

# METHOD AND APP FOR ASSESSMENT OF TACTICAL PERFORMANCE IN THE GAME OF SOCCER

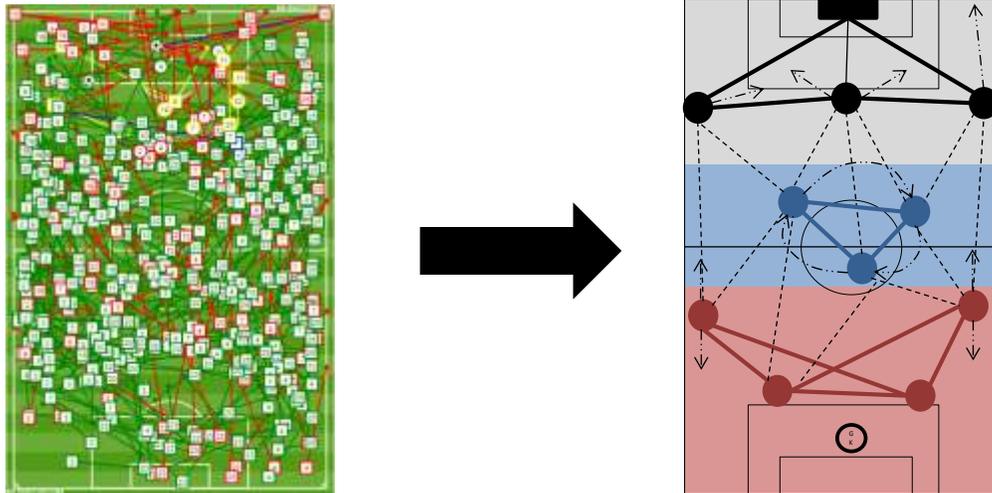
## ***Abstract:***

Soccer games are won and lost on the outcome of only a handful of random events. These events are a subset of the 250 to 1200 random events that occur in a game. A coach positions their team to score goals and win by: (1) developing individual player skills and decision-making to be able to participate in the, (2) safe and efficient movement of the ball into shooting position, (3) by the coordinated and synchronized movement of the players. The coordinated and synchronized movement of players, and the subsequent movement of the ball, is known as patterns-of-play. Sequences of patterns-of-play constitute the tactics, or style-of-play. Due to the larger number, speed, and complexity of events, it can be a challenge for (human) coaches to collect and analyze event data, to assess team tactical performance, and communicate this assessment to the players (to effect improved tactical performance).

This paper describes a method for analyzing the larger number, of rapidly occurring, complex events in the game of soccer to assess the tactical performance of the team. Tactical performance captured by the percentage of attempted passes (and completed passes) for each of 5 phases of play: (1) build-up, (2) transition to midfield, (3) consolidate in midfield, (4) transition to offense, and (5) break-down opponents defense. These pass statistics are collected, analyzed and visualized on a tablet (or laptop) App. Players and coaches both found value in (finally) being able to see quantitative measures of performance and to communicate effectively on this complex subject.

## 1 INTRODUCTION

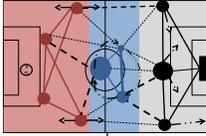
Team tactics, or style-of-play, is a description of how the team moves the ball into positions to get off quality shots to score goals. Due to the sheer number of events in a game (250 to 1200), the speed and the complexity of events, it is difficult for the human brain to collect, process, analyze, and communicate assessment of team performance. In addition, there is no formal language coaches and players share to communicate tactics in a quantifiable manner.



