## THE NATURE OF NORMAL SCIENCE

Here, the concept of paradigm-normal science relationship, its nature during and after revolution, and limitations sought by the reviewer will be briefly treated.

As to Kuhn, new paradigms inter into the paradigm debate with a promise to solve different problems that failed to be solved with the old paradigm. Normal science consists in the realization of that promise. In Kuhn's terms, "it is an actualization achieved by extending the knowledge of those facts that the paradigm displays as particularly revealing, by increasing the extent of the match between those facts and the paradigms' predictions, and by further articulation of the paradigm itself" (1962:24). A restricted emphasis of normal science enables scientists to focus on the development of science by making them to focus attention upon a small range of esoteric problems. This leads scientists to investigate some part of nature in detail and in-depth that would otherwise be unimaginable. However, as to Kuhn in normal science there is a possibility of being considered as a closed scientific attempt to novelty. He pointed out that

No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the boxes are often not seen at all. Nor do scientists normally aim to invent new theories, and they are often intolerant of those invented by others. Instead, normal scientific research is directed to the articulation of those phenomena and theories that the paradigm supplies (1962:24).

The author further indicated that there is a pick time in which normal science enables professionals to solve problems that its members could scarcely have imagined and would never have undertaken without commitment to the paradigm. But during its decaying periods, normal science tries to entertain novelties so as to lengthen its time. In this line, Kuhn (1962:24) asserted that

Normal science possesses a built-in mechanism that ensures the relaxation of the restrictions that bound research whenever the paradigm from which they derive ceases to function effectively. At that point scientists began to behave differently, and the nature of their research problems changes.

*In relation to this basic thesis, the reviewer came to scrutinize two basic limitations that need reconsideration in Kuhn's essay. He considered that normal science has its own pick time by which it becomes a totally closed scientific attempt to novelty. But I do not think science totally locks its gate from entering novelties that might happen so following valid and reliable scientific approaches. That is, it is the nature of science to always anew its field. Scientific methodology is self correcting. Second the term paradigm implies different concepts in different contexts. This threatens the internal consistency of the essay.*

## NORMAL SCIENCE AS PUZZLE SOLVING

Here, the reasons for considering normal science as puzzle solving will be briefly reviewed. Then, I will consider possible limitations of Kuhn's assertion vis-à-vis this thesis.

Kuhn disclosed that normal science research problems are anticipated before data collection, analysis and interpretation (1962:36). Similarly, problems that fit to a puzzle are selected on the basis of whether they have solutions (Kuhn, 1962:37). Moreover, normal science has commitments such as conceptual, theoretical, instrumental, and methodological rules which are derived from the respective paradigms (Kuhn, 1962:44). Similarly, puzzles should have rules that limit both the nature of acceptable solutions and the steps by which they are to be obtained (Kuhn, 1962:38). As you see, normal science satisfies all the criteria required to be fulfilled in the puzzle solving context. That is why Kuhn considered normal science as puzzle solving activity.

*Kuhn (1962:35) pinpointed that normal science aim little to produce major novelties, conceptual or phenomenal. However, the reviewer feels that there is no dormant period in science to the entrudement of major novelties into the field. As far as my knowledge is concerned, scientific investigations are always abound by discoveries and novelties, too. Another criticism is directed towards the belief that research results in normal science are anticipated before data collection and interpretation (Kuhn, 1962:36). The assertion may be true in quantitative research but it may be wrong in case of qualitative research. It is so due to the fact that in qualitative research there is no exhaustive design sought in advance of the research process.*

## THE PRIORITY OF PARADIGMS

Kuhn tried to air points about why paradigms are prioritized to rules, and procedures in normal science. Having summarized these, the reviewer will deal with some limitations of the author with respect to this thesis.

It is asserted that paradigm is easier to develop than rules and procedures in normal science. Supporting this point, the author indicated that “the search for a body of rules competent to constitute a given normal research tradition becomes a source of continual and deep frustration among scientist” (Kuhn, 1962:44). Lack of an agreed reduction to rules, however, will not prevent a paradigm from guiding research (Kuhn, 1962:44). He further disclosed that “normal science can be determined in part by the direct inspection of paradigms, a process that is often aided by but does not depend upon the formation of rules and assumptions. Indeed, the existence of a paradigm need not even imply that any full set of rules exist” (Kuhn, 1962:38).

