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UNDERSTANDING FOOTBALL TACTICS THROUGH THE LOGIC OF PARADIGM SHIFT[i]

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Abstract:
The aim of this study is to be able to discover methodological similarities between the emergence of new tactics in the context of tactical changes in football history and the theory of paradigm shifts related to scientific revolutions in the philosophy of science. In this context, it has been argued that whether the changes in football tactics can be regarded as paradigmatic changes or not, taking into consideration certain points, and the question of whether the changes in football tactics can be handled as paradigm shifts in the scientific framework, and it has been analysed whether changes in soccer tactics can be handled as paradigm shifts in the scientific framework. The work's philosophical framework is based on the views of Thomas Kuhn on the philosophy of science in his work titled "The Structure of Scientific Revolutions". The paradigm shift in this context is explained in detail through the concepts such as the anomalies in the paradigm, the period of scientific crisis and the scientific revolution. In the second part of the work, it is examined whether the methods (tactics) created to gain success in the football can be taken as paradigm in detail through examples in football history. As a result, it has been shown that football tactics can be regarded as paradigms and tactical changes can be regarded as paradigm shifts. With this study, it was expected to open a new discussion area about the evaluation of sport - especially football - through philosophy.

[i] This article has been derived from a Master's Thesis *"Understanding Football Tactics through the Logic of Paradigm Shift"*. I completed the thesis in 2014/2015 academic year under the supervision of Dr. Robert Northcott at the Department of Philosophy in Birkbeck, University of London.
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1. Introduction

Since the understanding of science through paradigms proposed by Thomas Kuhn (1962), we have developed a new discourse about how to look at science. This concept brought with it both controversy and insight, and thus "The Structure of Scientific Revolutions" became a mainstay of the Philosophy of Science literature. Given the subtle structure of football tactics and the significance of Kuhn, it is an interesting question to see if they can be fruitfully interrelated.

Football is a sport that is followed worldwide, perhaps the most watched game in the world. Football originally a simple game, is now famous worldwide and has become a multi-billion business. No longer do you just need an empty field and a ball to play football successfully. Since state of the art sport complexes have been designed around the world to stage football games, they can be beamed to billions of people via broadcast. In the modern game, a football match is played by elite athletes and can be watched by worldwide audience.

In this context, Mike Carson, who is the author of the book "The Manager", defines football in the preface of his work as follows.

> *"Football as a sport and more broadly as an industry is unique – in the breadth of its appeal, the scale of its support and its ability to generate emotion. For generations, the game has created extraordinary memories, offering us visions of sublime skill and moments of great passion. It has also generated pain and anguish, and tragically has known its own human disasters. Across the world, it both divides and unites people of different races, nationalities and every conceivable status. It is the sport of rulers and workers, of children and the elderly."*
>
> (Carson, 2013:6)

One of the more subtle features of the game is the notion of a "tactic"; the structural strategy the team tries to maintain. This additional feature gives the game depth, despite its initial simplicity. Therefore, though there is only one winning team in a competition, there is a large diversity of different tactics that can bring success. On this subject, Carson says that:

> *"In professional football, nothing is more public or more defining than the team's results. From technical areas and half-time talks to technical reviews and training sessions, every intervention counts."*
>
> (Carson, 2013:67)

Roughly speaking, tactics are all ways and methods followed in order to achieve the desired results. So, this term is a very broad notion, including features such as having a team formation, having talented footballers suitable for team formation, financial opportunities of the football club, having an efficient management team, and so on, because *"…it is about creating winning environments, delivering on enormous expectations, overcoming significant challenges, handling pressure and staying centred throughout…*" (Carson, 2013:9). In addition to these differences, the methods used to achieve success are also diverse as *"tactically, the modern game is in continuous change…"* (Carson, 2013:50)

In the light of this fact, we can accept that a "more effective" tactic is chosen over a "less effective" one in a similar way to the change between old and new paradigms.

In this context, this paper will focus on this research question *"To what extent can football tactics be understood in a Kuhnian framework by considering paradigm shift?"*

Examining this question will be helpful in clarifying whether football tactics can be accepted as a paradigm. Through this objective, this paper will analyse two main issues by considering main question:

1. How and why do football tactics change?
2. What are the contributions of irrational effects in football tactics?

These two issues will help to demonstrate the analogy between football tactics and paradigm shift. In this way, we can comprehend whether we can discover methodological similarities between Kuhn's theory concerning scientific revolutions and the emergence of new tactics in the context of tactical change in the history of football.

After this introduction, the paper is structured into two main sections. In the first section, I will explore how paradigm shift occurs according to Kuhn. The second section will concern how football tactics can be considered as a paradigm by referring to examples of Kuhnian paradigm shift. Thus, the chapters will help to demonstrate why a Kuhnian framework is well suited for making connections between football tactics and paradigms.

2. Understanding the Logic of Paradigm Shift

Kuhn, when he published The Structure of Scientific Revolutions in 1962, brought a new and different perspective to the Philosophy of Science. His opinions were both controversial and had influence over the contemporary philosophy. The most important notion in Kuhnian framework is "paradigm". We can say that paradigm is the first example of a scientific idea accepted by the scientific community within a certain period of time. Paradigm as a unique model emerged in the results of several long scientific studies.

This model contains the answers about the phenomena of its own scientific period. At this point, we should mention that theory is not a paradigm, because the paradigm must be new, unique, and a source of future scientific works. Moreover, a paradigm reflects the style of thinking and perspectives of the scientific community within a certain time. So, the paradigm is what determines the worldview of scientists.

According to Kuhn, changes in science are intermittent and radical, so the structure of science contains revolutions.

