

## ANALYSIS OF STRATEGY

By Pete Palmer

A useful tool in analyzing football strategy is the relationship between field position and scoring potential. This can be easily calculated from play-by-play data. Simply record type and team for the next score from each first down situation.

For example, in my study of fifty games, there were 162 first down plays from the fifty-yard line (plus or minus two yards). The offense scored next in 101 cases (55 touchdowns and 46 field goals), while 39 times the defense was the first to score (28 TD's and 11 field goals). There were 22 times that no score occurred before the half ran out, but since most of these were in the final minutes, they were not counted. The net result was 517 points for the offense and 229 for the defense, all divided by 140 opportunities, or 2.06 points for the offense.

If you look at all first down situations from anywhere on the field, you get a straight line which passes through minus two points at your own goal line, plus two at midfield, and plus six at the other goal line. Plus seven is never reached because a touchdown is not assured no matter how close you are to the opponent's goal. A similar study using a slightly different method, but reaching basically the same conclusions was performed by Virgil Carter and Robert Machol and reported in the Operations Research Journal of March-April, 1971.

This data varies from situation to situation. For example, there is an overall league average that assumes each team is equal and typical of the league as a whole. Data can be developed for matchups between particular teams, which could be different, although the reliability would be less due to smaller samples. Also, the league average data may change from season to season because of the evolution of the game and particularly because of changes in the rules. There is also a variation within a game due to the current score and time remaining. This final factor can be taken into account by developing a model which uses the scoring potential as input and outputs a probability of winning the game as a function of score, time and field position.

At any rate, it is possible to reach some general conclusions that apply in most cases, but may differ depending on the game situation and the teams and years involved.

Traditional football strategy has dictated careful conservative offensive play while near one's own goal line, with a gradual opening up as the ball moved down the field. However, it turns out that a turnover creates the same amount of damage wherever it occurs, and in most cases the traditional philosophy is unfounded. If you take the scoring potential plot described above, you can see that a turnover which results in a first down for the other team at the same spot on the field that you had a first down results in a net loss of exactly four points no matter where it happens. Thus there should be no reluctance to try any type of play while deep in your own territory unless, of course, it is near the end of a half and conservative strategy would make it likely your opponent could not score before time runs out.

When a coach faces a fourth-down situation, the decision is nearly always made to kick a field goal if within range, or otherwise to punt. Going for it on fourth down usually occurs only in desperate situations where giving the ball up virtually eliminates any chance of victory. Analyzing the problem mathematically, though, it seems that the correct strategy is to go for a first down if the probability of making it is 65 per cent or better. This would apply in any case up to two yards to go, about fifteen per cent of all fourth-down plays.

Let's take the case of fourth and two on your own ten. If you choose to punt, the other team will probably have a first down around your 45-yard line, worth a potential 2.4 points for them. If you go for it and make it, you will be on your own twelve, worth minus one point for you, or plus one for your opponent. If you fail, the other team will have a first down on your ten, worth five points to them. A success rate of 65 per cent gives exactly

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2.4 points for the opposition, the same as a punt. This is calculated by taking 0.65 times the one point if successful plus 0.35 times the five points if unsuccessful. What is usually overlooked in such situations, I believe, is the fact that even if you punt the other team will have relatively good field position.

Now let's look at fourth and two on your opponent's twelve. Kicking a field goal is worth three points if you make it, and the success rate is about 78 per cent for the 29-yard attempt. A missed field goal gives the other team a first down on their own twenty, a minus 0.4 points for them, or plus 0.4 points for you. The net potential is again 2.4 points. Going for it means 5 points if you succeed, only one if you fail, the mirror image of the previous situation, so the same 65 per cent break-even point exists.

Of course it would be helpful for any coach who uses this strategy to have a long-term contract to comfort him through the barrage of criticism for the 35 per cent of the time his tactics fail.