Kuhn (1962:46) further attests that “paradigms may be prior to, more binding, and more complete than any set of rules for research that could be unequivocally abstracted from them.” To this end, he suggested four reasons:

1. The sever difficulty of discovering rules that have guided particular normal science tradition.
2. Theories are accompanied by their applications during their exposition to the scientific community. Therefore, rules have little uses in such circumstances.
3. Paradigm guide research by direct modeling and through abstract rules.
4. Paradigms provide reasonable flexibility than rules in handling scientific research problems.

*Kuhn asserted that paradigms are prioritized due to the fact that they guide research in the absence of rules. But, as far as the reviewer's understanding is concerned, when scientists enter into the research process they should follow some specified scientific rules, assumptions and procedures which are considered as scientific methodologies. Unless and otherwise how do they maintain easy communication, logical reasoning and inter-subjectivity of scientific research results, which are the basics in scientific research?*

## ANOMALY AND THE EMERGENCE OF SCIENTIFIC DISCOVERIES

In this thesis, an attempt is made to explain how anomalies prompt scientists to do scientific discoveries. Having briefly shared this, an attempt will be given to surface basic limitations.

As it is purported by the author, discovery commences with the awareness of anomaly. It then continues with a more or less extended exploration of the anomaly. And it closes only when the paradigm theory has been adjusted so that the anomalies have become the expected (Kuhn, 1962:53). But discovering a new sort of phenomenon is necessarily a complex event, one which involves recognizing both that some *thing is* and *what it is*. As to the author, discovery can be either part of normal science or a bouncing point for some scientists towards the revolutionary science. In this line, (Kuhn, 1962:61) recommended that “discoveries predicted by theory in advance are parts of normal science and result in no new sort of fact.”

*The limitation which I want to rise here is that the author failed to pinpoint the contributing factors to the existence of anomalies in normal science. It would be good if he were in a position to consider the effect of factors such as technology, economy, politics etc on the nature and magnitude of anomalies. At last, I want to raise not a limitation but a point which is not given the required emphasis. It is human nature that we all resist change. This is also true in case of paradigm shifts, too. If so it will be very tough if not impossible to get scientists who take the initiative to converse all the scientific community from the old paradigm to the new one. It is generally a demanding task left for members of the scientific community who take this initiative.*

## CRISIS AND THE EMERGENCE OF SCIENTIFIC THEORIES

Here an attempt is made to expose how crisis is felt in any normal science and lead to the emergence of new scientific theories. Subsequently, the critic will see some limitations of the essay vis-à-vis this thesis statement.

Even though awareness of anomalies takes a long time to create crisis in the state of normal science research (Kuhn, 1962:67), it depends upon some external factors such as nature of the existing paradigm, nature of the scientific community, nature of problems, etc. It is further pointed out that explosion of versions of a theory is a very usual symptom of crisis.

Kuhn asserted that the emergence of new theory is preceded by a period of pronounced insecurity. Such insecurity is generated by the persistent failure of the puzzles of normal science to come out as they should. Failure of existing rules is a prelude to search for new ones. New theories emerge only after a marked failure in the normal problem solving activity or crisis. Thus, they seem the direct response to crisis (Kuhn, 1962:75).

*Generally, Kuhn's assertion that solutions to certain problems are felt before scientists' sense that they are at the verge of crisis but they ignored the anticipated solutions before the crisis and react towards those problems only after they sense crisis in their field (Kuhn, 1962:75). This has to be an issue for debate. As far as my experience is concerned, I don't think that scientists are that far conservative and pessimist to their field. Rather they are people who always usher-in novelties as long as they are arrived at through scientific approaches and procedures. Secondly, the author failed to indicate basic causes of crisis in the intellectual world. As to me he could have seen a number of factors that lead to crisis in the scientific enterprise. Third, the author failed to inform the detail procedures the rival paradigm formulation passes through. He simply provides an advice to develop a rival paradigm that is capable of replacing the old one.*

## THE RESPONSE TO CRISIS

The author's attempt to dispel possible reactions of scientists about crisis, and state of transmission from normal science to crisis will be briefly considered. In the end, the reviewer's comments will also be explained.