We can say that paradigm is a product of a scientific idea that is created and adopted by a community in a certain period of time. Kuhn claimed that the possibility of conventional scientific definitions using a cumulative method seems to depend on neutral and objective scientific criteria. However, a breakthrough leading to scientific innovation occurs through a conflict between different scientific communities. For this purpose, substantial theoretical development is based on a scientific decision. In this case, if the decision depends on the scientific criteria, they seem to treat every innovation equally. However, if one is a scientist, and if there is more than one scientific product accepted as consistent by a scientific community, one wants to determine which is more selectable. This selection is usually based on scientists' individual preferences (known as "irrational effects"), which contain some factors such as being a member of a scientific community, a sense of commitment towards a paradigm, trust in the correctness of paradigm, feeling that something is wrong in a paradigm, the desire to create a new paradigm, and so on.

Each of these different scientific approaches in competition with each other is called a "paradigm" by Kuhn. Further, his framework was not based on conventional scientific definitions and a cumulative method. Cumulativity is a scientific method that aims at improvement in science by adding new knowledge to the existing knowledge. Through this method, a scientific theory is developed by providing further and better results on top of the existing one. In this method, science is generally considered to be depending upon a continuous and uninterrupted road. Scientists want to reach "better" results than those possessed by the old and existing theory. Agazzi expressed the point as follows:

> *"The idea of the 'better' is then more or less vaguely understood in terms of deeper insight or of better correlation between the different truths, and its expression is perhaps given by the familiar image of science as a great and complex building, to the erection of which every single scientist contributes by adding something like a new floor with beautiful rooms. Roughly speaking, there is some kind of common consensus in the appreciation of the development of scientific knowledge not simply as change, but rather as 'linear and cumulative progress."*
>
> (Agazzi, 1985:57)

In this context, Agazzi claimed that cumulativity has a linear content in a scientific progress. Through linearity, new scientific knowledge is put on the existing knowledge. So, the product obtained as a result of this process is similar to take it a step further without changing direction. These steps are taken using the available scientific data. So, we can say that new knowledge depends on the existing knowledge about a scientific theory. For example, we can establish a scientific hypothesis about an existing theory, and we can improve this theory by adding the information we have achieved from our hypothesis and experimental testing. In this case, we can mention the influence of observation and experimentation which are the principles of this scientific method. They emerged as main elements of gaining scientific knowledge, so they have been the source of scientific developments.

Science and its Philosophy also were based on this empirical perspective which is dependent on experiments and observations as a way of gaining knowledge. By empirical method, I mean a scientific system which reaches results through experiment and observation. Thus science, as understood by the empirical tradition, was a system based on empirical experiments and observations. In this case, empirical scientific activities seem to be an initiator for cumulativity. As we have seen in Agazzi's definition of cumulativity, this continuous process is similar to contribution of every single scientist by adding a new floor in the science building. At this point, cumulative approach in scientific development will become more apparent through the ideas of the constructive empiricists.

> *"For a constructive empiricist, it would be natural to think that among empirically adequate theories one theory T2 is better than another theory T1 if T2 entails more true observational statements than T1. Such a comparison makes sense at least if the observation statements entailed by T1 are a proper subset of those entailed by T2. Kemeny and Oppenheim (1956) gave a similar condition in their definition of reduction: T1 is reducible to T2 if and only if T2 is at least as well systematized as T1and T2 is observationally stronger than T1, i.e., all observational statements explained by T1 are also consequences of T2."*
>
> (Niiniluoto, 2015:14)

In this context, T1 is analogous to a floor added by a scientist in a science building. A new floor (T2) can be added, accounting for more data than T1. In this way science has a continuous and linear structure. Thus, this T2 will have the opportunity to be the subset –or new T1- of a new T2 for cumulativity.

On the other hand, according to Kuhn science is done in two alternating ways: The first way is that a paradigm is accepted and "normal science" is made by scientists. Kuhn defined this term as follows:

> *"…'normal science' means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice."*
>
> (Kuhn, 1970:10)

Kuhn argued that normal science involves a specific scientific progress which is carried out with puzzle-solving. So, normal science does not aim to make changes about a scientific paradigm. It just focuses on contributing to the consistency of a paradigm. For this reason, scientists generate some scientific solutions which are called puzzle-solving within a paradigm to strengthen this paradigm and to keep it alive. In other words, the notion of puzzle-solving is to achieve the estimated scientific results by using a new hypothesis within an existing paradigm. So, let us see what Kuhn claimed about the conditions of normal science.

> *"Aristotle's Physica, Ptolemy's Almagest, Newton's Principia and Opticks, Franklin's Electricity, Lavoisier's Chemistry, and Lyell's Geology—these and many other works served for a time implicitly to define the legitimate problems and methods of a research field for succeeding generations of practitioners. They were able to do so because they shared two essential characteristics. Their achievement was sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity. Simultaneously, it was sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve."*
>
> (Kuhn, 1970:10)

Based on the above-mentioned examples, we see that scientific work has progress within periods of normal science, and puzzle-solving is a guarantor of this scientific work. In fact, we can accept that normal science is closely linked with the notion of paradigm, because the mission of normal science is to find a large mass of data and provide theoretical explanation within a particular paradigm. For this reason, the product of normal science must be unique and innovative enough to impress opponent scientists. However, normal science will lead to crisis sooner or later, because it falls short of finding a radical solution against the anomalies occurring in a paradigm. This situation shows that science has a revolutionary and intermittent structure instead of being linear and uninterrupted.

The second way is that scientists try to change the paradigm. These changes happen through scientific revolutions. So, when the build-up of anomalies in the old paradigm, crisis science occurs and then the old paradigm begins to lose its stability. In this case, a scientific revolution is required to choose a new paradigm which is available to take over among different paradigms.

In this context Kuhnian framework consists of the following steps, respectively: (1.) normal science, (2.) anomalies, (3.) puzzle solving, (4.) crisis, and (5.) revolution.

2.1. Can Cumulativity Lead Us Astray?

When we look at the new style of the scientific progress in the first part, we can see that the content of the cumulative approach has a linear form.