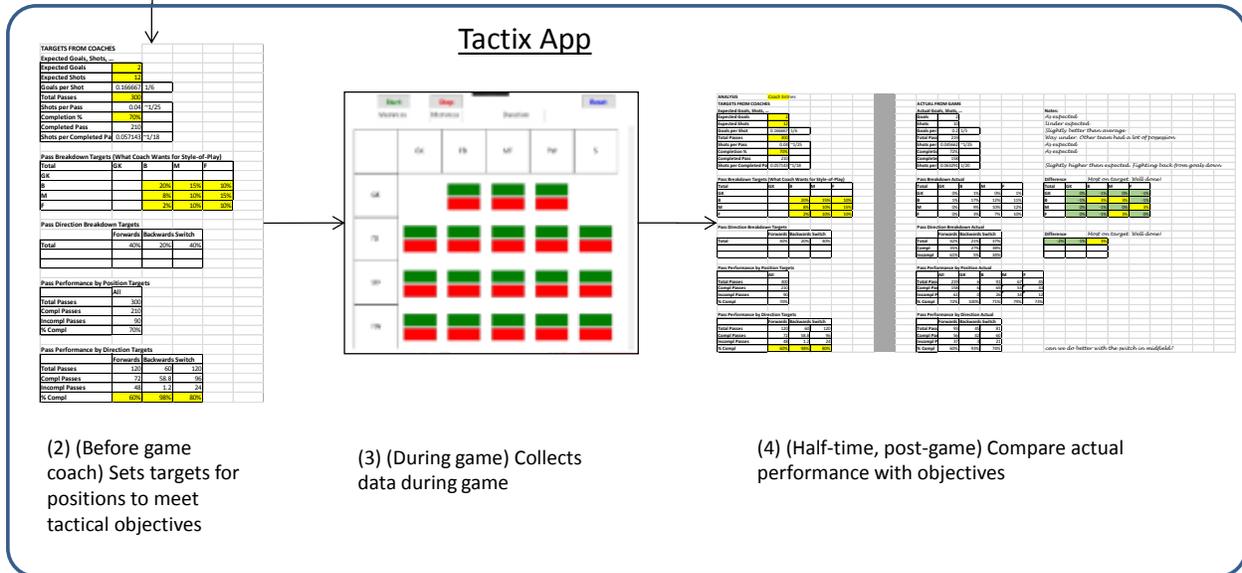
**FIGURE 1: Players and coaches must to collect, process, analyze, and communicate assess team performance based on large number of rapid complex events.**

Professional teams overcome these limitations by using sophisticated camera systems to collect player and ball movement, and event data. They then use complex algorithms to analyze the data to assess tactical performance. Tactical adjustments are then determined by the coaching staff and communicated to the players in the form of “X-and-O” diagrams or verbal instructions.

This paper describes a method for analyzing the tactical performance of a team based on a tablet/laptop based App (“Tactix”) to collect the data, analyze the team tactical performance, and identify areas for improvement (Figure 2). The method for analysis is based on a technique for analyzing soccer as a sequence of passing events that together yield patterns-of-play that are designed to fulfill a tactical plan implemented to *maximize* the *probabilities* of event *outcomes* that lead to goals. Although not as sophisticated as professional team analysis, this method has proven useful in assisting coaches: (i) communicating their desired tactics/style of play to players, (ii) in assessing team tactical performance at half-time and post-game, and (iii) in demonstrating progress over time to Athletic Directors.



(1) Coach develops team tactics in training



**FIGURE 2: Tactix App. (1) Coach establishes and trains teams tactics/style-of-play, (2) Coach establishes targets for a game, (3) Assistants collect game data during game, and (4) app assess performance against targets.**

This paper is organized as follows: Section 2 describes an event-based “theory” of soccer that is used as the basis of defining tactical performance. Section 3 describes the method for defining and assessing tactical performance, Section 4 describes the App with an example. Section 5 discusses the limitations of the application and the implications of the method.

## 2 THEORY OF SOCCER AND TACTIAL TEAM PERFORMANCE

There are many ways to “see” and enjoy the game of soccer. Some people may see the individual athleticism involved in the sport, others may see the synchronized movement of players on a team and the resulting ball movement. In fact, players and coaches probably “see” the game with many different lenses. Further, at any given time, coaches may be using the same words to explain and understand the game, but not share the same underlying model of the game.

This section describes a (simple) model or way of looking at soccer that is suited for taking measurements and understanding the intricacies of the ball and player movement that can lead to improved team tactical play and improved coaching.