Kuhn (1962:80) felt that normal science plays two basic roles. One, it tries to create closer agreement between theory and fact. Two, puzzle solving. Failing to realize these basic tasks is believed to be not the problems of rules and procedures of science but the scientist him/herself. Although how rigid normal science is, as to the author, it is a must to shift the old by the new paradigm. Scientists reject the old paradigm only if they are confronted with anomalies or counter instances. The decision to accept one and to reject the other is made by comparing both paradigms with nature and with each other (Kuhn, 1962:77). He believed that "the transition of a paradigm in crisis to a new one from which a new tradition of normal science can emerge is far from a cumulative process.... It is the reconstruction of the field from new fundamentals." (1962:84-85)

*Here the reviewer tries to explain basic comments that need to be reconsidered in Kuhn's thesis. One, failure to find a solution for puzzles during normal science discredits only the scientist and not the paradigm and its rules (Kuhn, 1962:80). I think this is not a normal state of science. Science as an approach should always evaluate not only the scientist but also the rules and procedures followed in science (recall evaluation criteria borrowed from Journalism-Dane, 1990). Second, the journey from the old to a new one is far from a cumulative process (Kuhn, 1962:84) is also doubtful. Does not this mean that one can't learn from experience? Is there really a total revolution in the intellectual world (science)? To start from scratch is the tag of the day in the Business Program Reengineering (BPR) attempt of this country. But I have been puzzled with this assumption and got no satisfactory answer. Are early research works mere futile exercises to the existing scientific community?*

## THE NATURE AND NECESSITY OF SCIENTIFIC REVOLUTION

Here the nature of scientific revolution and its necessity will be summarized. Afterwards, some comments will also be forwarded in focus of this thesis.

Scientific revolution is defined as those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one (Kuhn, 1962:92). He explains the metaphor made between science and politics (1962:92-93). For him scientific revolution passes through the same process as to political revolution. It is on this background that Kuhn asserted the fact that revolutionary science is not a cumulative acquisition of prior research developments whereas normal science is the cumulative acquisition of scientific achievements (Kuhn, 1962:96).

In another development, Kuhn (1962:103) disclosed the fact that successive paradigms are different in many respects. He believed that this difference is both necessary and incompatible. The difference is simply betterment of the new from the old paradigm, but the author advised us not to concluded this development as a cumulative one (Kuhn, 1962:108).

*In here scientific revolution is equated to political revolution. But, is there any total destruction of science (the intellectual world) as a field in its history? Do not we have some lessons gained from the scientific field that may cross the different scientific epochs? As far as my understanding is concerned, scientific developments are rather more of a piece meal approach or evolutionary than being revolutionary. It may be his political orientation that made him to come up with a revolutionary conception of this sort.*

## REVOLUTION AS CHANGES OF WORLD VIEW

Kuhn's assertion that revolution is accompanied with a different view of the world and actions taken to enable the community better fit with these changes will be summarized. Last, I will briefly spell out basic limitations of this essay in relation to this thesis statement.

It is believed that when paradigm changes, the world itself changes with it. Kuhn (1962:111) asserted that "it{revolution}is rather as if the professional community had been suddenly transported to another planet where familiar objects are seen in a different light and are joined by unfamiliar ones as well." However, as to the author, paradigm shifts are not made by deliberation but it is made suddenly. In this line, he pointed out that:

"...both anomalies and incongruent, gained with the old paradigm, they are not logically or peace meal linked to particular items of that experience as an interpretation will be. Instead they gather up large portion of that experience and transform them to rather different bundle of experience that will there after linked peace meal to the new paradigm but not to the old" (Kuhn, 1962:123).

Due to such entirely new change observed, he advised scientists to provide extensive training to the community about the knowledge, skill, and attitudinal components of the shift (Kuhn, 1962:113). As to the author, training enables the scientific community to have a different world view from the old culture (Kuhn, 1962:113).