However, are we sure about the scientific information what we use in order to learn further will definitely let us progress in science? Let us see whether the aim of learning further give us a definite scientific progress with respect to the example of Phlogiston theory. This theory was described by Becher at first, concerns what happens when a substance burns, so it is a good example for the revolution of combustion in science.

> *"Johann Joackim Becher (1635–82) modified these ideas at the end of the 17th century, arguing that the calcination of metals is a kind of combustion involving the loss of what*

he called the principle flammability. Stahl subsequently renamed this principle 'phlogiston' and further modified the theory, maintaining that phlogiston could be transferred from one substance to another in chemical reactions, but that it could never be isolated."

(Weisberg, Needham, and Hendry, 2011:29-30)

According to the accepted combustion theory, combustion was happening through a mysterious substance which is located in the burning object. This substance was named "phlogiston", and it causes the combustion of a material. The key idea was that the combustion of an object consists in it releasing phlogiston. Furthermore, this theory claimed that the amount of phlogiston in an object is important issue in terms of combustion. For example, some objects leave much more ashes than others such as heat-shrinking papers and pieces of wood. This is explained by phlogiston theory by holding that some objects contain a higher proportion of phlogiston:

"Substances such as carbon which left little or no ash after burning were taken to be rich in phlogiston.''

(Weisberg, Needham, and Hendry, 2011:30)

This theory was furthered by Cavendish and Priestley. The experiments had demonstrated that the air is needed for combustion. For example, it was known that a burning candle will be extinguished when it covered by an air tight glass. In light of phlogiston theory, this phenomenon believed that air can absorb a limited amount of phlogiston, and the candle does not burn anymore when the air is completely saturated by phlogiston:

"After 1760, phlogiston was commonly identified with what they called 'inflammable air' (hydrogen), which they successfully captured by reacting metals with muriatic (hydrochloric) acid. Upon further experimental work on the production and characterizations of these "airs," Cavendish and Priestley identified what we now call oxygen as 'dephlogisticated air' and nitrogen as 'phlogiston-saturated air.'

(Weisberg, Needham, and Hendry, 2011:30)

In fact, this theory was very capable of being disproved in the future even though phlogiston theory also predicts that the candle in the bell jar will also go out. The key fact in this example, phlogiston theory could explain the combustion of objects in certain contexts. So, at a particular point in time this theory seemed to be consistent with the data. At this point, Scientists wanted to support Phlogiston with an assumption that the combustion of an object consists in it releasing phlogiston, but the main factor for the combustion is objects to interact with oxygen gas for Lavoisier. In the light of this example, we can conclude that false theories can be confirmed by experimental results.

As we have seen, Phlogiston theory played a very useful role as an explanatory concept, and it regulated many cases about combustion in the first place. However, we can say that this theory became inadequate over some increasing experimental results. Scientists put forward some strange thoughts such as "negative weight" in order to improve Phlogiston theory. According to them, metals lose negative mass during the combustion process. Thus, a burned metal material becomes heavier than the previous weight before combustion. They made this selection by using the results of their experiments and observations, because the experimental data of Phlogiston theory created the obligation to make such a judgment. This is the way to keep the theory alive. According to Kuhn, this is the "puzzle solving" of normal science, designed to meet the deficiencies in the theory, and render it consistent. However, the reality is that we can be misled by the experimental data.

In the rest of this example, Phlogiston theory lost its title of being the dominant theory of combustion in science when its inadequacy was shown by new scientific findings. For example, Lavoisier showed that combustion requires a gas, namely oxygen. In fact, one reason for the wrong conclusion was a lack of understanding concerning gases. So, we have to accept that the cumulativity gave misleading results in some cases as in Phlogiston theory.

2.2. The Occurrence of Anomalies

Kuhn claimed that when a theory contains some small problems and contradictory statements, scientists generate some arguments to keep the theory alive. Kuhn called this step what scientists need to give an explanation to resolve these problems as the occurrence of anomalies in science.

> *"Normal science does not aim at novelties of fact or theory and, when successful, finds none. New and unsuspected phenomena are, however, repeatedly uncovered by scientific research, and radical new theories have again and again been invented by scientists. History even suggests that the scientific enterprise has developed a uniquely powerful technique for producing surprises of this sort. If this characteristic of science is to be reconciled with what has already been said, then research under a paradigm must be a particularly effective way of inducing paradigm change. That is what fundamental novelties of fact and theory do."*
>
> (Kuhn, 1970:52)

According to Kuhn, scientific theories are supposed to be successful and complete if they do not intend to bring innovation in its theory. In this case, we can state that the attitude of solving small problems as if the only thing that we need is not enough for scientific developments. Furthermore, coping with small details can block to see the big picture just as in Phlogiston example. Scientists wanted to focus on finding a connection between the amount of remaining ashes and the proportion of phlogiston released. Thus, this connection would ensure the consistency of Phlogiston theory to explain combustion.

As we have noted in Section 2.1, this behaviour can also lead us astray. In this case, the first step to get rid of the anomaly is to be aware of the existence of anomalies. Then, scientists must be aware of the problem-solving method is not enough to eliminate anomalies in a theory. Thus, scientists must manage the crisis determinedly and should take the decision to change the paradigm.

As I mentioned before, traditional scientific progress had a regular structure, but occurrence of crisis and revolution in science result in the interruption of the linear structure of normal science. So, we should first look at the causes of discovery to understand the intermittent structure of science. According to Kuhn, it is better to consider scientific discoveries as regularly repeated events rather than having an individualistic and separate structure.