This way of looking at the game is based on the recognition that the game of soccer involves a large number of random events. Before a description of the model of the game, here is brief introduction into the probabilities in soccer.

### Soccer is a Game of Events

One of the ways to view soccer is as a sequence of ball movement events such as a passes or shots.

Each event type has a set of outcomes. For example the outcome of passes can be: completed, intercepted, out of bounds, goal-kick, corner, ... The outcome of Shots can be: goal, rebound, corner, goal kick, save, .

Some outcomes are positive and increase a team's chances of getting off a shot and scoring a goal. Other events are negative resulting in a turn-over and increasing the opponent's chance of getting off a shot and scoring a goal.

### **Event Outcomes can be Characterized by a Probability**

The likelihood of an outcome of an event can be characterized as a probability. A probability is the likelihood of a specific number following a roll of a dice. For example a team may have a history of needing 6 shots to score 1 goal. This would be the equivalent of rolling a six-sided dice over and over again. Each time the dice rolled a "1" the team would score a goal.

Likewise a team may have a history of needing to complete, on average, 20 passes to get off one shot. It would take 120 completed passes to yield 6 shots that, on average, would result in 1 goal.

The joint probability of  $1/6$  goals per shot multiplied by  $1/20$  shots per completed pass indicates a team needs to complete 120 passes to score 1 goal.

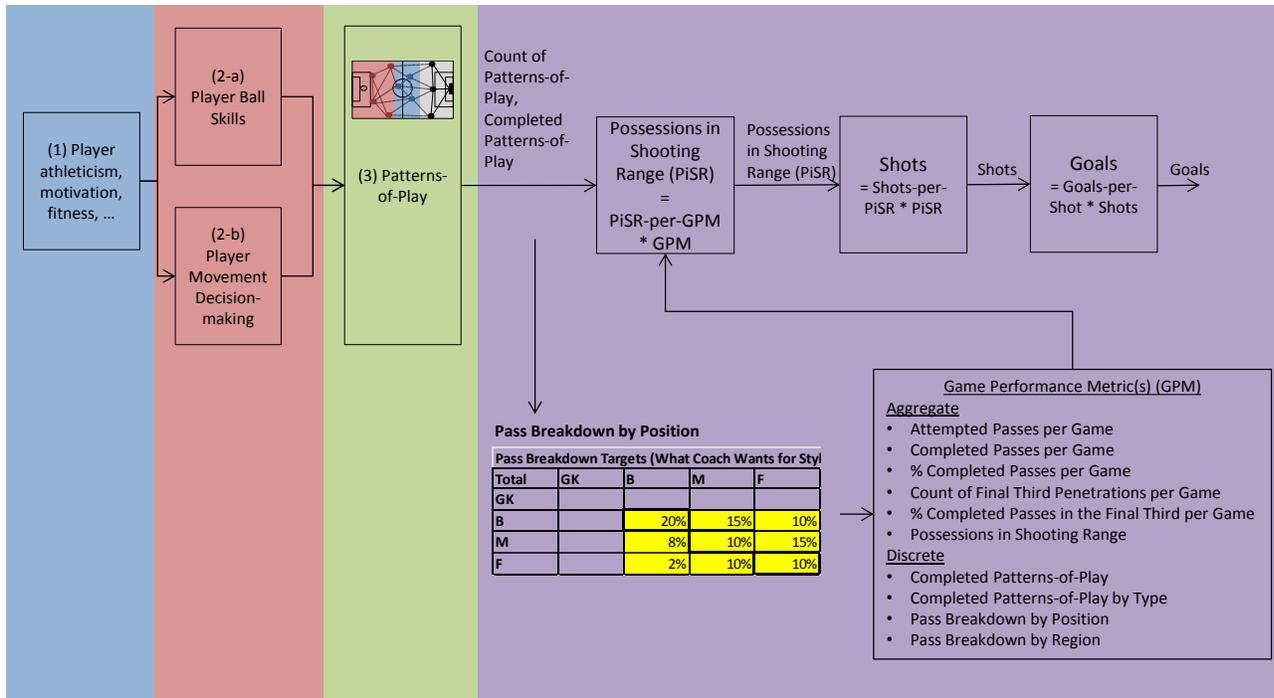
The coaches job is to *maximize* the *probabilities* of event *outcomes* that lead to goals. This is the role of tactics and the associated patterns-of-play that are determined by coaches and trained in practice. The success in a given game is based on the appropriate choice of tactics and the degree to which the tactics and their associate patterns-of-pay are executed.

