Network Analysis of Basketball Passing Patterns II

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ABSTRACT
In this paper, I attempt to extend an earlier study of mine on basketball teams’ passing patterns, with a new set of games. A complexity framework is introduced to help situate the present analyses of walks in teams’ passing sequences.

1. INTRODUCTION
The study of sports teams within a network framework, where players are the nodes and ball passes are the linkages, goes back to the 1970s. Perhaps the most prominent example is a soccer study by Gould and Gatrell [3]. More recent examples, both presented at the 2005 International Network for Social Network Analysis Sunbelt Conference, include papers by Lee and colleagues [4], also on soccer, and Reifman [6], on basketball.

1.1 Prior Research
Reifman [6] examined videotapes from a set of games in the 2003 National Collegiate Athletic Association men’s and women’s basketball tournaments to chart passing relationships between players. The main finding of this preliminary study was the documentation of differences between teams in whether they tended to concentrate ball passing (outgoing and/or incoming) in one or two players’ hands vs. exhibiting balanced passing distributions.

Limitations of this initial study included the following: segments consisting of only the first four minutes of a game were coded; analyses did not look at the temporal sequence of passes in a possession (e.g., A→C→A→D→B, where each letter represents a player), known in the networks literature as a walk, instead examining passing only within pairs of players (i.e., total number of passes from A→B, B→A, A→C, etc., and total number of non-directional passes between A and B, A and C, etc.); and the videotapes were not coded for players’ location on the court when making or receiving passes.

1.2 Theoretical Framework
The present examination of basketball passing is situated within a complexity or complex systems framework. Bar-Yam [1] presented a theoretical analysis of complexity as applied to basketball strategy (using the National Basketball Association’s Los Angeles Lakers and Indiana Pacers in the examples). Writes Bar-Yam:

Complexity is a measure of the number of possibilities. In the context of sports, an effective defense has to meet the possible choices of the offense. Thus, the number of possible ways a player or team can create an offense is important. If a player or team has a more diverse set of offensive plays, the other side may not be able to defend against each play...

The importance of having a variety of different team plays is generally recognized in the game of basketball. Teams practice passes to set up different shots, establishing first options and, if blocked by the defense, second or third options.

1.3 Aims of the Present Study
The present study sought to extend Reifman’s earlier basketball research by applying the aforementioned complexity framework and by addressing some of the deficiencies in the earlier study. Full halves of games and full sequences of passes on team possessions (i.e., walks) were examined, and floor locations of the players when passing were coded.

Bob Knight, the current men’s coach at Texas Tech University and the coach at Indiana University from 1971-2000, is well known for his passing game and motion offense [2]. Knight’s offensive strategies are considered to be complex and thus difficult to defend against. It was thought that mapping the passing patterns of Knight’s Texas Tech squad would be a good starting point in the present investigation.

Considering that any of five players on a team can make the first pass of a possession, which can go to any of the four other players, and the recipient of a pass can then pass to any of the four other players, and so forth, the number of possible sequences quickly becomes very large (i.e., 5 X 4 X 4......). This perspective seems highly consistent with the conceptualization of complexity noted above.

It was expected that Knight’s Texas Tech offense would exhibit a relatively large number of unique, non-repetitive passing sequences. Examination of other teams (to be done in the near future) is expected to reveal substantial variation in offensive complexity.
2. METHODS

2.1 Data Collection

Several men's college basketball games from the latter part of the 2005-06 season have been videotaped (only one half per game, as 20 minutes of play would still provide more extensive information about a team's passing than would the four-minute segments used in my previous study, [6]). Two of the newly recorded games involve Texas Tech University. Other games involve Syracuse University, whose 2003 team was found in my previous study to pass the ball readily among many players in balanced fashion, and the University of Texas, whose 2003 team was found to concentrate the ball in only a few players' hands.

2.2 Coding

All passing sequences of a given team in a given half of play (20:00 of game time) are charted, once the ball has crossed mid-court (the same player, the "point guard," typically brings the ball up the court on each possession).

The following data were noted for each possession: time when possession began; uniform number of each player receiving the ball, in sequence; area of the floor (Oliver [5], p. 10) from where he passes the ball or takes another action such as shooting; and the event that ended the passing sequence (e.g., shot, turnover, foul).

A rough description of how the floor is divided into areas is as follows. Going from left to center to right (from the perspective of looking at the basket), areas closest to the basket are coded, respectively, as 1, 2, and 3; areas moderately far from the basket (roughly between the key and the three-point arc) are coded A, B, and C; and the most distant areas from the basket, behind the arc, are coded X, Y, and Z. A sample coding would be:

| 19:29 | 33 32 44 3 22 | Y B X X Y | SHOT |

3. RESULTS

Depictions of the passing sequences in a network/tree structure are fairly dense and complex, making it impractical to shrink figures for inclusion here. Instead, two illustrative figures are available for viewing on the World Wide Web at the following URL: [http://www.hs.ttu.edu/research/reifman/netsci2006.htm](http://www.hs.ttu.edu/research/reifman/netsci2006.htm).

Two graphs are shown for Texas Tech's passing in the first half of its February 20, 2006 home game against Oklahoma. The diagrams include all sequences of at least three players touching the ball, although sequences of four or more takes are cut off at four. A sequence of four touches (which would involve three passes) could result in 320 potential combinations of players, including those in which one player passes the ball and receives it back (based on the multiplication shown above). Although any of a team's five players on the court can initiate a sequence, the linked graphs present only sequences initiated by Jay Jackson (22) and by LucQuenté White (33), the players who most commonly filled that role. With the initiator narrowed to one player in each graph, a more manageable 64 possible combinations are available (4 X 4 X 4).

In the graph of sequences initiated by Jackson (22), he threw at least two passes to each of the four available recipients, and no more than four passes to anyone. Two players who received initial passes from Jackson, Martin Zeno (3) and Jon Pfliega (32), each showed variety in whom they next passed to, directing the ball to three of the possible four recipients at various times in the half. The graph of White (33) as the initiator shows that he concentrated his passes to one player, Darryl Dora (44).

These network/tree graphs underscore the complexity of the team's offense, as players' locations on the floor when making and receiving the passes are not yet depicted. Initial inspection of the coding sheets suggests that any given player's location on the floor differs from one sequence (team possession) to another (and sometimes even within the same sequence).

4. DISCUSSION

Although only preliminary, graphical results are currently available for this new (2006) project, the study of full walks, over longer stretches of game time, should extend research on basketball passing patterns beyond my earlier dyad-focused investigation. As additional data are collected, Texas Tech's passing patterns will be compared to those of other teams. Options will also be explored for converting the graphical representations into statistical indices, such as player-to-player transition probabilities.

Practical applications of this kind of research include the possibility of informing basketball coaching strategy. [Bar-Yam [1] discusses how teams' failure to diversify their offensive attack can put them at a competitive disadvantage.

5. REFERENCES