> *"Discovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues with a more or less extended exploration of the area of anomaly. And it closes only when the paradigm theory has been adjusted so that the anomalous has become the expected. Assimilating a new sort of fact demands a more than additive adjustment of theory, and until that adjustment is completed—until the scientist has learned to see nature in a different way—the new fact is not quite a scientific fact at all."*
>
> (Kuhn, 1970:52-53)

In this context, each anomaly is a good opportunity for a scientist to see shortcomings of a theory. Furthermore, these shortcomings can help him to discover new things. For example, Lavoisier realized that something was wrong concerning phlogiston theory. Also, Priestley probably realized an anomaly in Phlogiston theory and he called oxygen as *"dephlogisticated air."* (Weisberg, Needham, and Hendry, 2011:30) However, his clarifications did not make sense to Lavoisier, and he identified this gas as "oxygen".

When we look at Kuhn's own sentences about this example, he said that;

> *"Grant now that discovery involves an extended, though not necessarily long, process of conceptual assimilation. Can we also say that it involves a change in paradigm? To that question, no general answer can yet be given, but in this case at least, the answer must be yes. What Lavoisier announced in his papers from 1777 on was not so much the discovery of oxygen as the oxygen theory of combustion. That theory was the keystone for a reformulation of chemistry so vast that it is usually called the chemical revolution. Indeed, if the discovery of oxygen had not been an intimate part of the emergence of a new paradigm for chemistry, the question of priority from which we began would never have seemed so important."*
>
> (Kuhn, 1970:56)

Lavoisier's determinations on the nature of this gas brought a new perspective in chemistry, because no one had done a complete change in combating the anomalies of

Phlogiston until Lavoisier. Roughly speaking, we can say that being the first scientist who discovered oxygen will lead to be the scientist who takes the initiative for paradigm changes; because he already realized that a gas has an important role in combustion. Priestley's thoughts were probably similar, but the main difference was that Lavoisier caused the paradigm change. At this point, Priestley, as a scientist who could notice anomalies, would lead to misleading result even if he understood something was wrong in Phlogiston.

In consequence, consciousness of these anomalies will bring a new perspective about the existing theory, and then we can understand that solving problems is not enough to keep this theory alive.

At this point, we can continue to explain the occurrence of anomalies with reference to the concept of Phlogiston theory. For instance, explaining the cause of the combustion by considering the amount of phlogiston in an object led to a problem. Heat-shrinking papers and pieces of wood and smoke coming out of a burning object were good evidence for phlogiston emerging from burning objects. However, a burning metal is heavier than it was before burning. This fact is an anomaly in this theory, because it was supposed to have lost weight like the others such as pieces of wood, or papers. Also, a second piece of evidence is that a burning object in an air-tight container will be extinguished, because the air inside of the container will be saturated with phlogiston. Later, however, it became clear that it is not the case. As a result, these anomalies have undermined the consistency of the theory even though scientists stated that the weight of phlogiston is negative in order to improve Phlogiston.

In this case, we should come back the fact that the first step in making the discovery is awareness of the anomalies. When considering anomalies in Phlogiston, we must keep in mind that a scientific result which contains some anomalies is constituted by scientific observations and experiments. Through these methods, we have a paradigm claiming that combustion consisted in release of phlogiston located in the burning object. But then, this theory of combustion contains several anomalies. As a conclusion, the existing paradigm enters the new period where we can call the breaking point because of the accumulation of anomalies. For Kuhnian framework, it is "crisis" period.

2.3. Crisis and Emergence of a New Scientific Theory

We confirmed before that problem solving is not enough to get rid of anomalies by referring Kuhnian framework. If we choose it, we have seen that anomalies will grow and they will lead us to false conclusions. Let us think about it now: We have a scientific theory, and it grows in a linear form. A wrong interpretation to be made anywhere in the scientific theory will take its own place in explanation of combustion just as scientists assumed that the existence of a substance called phlogiston. We can understand this better through an analogy. We can consider the occurrence of anomalies as if a nail gets in tire. In this case, we will experience tire blowout sooner or later. The first thing we do in this case is to repair a punctured tire. Perhaps it seems to be sufficient, but it has lost some durability. After a while, it is likely to encounter the same problem again. Eventually, we decide to replace it with to new tire, because it became dysfunctional due to several patches. Roughly speaking, the stage of crisis in paradigm is similar to tire becomes unusable. Moreover, it is important that whether the driver is aware of this malfunction about the tire. At this point, we can say that this awareness stage is similar to realize that something was wrong for Lavoisier in Phlogiston theory. In this example, the role of crisis is to tell that something such as tire, or paradigm, needs a radical change.

After making an illustration about what crisis means, we need to pay attention to Kuhn's ideas about crisis in Phlogiston theory.

> *"…the phlogiston theory proved increasingly little able to cope with laboratory experience. Though none of these chemists suggested that the theory should be replaced, they were unable to apply it consistently. By the time Lavoisier began his experiments on airs in the early 1770's, there were almost as many versions of the phlogiston theory as there were pneumatic chemists. That proliferation of versions of a theory is a very usual symptom of crisis."*
>
> (Kuhn, 1970:70-71)

According to Kuhn, the effort of keep the theory alive makes anomalies more complicated, because scientific assumptions contained within the theory could not keep up the results of the experiments. Even though scientists could not succeed to put theory on the right track, they did not think about changing it. In fact, scientific communities generally do not think about get rid of their theory despite it contains several inconsistencies. We can claim that the reason is very clear, because nobody wants to leave the theory that their products at the first stage. However, this insistence seems to damage the theory itself.

> *"Like the problems of pneumatic chemistry, those of weight-gain were making it harder and harder to know what the phlogiston theory was. Though still believed and trusted as a working tool, a paradigm of eighteenth-century chemistry was gradually losing its unique status. Increasingly, the research it guided resembled that conducted under the competing schools of the preparadigm period, another typical effect of crisis."*
>
> (Kuhn, 1970:72)

As we have seen in this quotation, when some scientists detect anomalies, they want to demonstrate that the result of Phlogiston theory leads us astray. On the other hand, these claims can be rejected by some scientists who are follower of this paradigm. As a result of serious discussions initiated by some scientists who realize something is wrong, the consistency of Phlogiston theory will shake the confidence of the certain parts of the scientists to the paradigm even if some scientific communities want to maintain it. Thus, the paradigm enters the crisis period.