Note: Since the outcome of a given game is based on random events and chance, the best a coach can do is increase the number of rolls of the dice (e.g. completed passes, possessions in shooting range, ...) and/or "weight" the dice (e.g. improve accuracy of shooting to reduce 1 goal from 6 shots to 1 goal from 5 shots).

### **A Theory of Soccer and Tactical Performance**

A theory of soccer is summarized in Figure 3. There are four components to the model:

- (1) Player athletic motor skills (blue)
- (2) Individual player ball skills and decision-making (red)
- (3) Patterns-of-Play (green)
- (4) Game outcome (purple)



**FIGURE 3: A Theory of Soccer and Tactics Performance**

First, a group of **athletic, fit and motivated** players are recruited, selected, and trained by coaches. The objective is to achieve the necessary agility, speed and endurance performance required to master the ball skills and decision-making required for the targeted level of soccer.

Second, this group of players must develop **individual ball skills** and **decision-making**. These are skills associated with controlling the ball in tight spaces, and solving complex space-time geometries to make passes and takes hots as opponents close the space. These skills are cognitively and physically complex and can take 10,000s of repetitions to achieve proficiency.

Third, once a coach has a group of players with a minimum standard of individual ball skills and decision-making, the coach can prescribe **patterns-of-play** to move the ball safely and effectively to maximize the probabilities of scoring goals.

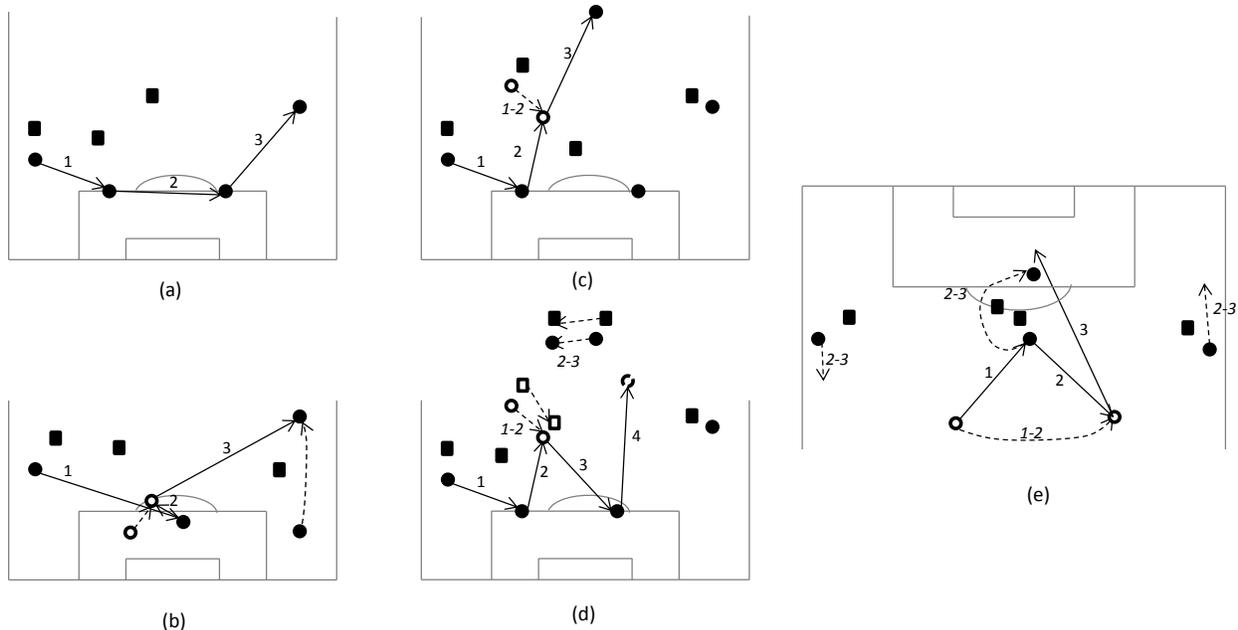
Patterns-of-play are specifically the synchronized movement of groups of players for specific circumstances in a game to possess and advance the ball. Patterns-of-play inherently involve coordinated movement of players. The individual players in a group must reach the same assessment of the situation, decide on the same pattern-of-play in response and then execute the pattern with the requisite ball skills.