*Kuhn's consideration that paradigm shift is not made through deliberation and interpretation needs to be a point of discussion. Is it really the case? Do not we see scientists deliberating formally on their differences? I think it is the opposite what happened in the intellectual world. To me science is a rational and deliberate activity.*

## THE INVISIBILITY OF REVOLUTIONS

In here Kuhn attempted to disclose the invisibility of scientific revolutions. This will be briefly considered. And then limitations towards this emphasis will be discussed.

Mainly commitments of science are consulted from authoritative sources which makes its effect highly immaterial, that is Kuhn (1962:136) asserted that "both scientists and laymen take much of their image of creative scientific from an authoritative source that systematically disguises... the existence and significance of scientific revolutions."

*Scientific revolutions are equated to political revolutions in the preceding thesis. If so, how do we say that scientific revolutions are invisible? I think scientific revolutions are ushered-in after a strenuous and long time debate among members of the scientific community, and the sources are not only authorities but others, too. So, can we say that it is invisible?*

## THE RESOLUTIONS OF REVOLUTIONS

Textbooks written in the aftermath of a scientific revolution are the basis for a new tradition of normal science research. Such kind of research, Kuhn (1962:144), focuses on puzzle solving not on testing paradigms. Revolutionary science suppresses the old paradigm only if it becomes normal science (Kuhn, 1962:152). It is believed that paradigm testing occurs after a repeated failure to solve a puzzle has given rise to crisis (Kuhn, 1962:145). The testing situation is not a single paradigm with nature rather it occurs as part of the competition between two rival paradigms for the scientific faithfulness of the community (Kuhn, 1962:145). It is made because of the fact that no theory in the normal science solves all the puzzles.

Kuhn, (1962:147) further stressed the challenge sensed in the process of reconciling consecutive paradigm debate. This is so due to the fact that paradigm debate is not solved by proof/interpretation. This is due to the incommensurability of the pre and post revolutionary normal science traditions (Kuhn, 1962:148). As a result of this, making revolutionary science instilled into the minds of the scientific community calls strong and argumentative supporter (Kuhn, 1962:158-159).

*My first comment goes to the point that normal science research focuses on puzzle solving but not on testing the paradigm (Kuhn, 1962:144). But scientists in the normal science may come up with a number of anomalies in the process of solving puzzles. I think this situation informs something about the status of the paradigm, which implies the testing of the paradigm. The second comment focuses on the point that 'paradigm is not solved by proof' (Kuhn, 1962:148). As far as my understanding to the concept of science is concerned, this is violating the reality. Science is known by its discoveries and innovations. Science grapples with unusual nature of reality so as to see something new*

*out of it. Therefore, the preceding conception by Kuhn needs revisiting.*

## PROGRESS THROUGH REVOLUTIONS

The term “science” is reserved for fields that do progress in obvious ways (Kuhn, 1962:160). Progress is the result of successful creative work. Even though science is believed to have an impact on progress in the field, there are times in which it is doubted. These include the pre-paradigm period in which there is a multiplicity of competing schools, and during the period of revolution in which scientists are in dilemma to select which is which (Kuhn, 1962:163).

In this sense, Kuhn (1962:163) asserted that it is only during periods of normal science that progress seems both obvious and assured. He further reminds us that supporters of revolutionary science may feel that they are making progress in the field (Kuhn, 1962:166). As to the author, there are losses and gains in scientific revolution that leads the author to be ambivalent to say revolution brings progress or not.

*Claims that progress in science is observed only in normal science (Kuhn, 1962:163) should be a point of discussion. How about during scientific revolution? I think the term revolution has a positive connotation. That is, a shift from the old to the new paradigm is by itself progress and promising in scientific thinking.*

## CONCLUSION

Generally, I found the book a high level literary work. I learnt some basic scientific research concepts which I did not come across through any other means so far in my professional as well as student hood years. My level of understanding of the basic thesis of this book triggered me to say that Kuhn is an intellectual “angel” who tried to lift up science from an extreme positivist tradition to the consideration of both- mainly the subjective world. Specifically speaking, the book has the following strengths:

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## REFERENCES

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