During this period, scientists pursue a new paradigm, adopting new tools and beginning to look in different places. More importantly, when they again focus on the previous data, they usually see some new scientific findings differently. So, the attitude of scientists is very important when choosing a new paradigm among different alternative paradigms, because the world postulated by scientists who are supporters of a new paradigm and is different from the world postulated by the old paradigm.

We now describe the notion of the incommensurability of scientific theories between different paradigms. There is diversity (based on the differences in scientific interpretation made by scientists) about the explanation of what is observed in the real world.

For this reason, the alternative paradigms are incommensurable with each other.

"Do we, however, really need to describe what separates Galileo from Aristotle, or Lavoisier from Priestley, as a transformation of vision? Did these men really see different things when looking at the same sorts of objects? ….changes with a paradigm is only the scientist's interpretation of observations that themselves are fixed once and for all by the nature of the environment and of the perceptual apparatus. On this view, Priestley and Lavoisier both saw oxygen, but they interpreted their observations differently..."

(Kuhn, 1970:120-121)

In the light of this quotation, we can accept that if scientists' perceptions contain differences for different paradigms, also we cannot talk about the existence of absolute certain scientific data even though all scientists live in the same real world. At this point, Kuhn depicted a scientist who supports the new paradigm as follows:

"Rather than being an interpreter, the scientist who embraces a new paradigm is like the man wearing inverting lenses. Confronting the same constellation of objects as before and knowing that he does so, he nevertheless finds them transformed through and through in many of their details."

(Kuhn, 1970:122)

In this context, it is possible to say that every paradigm has its own unique perspective, and this is a basic feature that makes them different from each other. According to Kuhn, all these differences between paradigms mean that different paradigms are incommensurable. Through incommensurability of the paradigms, each paradigm has its own scientific world and every observed phenomenon occurs according to the nature of this world. The changing things about these objects are our definitions, our judgements, and our perceptions for each different paradigm. For this reason, incommensurability means that paradigms cannot be compared with each other. So, we can say that when Priestley and Lavoisier use the word 'air', it means different things.

Thus, we can claim that the incommensurability of paradigms can be understood by looking at the situation of scientists who perceive something different from before. So, paradigm shift causes us to see and understand the world by having a new perspective. Scientists have to learn and comprehend their environment all over again when the existing paradigm changes. The new world of the researcher is the same as that previous one he was used to. Thus, the transition to the new paradigm is a scientific revolution. At this point, the notion of incommensurability is strong evidence to consider scientific progress as intermittent rather than cumulative and linear, in virtue of the relevant scientific perceptions and judgements. As a result of our acceptance that paradigms are incommensurable, we can talk about scientific revolutions more easily.

2.4. Scientific Revolutions

When scientific communities discuss the anomalies of a paradigm, some of them do not want to abandon existing paradigm even if communities have already begun to examine other alternatives, because scientist never give up their own paradigm against the first few difficulties.

Kuhn claimed that some scientific results, widely hailed as progress by the scientific community of the time on the basis of a background paradigm, could lead to misleading conclusions. As a consequence of Phlogiston example, we can argue why he claimed that scientific communities tend to hold that the latest stage in scientific discoveries is the only correct system.

On this subject, Kuhn says that:

> *"…invention of alternates is just what scientists seldom undertake except during the pre-paradigm stage of their science's development and at very special occasions during its subsequent evolution. So long as the tools a paradigm supplies continue to prove capable of solving the problems it defines, science moves fastest and penetrates most deeply through confident employment of those tools. The reason is clear. As in manufacture so in science—retooling is an extravagance to be reserved for the occasion that demands it. The significance of crises is the indication they provide that an occasion for retooling has arrived."*
>
> (Kuhn, 1970:76)

In this case, scientists want to evaluate the paradigm that they have, because a paradigm is not something that can be easily and suddenly changed. If new scientific theories succeed and become a widely held paradigm, and then if the new paradigm reaches to the level that it replaces the old, the existing paradigm (which could not be successful in terms of solving its own anomalies) becomes invalidated. At this point, a scientific revolution indicates that the current and the next scientific theories are just one of many possible scientific methodologies instead of being the single correct such. Thus, the source of the paradigm changes contains revolution in science.

At this point, we should mention the preferences of scientists in causing their decisions about paradigm change. As we mentioned before, the scientist does not want to give up his paradigm. However, during a crisis and the emergence of new paradigms, something becomes clear, and scientific data starts to be the source of inspiration for the scientist. Let us see how Kuhn illustrated this effect which seems to be irrational.

> *"Scientists then often speak of the "scales falling from the eyes" or of the "lightning flash" that "inundates" a previously obscure puzzle, enabling its components to be seen in a new way that for the first time permits its solution. On other occasions, the relevant illumination comes in sleep. No ordinary sense of the term 'interpretation' fits these flashes of intuition through which a new paradigm is born."*
>
> (Kuhn, 1970:122-123)

At this point, we can say that some effects happen in an instant, and then the scientist is freed from the impact of the old paradigm. So, these kinds of things for example *"scales falling from the eyes"*, or the *"lightning flash"* experienced by scientists seem to be the irrational influences, which trigger scientific revolutions. As we have noted in the first quotation of this section, retooling unless it is necessary means that a kind of extravagance in science. Furthermore, the attitude of not wanting to give up paradigm is also important. On the other hand, we can say that to be convinced of something absolutely (for example the necessity of a new paradigm) is also an irrational behaviour as it discourages one from leaving the paradigm. So, these kinds of irrational behaviours seem to have an impact on the decision of the scientific revolution.