Unlike (American) football and basketball in which routes and plays can be drawn-up, the size of the soccer field and the number of players in a space can yield a large number space-time geometries. Individual players and groups of players must constantly adjust within the framework of the pattern-of-play to meet the objectives of the pattern.

Patterns-of-play can be categorized by tactical objectives for the phases of play. For example, a traditional 4-3-3 formation will have the following objectives/phases of play:

- 1 Maintain Possession/Reset (by defenders)
- 2 Transition from defenders to midfield or to forwards
- 3 Consolidate possession in midfield
- 4 Transition from defenders or midfielders to forwards
- 5 Breakdown defense to get into shooting range
- 6 Shoot

Within each category a coach can identify and train specific patterns for specific situations. Figure 4-a and 4-b illustrate variants of a pattern-of-play for maintaining possession by defenders and switching points of attack. Figure 4-c and 4-d illustrates patterns-of-play for transitioning from maintaining possession by defenders to consolidating in midfield. Figure 4-d illustrates a synchronized rotation of midfielders to create space for the transition pass. Figure 5-e illustrates a pattern for a “target” forward to get behind the defense with a “bounce pass” and a “C”-shaped run to the weak side. Note the synchronized movement by the wingers to hold the opponents outside backs.



**FIGURE 4:**

Finally, theory of soccer has the **game outcome**. The degree to which the appropriate pattern-of-play is selected by the group of players, and how well the patterns-of-play are executed can lead to ball possession in shooting range. The ball possessions in shooting range leads to shots. Shots lead to goals.

### Passing Performance Matrix (PPM)

Using this model of soccer, tactical performance should be assessed by the performance of choice of pattern-of-play by a group of players given the space-time geometry at that moment of the game, and the execution of the pattern. Collecting patterns-of-play data is very difficult and beyond the scope of a program without significant equipment, analysis resources, and budget.

To overcome this limitation, a simple Position Passing Matrix (PPM) provides a more feasible way to collect and analyze the data (Figure 5). Each of the cells in the matrix corresponds to a phase of play. For

example FROM Back to TO Back represents the phase of play “Maintain Possession/Reset (by defenders).”

The contents of the cell identify the percentage of total attempted passes in a game that should be executed in game to achieve the desired tactics. The example PPM in Figure 5 is for a very patient, possession oriented team. This team may be following club policy with regard to tactics, be staffed with players slower or with less strength than the opponents, or simply be a coaches aesthetic choice. Note that 53% of the attempted passes involve Backs and Midfielders advancing the ball through possession. Only 35% of the passes are forward passes and that Forwards are required to possess the ball as much as the midfielders.

**TO**

		<b>Pass Breakdown Targets (What Coach Wants for Styl</b>				
		<b>Total</b>	<b>GK</b>	<b>B</b>	<b>M</b>	<b>F</b>
<b>FROM</b>	<b>GK</b>					
	<b>B</b>			20%	15%	10%
	<b>M</b>			8%	10%	15%
	<b>F</b>			2%	10%	10%
	<b>Total</b>					

**FIGURE 5: Position Passing matrix (PPM) shows the count and percentage of passes between positions (i.e. goal-keeper, backs, midfield, forwards).**

In addition to the number of passes in each cell (i.e. phase of play), the completion rate of the passes can be collected and assessed. For example the Back to Back completion rate should approach 100%. The Midfield to Forward and Forward to Forward completion rate can be lower, say 60%. One losing possession in the final 3rg of the field does not pose a threat. Two it may be necessary to take some risks to break-down the defense.

At half-time and post-game, the coaching staff can assess the tactical performance. If the percentage of passes and/or completion rates do not match the target, adjustments to the choice of pattern-of-play given the space-time geometry of the opponent, and/or the execution of the pattern (i.e. player movement and ball movement) can be made. For the tactics represented in Figure 5 it is common for possession teams to become predictable playing out the back and have a low percentage of passes for more “direct” play from Back to Forwards and Midfielders to Forwards. In response, opponents will frequently press high up the field. By playing some long balls (e.g. 10% from Back to Forward), a team can relieve and reduce the high pressing allowing them to play to their strengths and advance the ball through possession.

**Game Performance Metrics and Calculating Expected Goals**

The passing data and statistics captured in the PPM are to assess game performance taking into account the random nature of the game. That is the coaches responsibility is to maximize the probabilities of scoring goals by selection and execution of a tactical style of play embodied in the patterns-of-play. The outcome of the game, however is up to the outcome of a few random events (i.e. “luck”).

There is no finite or complete set of GPMs. Defining new and interesting GPMs is the creative work of the coaching staff and data analysts. A sample of GPMs are listed below:

- Attempted Passes per Game (e.g. > 240)
- Completed Passes per Game (e.g. > 140)
- % Completed Passes per Game (e.g. > 60%)
- Count of Final Third Penetrations per Game (e.g. > 36)
- % Completed Passes in the Final Third per Game (e.g. > 45%)

The PPM and GPMs provide the means for the coach to estimate the Expected Goals per game.

One or more GPMs can be correlated with expected Possessions in Shooting Range (PiSR). For example, the number of expected PiSRs in a game can be defined as a function of a GPM such as Completed Passes (CP) multiplied by the historic average of the ratio of PiSR per-Completed Pass ( $R_{\text{PiSR/Comp}}$ ). A typical value of the ratio of  $R_{\text{PiSR/Comp}} = 1/20$  (i.e. 1 PiSR for every 20 completed passes).

$$\text{PiSR} = \text{GPM} * R_{\text{PiSR/Comp}}$$

The expected **Shots** in a game (S) can be defined as a function of the PiSR multiplied by the historic average of the ratio of Shots-per-Completed Pass ( $R_{\text{S/PiSR}}$ ). A typical value of the ratio of  $R_{\text{S/PiSR}} = 1/6$  (i.e. 1 shot for every 6 PiSRs).

$$S = \text{GPM} * R_{\text{S/PiSR}}$$

Likewise, expected **Goals** in a game are highly correlated with Shots based on the historic ratio of Goals per Shots ( $R_{\text{G/S}}$ ). A typical value of the ratio of  $R_{\text{G/S}} = 1/6$  (i.e. 1 goal for every 6 shots).

$$G = S * R_{\text{G/S}}$$

#### 4 TEAM PERFORMANCE AND TEAM TACTICS

The Tactics Matrix (TM) represents the number (or percentage) of passes between the phases of play. The rows are the starting position (i.e. FROM) and the columns are the ending position (i.e. TO).

The example TM shown in Figure 6 describes a style-of-play that emphasizes possession. The full backs are expected to possess the ball the highest percentage of passes amongst themselves (20%). The fullbacks transition the ball predominantly to midfield with 15% of the total passes. To keep the opponents from pressing up the field, it is expected that 10% of the total passes will go directly to the forwards.

Midfielders are expected to relieve pressure in midfield with passes to the backs (8%) , consolidate in midfield with 10% of the passes, and create opportunities for forwards 15% of the time.

Forwards are encouraged to pass to overlapping wing-backs (2%), but maintain possession with midfielders and other forwards 10% each.