The notion of revolution and its place in Kuhn's framework have a considerable importance for his claims about the structure of science. The revolution caused by the crisis involves choosing a totally different and unique scientific paradigm than before. Kuhnian perspective claimed that paradigm is necessary to do science. Therefore, the continuation of scientific progress is actually based on paradigm changes, and revolutions are the essences of the paradigm shifts. Kuhn claimed that

> *"…scientific revolutions are here taken to be those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one. There is more to be said, however, and an essential part of it can be introduced by asking one further question. Why should a change of paradigm be called a revolution? In the face of the vast and essential differences between political and scientific development, what parallelism can justify the metaphor that finds revolutions in both?"*
>
> (Kuhn, 1970:92)

In this context, Kuhn explained the process of a scientific revolution by referring the political revolutions. Thus, scientists are similar to public in terms of who make a selection among different alternatives. Each political regime have own specific method about who and how holds the elements of a *legislature*, an *executive*, and a judiciary just like scientific paradigms have their own tools to do science. So, political revolutions occur when these elements mentioned above remain incapable against anomalies in their own political environment. Then, a political system starts to lose its functionality, and someone will be aware of this irregularity in a regime. In other words, it is the revolution time when the political order loses its self-contained property for its public. In this context, revolution in science is also just like in politics. Through this comparison, we can claim that neither scientific judgments nor political regimes are absolute, because both of them contain making a choice among alternative options. Thus, all these facts are premises of the notion of scientific revolution in Kuhnian framework.

So, we can make it clear better, why Kuhn had the aim of creating the concept of paradigm shift against the concept of science was accepted as cumulative. Before "the Structure of Scientific Revolutions", science world generally believed that scientific knowledge and theories are obtained and constituted through continuous and uninterrupted accumulation. So, the progressive structure of science formed by these scientific developments leads to the formation of an uninterrupted history of science.

On the other hand, scientific practices in a similar way above are not acceptable for Kuhn. According to him, this empirical and progressive concept seems to require that it is the most certain perspective in the history of science. However, he claims that he can establish totally different scientific methods and results by looking at the same history of science. For this purpose, he wrote "the Structure of Scientific Revolutions", and created the notion of paradigm shift to demonstrate different interpretations of scientific results from a new and original perspective against usual assumptions of scientific methods. In his framework, history of science can develop through huge interruptions in scientific accumulation instead of a continuous scientific process. These interruptions he called revolutions.

To sum up, when revolution is completed and the new paradigm selected, more scientists will participate in the new paradigm depending on its consistency and strength. Eventually, something associated with paradigm for example the experiments, the number of scientific tools, and publications will increase. As a result, more scientists will adopt the new paradigm's style of doing normal science. In this case, we can say that all these events restart when a new paradigm is accepted by scientists and called as "normal science". In other words, anomalies occur in a paradigm through the discoveries of normal science, this leads to crisis, crisis leads to revolution, a new paradigm is accepted, and then the process repeats. Thus, science develops in an intermittent structure.

3. How Football Tactics Can Be Considered as a Paradigm

We discussed how the scientific revolution and paradigm shift occurred by using Kuhnian perspective so far. Now it is time for examining changes in football tactics on the basis of the paradigm shift by analysing two main issues, "*how and why football tactics change*", and "*what the contributions of irrational effects are in football tactics*".

The tactics, which are produced to be more successful than the opponents, are based on not only a line-up on the pitch but also all ways and advantages followed in order to achieve the desired results. So, a successful tactic, as a paradigm, contains a unique team formation, having talented footballers suitable for team formation, financial opportunities of the football club, having an efficient management team, and so on. These are tools to create a successful tactic. So, the consideration that retooling is extravagance in science except for special cases is almost exactly the same in football tactics. In this case, we can consider that finding a proper player for the existing tactic seems to be a puzzle-solving against anomalies in Kuhnian perspective. However, arranging the squad according to the new tactic, and giving new tasks to them on the pitch will give cause for paradigm change. At this point, we can remember that each paradigm has its own scientific world and every scientific movement occurs according to the nature of this world. For this reason, if a manager creates a new tactic instead of finding a proper player for a position, it means that creating a new perspective in football. The manager prefers to solve problems or new paradigm, but they are both based on irrational things that affect his choice. Thus, we can claim that each different tactic has its own ability to be successful just like each paradigm has its own scientific world.

Furthermore, we can understand these factors, which are tools of a paradigm in football tactics, as elements of a paradigm shift in football tactics, because anomalies that occur in one or more factors will bring the revolution. At this point, I want to briefly mention that a possible disanalogy between science and football tactics to better understand how football tactics can be considered as a paradigm.

The target of a scientific paradigm is the nature. So, the effectiveness of a scientific paradigm depends on Nature. On the other hand, the effectiveness of a football tactic depends in part on what tactics the opponents have or the rules of football, which can change. However, scientific paradigms do not have a flexible structure unlike football tactics, because their observations and experiments depend on objects in Nature. So, we can say that the nature of football tactics has occurred through previous tactics created by football managers. So, the effectiveness of a football tactic contains a changeable structure through what tactics the opponents have, but the effectiveness of a scientific paradigm presumably does not change. Nevertheless, this difference is not a serious problem for discussing changes in football tactics on the basis of the paradigm shift. Indeed, there is reason to think that this disanalogy makes the Kuhnian framework *more* appropriate for understanding football compared to natural science. Even if relativism is a problem in science, on the other hand, it is not priority in football case. So, subjectivity does not pose a problem in football tactics unlike science. Football tactics are evaluated in terms of the possibility to bring success at first. So, the priority in this case is whether the tactic is fruitful. The occurrence of a successful strategy depends on many variable factors such as team formation, talented footballers, financial opportunities, efficient manager, and so on. Thus, relativity is very usual thing in creating a fruitful tactic. For this reason, Kuhn's ideas which are accused of talking about relativity in science are more important and helpful than the opinions of critics to discuss the issue of change in football tactics to be considered as a paradigm change. Thus, the disanalogy between tactics and scientific paradigms makes the Kuhnian framework better for understanding football rather than natural science.