		TO				
		Pass Breakdown Targets (What Coach Wants for Styl				
		Total	GK	B	M	F
FROM	GK					
	B			20%	15%	10%
	M			8%	10%	15%
	F			2%	10%	10%

**FIGURE 6: Passing Performance Matrix (PPM) with breakdown in passes between positions.**

For a given PPM, the coach would have an expected number of attempted passes (e.g. 300), with an expected completed pass percentage (e.g. 70%). This would yield an expected completed pass count of 210 passes (e.g.  $210 = 300 * 70\%$ ). Using the Completed Passes as a GPM, with a historic  $R_{S/Comp} = 1/20$ , this yields an expected 12 shots (i.e.  $200 * 1/18$ ). With a historic  $R_{G/S} = 1/6$ , this yields 2 Goals (e.g.  $2 = 12 * 1/6$ ).

### USING THE TACTICS MATRIX

The method is used in three stages:

- (1) Setting tactical Targets
- (2) Adjustments at Half-time
- (3) Post-game Tactical Analysis

#### (1) Setting Tactical Targets (i.e. The Game Plan)

Prior to the game, the coaching staff enter the parameters in yellow in the Tactix App GUI (Figure 7).

The coach anticipates 2 goals is sufficient to win the game. So based on historic  $R_{G/S} = 1/6$ , and historic  $R_{S/Comp} = 1/20$ , the team needs 200 completed passes. To achieve 200 completed passes with a 70% pass completion rate, the team needs 300 attempted passes (Figure 7).

Given the players available for the game (and perhaps the anticipated opponents tactics), the coach establishes the tactics matrix shown in Figure 7 labeled as “Pass Breakdown Targets (what the Coach Wants for Style of Play)”

These entries can be adjusted to meet the coaching staff game plan. The Tactix App calculates additional performance targets to assess the game plan.

ANALYSIS		Coach Entries		
<b>TARGETS FROM COACHES</b>				
Expected Goals, Shots, ...				
Expected Goals	2			
Goals per Shot	0.166667	1/6		
Expected Shots	12			
Shots per Pass	0.04	~1/25		
Total Passes	300			
Completion %	70%			
Completed Pass	210			
Shots per Completed Pa	0.057143	~1/18		
<b>Pass Breakdown Targets (What Coach Wants for Style-of-Play)</b>				
Total	GK	B	M	F
GK				
B		20%	15%	10%
M		8%	10%	15%
F		2%	10%	10%
<b>Pass Direction Breakdown Targets</b>				
	Forwards	Backwards	Switch	
Total	40%	20%	40%	
<b>Pass Performance by Position Targets</b>				
	All			
Total Passes	300			
Compl Passes	210			
Incompl Passes	90			
% Compl	70%			
<b>Pass Performance by Direction Targets</b>				
	Forwards	Backwards	Switch	
Total Passes	120	60	120	
Compl Passes	72	58.8	96	
Incompl Passes	48	1.2	24	
% Compl	60%	98%	80%	