In this case, when we mention a disanalogy between the structures of nature and football tactics, there is no unchanging underlying structure; tactics aim explicitly at fruitfulness or effectiveness rather than truth as in natural science, partly because the tactics used depends upon the opponents' tactics. Thus, following a Kuhnian framework in the case of football tactics as opposed to natural science avoids one major criticism.

Let us start to illustrate in more detail the two main questions by focusing on specific examples in the history of football tactics and by referring to examples of Kuhnian paradigm shift.

3.1. The Occurrence of Anomalies in Tactics

"Anomaly" is a weakness of a tactic that becomes apparent when a team using this tactic does not succeed anymore. There are many causes of Kuhnian 'anomaly' is in the context of football tactics. For example, inability to replace the equivalent when a talented player transfers to another team, gets injured, or quits football leads to an anomaly. Anomalies can sometimes occur due to changes in football rules. Furthermore, even the lack of facilities, such as stadiums, may cause anomalies. There are two things to do in such cases: finding a solution within the tactic (like puzzle-solving against an anomaly in science) or changing the paradigm.

First of all, I want to discuss how an anomaly occurs in a successful system because of a lack of facilities with the help of a current example in football world. Donbass Arena is the home ground of FC Shakhtar Donetsk, which is one of the strongest teams in Ukrainian Premier League. FC Shakhtar was playing their home games in this stadium since 2009. Mircea Lucescu, who is the current manager of FC Shakhtar, has won the championship three times, and the UEFA Cup in 2009 as coach of this team between 2004 and 2009. Then, with the effect of a stadium which has a capacity to host around 50.000 fans and Lucescu's tactical capability combined, FC Shakhtar won the championship five-time in a row in the Ukrainian Premier League between the years of 2009 and 2014. However, Donbass Arena was hit by two artillery shells on 23 August, 2014 during pro-Russian unrest in Ukraine. As a result, it was damaged in such a way that cannot be home to any event. This incident badly affected the team's strength, and the team began to play the match in Lviv, located about 1,200 kilometres from Donetsk. In other words, this distance is about 745 miles (a very large distance, almost twice the distance between London and Edinburgh!). These unexpected situations such as the absence of a stadium, and being obliged to go to a distant city during the season caused the physical and mental fatigues on the players. So, these fatigues resulted in weakness (i.e. an anomaly), and FC Shakhtar, which were the league champions for the last five years, lost the league title of 2014-2015 against FC Dynamo Kiev (the most serious rival team of FC Shakhtar in Ukraine). In this case, we can claim that when an anomaly occurred due to an unexpected situation, a puzzle-solving –prefer to play the match in Lviv- led to a new anomaly such as fatigues of players instead of being successful to get rid of the existing anomaly. The decision about playing in Lviv until the end of the conflict, and until the stadium to be used again seems to be a puzzle-solving. However, is it considered as an alternative solution that not only on match days in Lviv but also move to Lviv from Donetsk completely for a while? These kinds of difficult questions can be asked only during revolutions. So, answering this question is equivalent to take the decision to change the paradigm.

Now, let us examine the other factors that cause anomalies. As an example of occurrence an anomaly due to changes in football rules, we can mention the first known formation called "the pyramid" which was popular until the 1920s.

> *"…the pyramid would remain the global default until the change in the offside law in 1925 led to the development, in England, of the W-M. Just as the dribbling game and all-out attack had once been the "right"—the only—way to play, so 2–3–5 became the touchstone."*

(Wilson, 2013:29)

Figure 1.1: "The Pyramid", or 2-3-5 (image available from [FB, 2015])

The old rule said that, "*a player was considered offside if he was ahead of the ball and near his opponent's goal with fewer than three opponents between him and the ball.*" (Orejan, 2011:68) 2-3-5 contained three players were usually two defenders back and a goalkeeper. Thus, it was very easy to use the offside rule in favour of the team. Thus, this situation made it difficult for the opponent to score a goal.

> *"…Newcastle United with their full-back pairing of Frank Hudspeth and Bill McCracken, had become so adept at setting an offside trap that games would be compressed into a narrow sliver either side of the halfway line. When Newcastle drew 0–0 at Bury in February 1925, it came as the final straw. It was Newcastle's sixth goalless draw of a season that produced what at the time was an unthinkably low average of 2.58 goals per game."*

(Wilson, 2013:41)

At this point, we can understand why the pyramid was so popular when the old offside rule was valid, because it contained some advantages such as three players were in defence. So, we can accept that Newcastle United manager would have an irrational behaviour when he use the pyramid just like to adopt so as not to leave the paradigm, because he had two full-backs using offside trap successfully even if lack of goals made football a boring game. Moreover, the best tactic was his own tactic until the offside rule was changed. So, we can remember the fact in Kuhnian framework that scientists do not want to give up their paradigm unless an extraordinary situation occurs.

In 1925, when the offside rule was changed in order to increase the amount of goals, the pyramid began to lose its credibility.

> *"Previously a side looking to play the offside trap had been able to retain one full-back as cover as his partner stepped up to try to catch the forward; the new legislation meant that a misjudgment risked leaving the forward one on one with the goalkeeper."*
>
> (Wilson, 2013:42)

As we understood from this quotation, the new rule said that two players instead of three (usually a goalkeeper and two defenders) were required for offside, and so the opportunity of finding goal will be easier than before. In this case, the most serious anomaly of the pyramid occurred, because it did not promise to be successful in the new offside rule. So, football world needed someone to realize that something is wrong in "the pyramid" under the circumstances when the new offside rule was successful to increase the number of goal than before. Thus, the pyramid was just like a paradigm in the crisis period. Some teams wanted to keep this tactic alive. For example, 1930 World Cup finalists Uruguay (dark blue shirts) and Argentina (blue and white shirts) used 2-3-5 five years after the new offside rule, despite it being considered (by and large) ineffective.