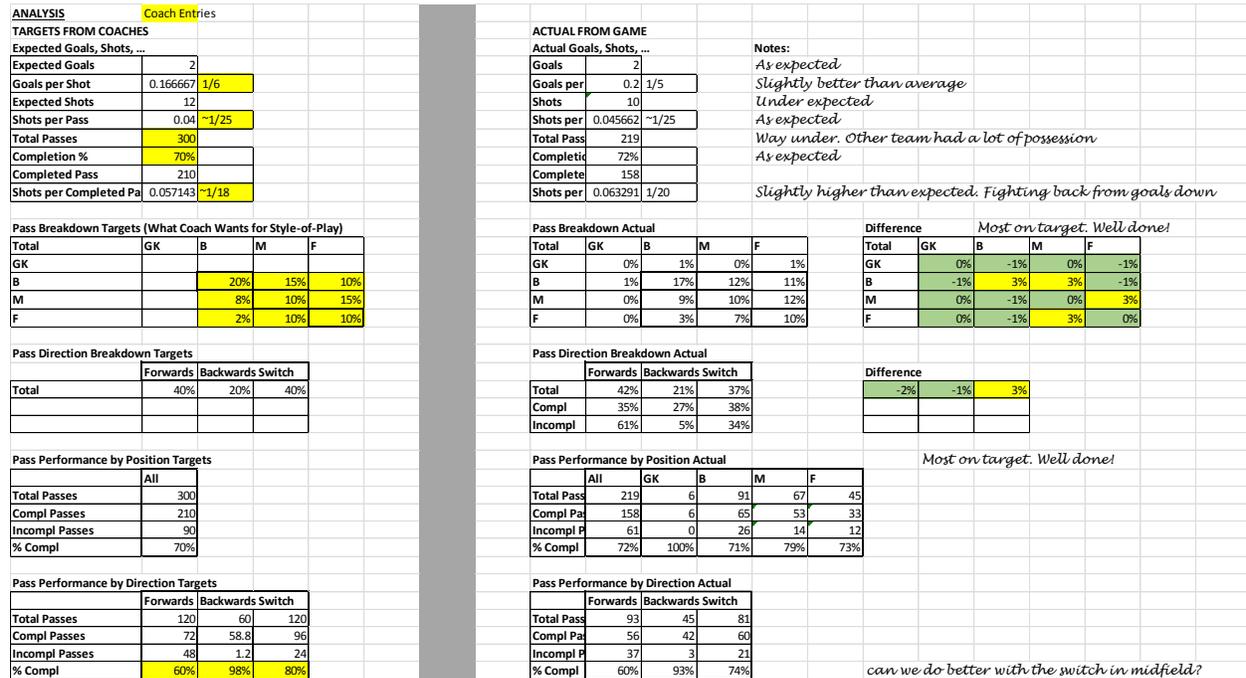
FIGURE 7: Tactix data entry for “game plan”

- (4) Adjustments at Half-time
- (5) Post-game Tactical Analysis

At half-time and after the game the actual TM can be compared to the desired TM (see Figure 8). In this example, the team executed the tactical game plan well resulting the expected passes, goals and shots.

The game ended with 2 goals scored from only 10 shots (instead of 12). There were 219 attempted passes with a 72% completion rate, yielding 159 completed passes.

The TM was almost to perfection. The actual ball movement matched the desired ball movement.



**FIGURE 8: Tactix App output showing Actual game performance (right) vs Target performance (left).**

Note: The team performance captured in Figure 8 lost the game 4-2. Opponents goals included the following random events: (1) own goal from poor clearance from corner, (2) twice deflected long range shot that sent goalkeeper wrong way, and (3) very well executed counter-attack when pressing late in the game to catch up. Had this game been played 100 times, it is likely the outcome would have been different.

## 5 CONCLUSIONS

### Coaching a Game based on Random Events

### Coaching and Tactical Performance

Given that the outcome of a soccer game is based on the random outcome of events, what does this model say about the role does a soccer coach and their choice of tactics?

The coaches responsibilities start with player recruitment, selection and motivation. Next the coach conducts training to assist the players in developing complex individual ball skills and individual decision-making. This allows the players to control and possess the ball in tight spaces, change directions, and release a variety of passes with high accuracy. Individual skills also include decision-making to solve complex geometry-space-time problems in a fast moving, densely populated space.

Once the players have a minimum standard of skill, the coaches responsibility is to develop skill in groups of players to safely and efficiently possess and move the ball. The players in the group follow a prescribed synchronized movement for a general pattern of play. For example, the defenders may drop into a "V" shape to relieve pressure from advancing opponents and switch the ball to the opposite side. Another example, the timing, direction and shape of runs behind the defense by forwards to receive a pass from a midfielder.

Within each pattern-of-play there are endless variants in response to small changes in opponents positioning that must be trained. Further a team will become to predictable if the same pattern of play is used in one part of the field. For this reason, coaches must train the groups of players with multiple patterns of play.

The combinations of patterns-of-play and the varieties of patterns-of-play define the tactics (or style-of-play). Ratios between possessing and playing direct, between patient build-up with a transition and build-up without a transition are defined in the table and is a measure of team tactics.

### **Common Language**

The problem in football is people often use general, vague language - they talk without saying anything,".

"Coaches use words you can interpret in a different way because you have a different definition or experience."

**Counting Patterns-of-Play is actually what you want to do.**

**Choosing GPM is an art and**