Figure 1.2: "The Pyramid" tactic of the final match (image available from [Wikipedia 2015])

Managers of Uruguay and Argentina seem to have coped with the anomaly to some extent, so this behaviour includes similarities with the behaviour of scientists in Kuhnian framework. Chemists had put forward some claims to cope with anomalies of Phlogiston theory until Lavoisier period. For example, "negative weight" to describe why a burned metal material becomes heavier than the previous weight before combustion is one of puzzle-solving activities to keep Phlogiston alive. On the other hand, just as in chemistry, football world was in need of a new paradigm although some supporters of this tactic wanted to keep it alive.

3.2. Paradigm Changes in Football Tactics

In the previous chapter, we analysed the steps of how an anomaly occurred in a successful tactic, and the reasons of how it came to the paradigm shift period. Now, we discuss why a tactic needed a paradigm change. When the old tactic lost its effectiveness and became useless under the new offside rule, football world needed someone to realize that something is wrong in "the pyramid". At this point, Herbert Chapman created a new tactic. Even if the pyramid was the winning tactic of the World Cup, it was time to give up old paradigm and change it, because solving problems such as avoiding conceding a goal more than you score were almost impossible the sovereignty of the new offside rule. As a result, he created the W-M tactic by putting a third player in defence instead of in midfield, and he had a defending third.

> *"On the face of it, the amendment was an immediate success, with the average number of goals per game shooting up to 3.69 the following season, but it brought about significant changes in the way the game was played and led directly to Herbert Chapman's development of the "third back" or W-M formation. And that, it is widely held, was what precipitated the decline and increasing negativity of English soccer."*
>
> (Wilson, 2013:42)

Chapman's tactic was called as the W-M, because the formations of defenders seem like "W", and the forwards seems like "M" on the field.

Chapman put a player, who is in the middle of the midfield, in the defence and made him into a stopper. He also put his two central defence players on the wings. So, he was the creator the concept of right-back and left-back. For Chapman's tactic, they would mark the opponent team's wingers. Also, the duty of midfield players was to mark the striker of opponent team. Although an extremely defensive game style as a result of this tactic, Chapman's Arsenal was very successful.

Figure 1.3: "W-M", or 3-2-5 (image available from [FB, 2015])

> *"'Breaking down old traditions,' a piece in the Daily Mail explained, 'he was the first manager who set out methodically to organise the winning of matches.' It worked. Arsenal won the league in 1931 and 1933 and were beaten in the 1932 Cup final only by a highly controversial goal."*
>
> (Wilson, 2013:49)

Chapman, in January 1934, died before seeing Arsenal's success that was the second team to take the championship title in three consecutive times in England. Nevertheless, Arsenal became the most famous and successful team of those years as a user of "W-M", and these successful years are based on the paradigm change by Chapman.

At this point, we should discuss whether these football paradigms are incommensurable. For Kuhnian perspective, each paradigm has its own scientific world and every scientific movements occurs according to the nature of this world. In football case, changing the offside rule in order to watch more goals in football matches led to a serious anomaly in the pyramid, but football was still the same game which designated by some fundamental rules. The presence of the offside is one of the basic rules, but a regulation in this fundamental rule does not change the essence of football. Therefore, the pyramid and the W-M are two different successful tactics of the same game, but they and their success belong to different periods. Therefore, we can claim that the pyramid and W-M are incommensurable by referring the incommensurability of scientific theories between old and new paradigms.

Furthermore, even if they invented under the same conditions of offside rule, they would still be accepted incommensurable although both of them were based on defensive mentality, because their solutions to avoid conceding goals are different. In this case, we would accept them as alternative paradigms by thinking incommensurability of the alternative paradigms.

Kuhn claimed that Priestley and Lavoisier saw oxygen while observing, but interpreted their observations concerning this gas differently from each other because of differences in perception. Each scientist perceives scientific world different even if they live in the same real world. This difference in perceptions is a main reason of the idea that alternative paradigms are incommensurable with each other. Thus, we can say that there is an analogy between incommensurability of paradigms and football tactics.

At the beginning of this stage, we said that a tactic is based on not only line-up, but also different elements to be successful. At this point, it is understood that the preferences such as keeping an existing paradigm alive, or taking the decision to revolution for paradigm change have an impact on paradigms.

4. Conclusions

In the light of all above examples, we can claim that it is possible to understand football tactics through the logic of paradigm shift. At this point, we can briefly re-examine paradigm shift through revolutions.

In scientific revolutions, anomalies become serious due to a paradigm's inability to find a solution. As we saw at the beginning of Section 2, we have mentioned that the effectiveness of a scientific paradigm depends on nature. The origin of experiments and observations are in nature, so every paradigm occurs within the boundaries of nature. In this case, the ability of analysing and making interpretation about these scientific results is important issue, so a scientist should have these abilities to build a paradigm. Managers also are similar to scientists, because they should have the ability to read the game. If they cannot detect anomalies within their own team or opponents’, they cannot be successful. In this case, the effectiveness of a football tactic depends in part on what tactics the opponents have or the rules of football, which can change. So, we should analyse whether this difference is a problem for accepting changes in tactics as paradigm change.

If we remember the steps of paradigm change, anomalies lead to crisis, and then it leads to a new paradigm’s occurrence among other alternatives, and finally scientists start to support the new paradigm. So, if we look at in the history of football tactic, we can see that these steps occur in a similar way. In this case, we discussed and accepted that changes in football tactics and Kuhn's thoughts are similar in many aspects. Thus, changes in football tactics can be examined based on the ideas of Kuhn. As a conclusion, football tactics can be understood through the logic of paradigm shift. Revolution in football tactics is possible even if the sources of anomalies are different from each other.

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