

**PLAYER PERFORMANCE EVALUATIONS
IN THE
NBA: APPLICATIONS OF SAS/GRAPH AND SAS/QC**

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1. INTRODUCTION

In most professional and collegiate sports, one of the major byproducts of competition between any two teams is a large quantity of recorded data on the performance of the teams and individuals taking part in the competition. With few exceptions, the primary incentives for the sports enterprise to record these massive amounts of data have been:

1. to satisfy league and conference requirements,
2. to satisfy the gargantuan appetite of the news media for sports statistics and trivia, or
3. to help keep track of team and individual records.

Very little attention has been given to the possibility of using mathematical statistics to help evaluate the performance of individual participants during a playing season. Indeed, most attempts at analyzing game data statistically have taken place well after the fact — after a series of games or a season is over — when it is too late to make strategic adjustments to improve a team's chances of winning (see for example, Goodman [2], Mosteller [3], Porter [4], and M. Thompson [6]).

There is no reason, however, why individual and team statistics, especially in such sports as football, basketball, baseball, soccer, and hockey, could not be analyzed on a per-game basis to see which individuals are contributing the most (or the least) to a team's success. Such analysis of individual performances in games of the National Basketball Association (NBA) is the subject of this paper. In particular, numerous SAS (Statistical Analysis System) procedures will be demonstrated that clarify the information residing in the NBA data. It will become clear that, although concentration will be on the analysis of individual and team performances in basketball, any team effort in which several different skills are brought into play by each participant

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can be analyzed in a similar fashion. The results of these analyses yield the comparative performance for each player in each measurable phase of the game played. These results can then be made available to coaches to help in training, strategy, and utilization of players' skills.

2. BASKETBALL DATA

First of all, let us look at the kinds of statistics being kept by teams in the NBA. Figure 1 shows an official NBA Scorer's Report for an regular season game played on December 26, 1980 between the Houston Rockets and the Detroit Pistons. The individual player statistics that appear on this report are minutes played (MIN), field goals made (FGM), field goals attempted (FGA), free throws made (FTM), free throws attempted (FTA), offensive rebounds (OFF), defensive rebounds (DEF), total rebounds (TOT), assists (AST), player fouls (PF), steals (Steals), and points scored (Points). At the bottom of the report are the number of shots blocked by each player. The NBA requires that an Official Scorer's Report be compiled by the home team at each game; incidentally, an additional statistic currently required that does not appear on this Scorer's Sheet is that of three-point shots made and three-points shots attempted. In addition to the required NBA data, many teams keep additional data not required by the league (see Figure 2), such as turnovers, burns (scoring after an opposing team's turnover), fast breaks, field goal percentages within certain radii of the basket, number of times a player is fouled, and undoubtedly many others.

3. ANALYSIS OF PLAYER PERFORMANCE

It is fairly apparent upon examination of the Scorer's Report in Figure 1 that it is not at all obvious how the various players' performances can be readily compared. For example, on the Rocket's team, Calvin Murphy scored 14 points in 20 minutes of play, while Phil Hubbard of the Pistons scored 22 points in 39 minutes of play, so Hubbard's scoring output seems superior. On the other hand, Murphy had 2 assists and 2 steals while Hubbard had 5 assists and 0 steals. Similar comparisons are notable from the other phases of the game. So who played better and by how much? And who needs to concentrate on improving what phase of his game during the next practice session? Multiply this question by the possible

$$\binom{24}{2} = 276$$

pairs of players in a game and by at least 13 different tabulations kept on each player, and a coach is bound to have an extremely difficult task in formulating team strategy based on game statistics. And this is unfortunate, because the game statistics should reflect player performance, and thus could conceivably aid the coach in achieving his objectives (winning), if only the information could be extracted in a usable form.

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Numerous pieces of key information will be discussed as a part of this presentation and use will be made of SAS (particularly SAS/GRAPH and SAS/QC) to clarify the information inherent in the data. The presented SAS usage will be done so as to be tutorial in nature.

A key method for extracting information concerning each player's performance is based on a two-step procedure (other information retrieval techniques using SAS will be discussed at conference time as well). The first is to standardize the players' game totals to a full, 48-minute game. For example, if a player made 4 offensive rebounds in 20 minutes of play, he would receive a "standardized" score of $\frac{4 \times 48}{20} = 9.6$ for offensive rebounds. This process is carried out for each player and each tabulation from the scorer's report (except minutes). The assumption, of course, is that the sample consisting of the time the player actually was in the game is representative of his performance had he played the entire game. The second phase of the analysis is to construct a Student's *t* statistic for each player in each phase of the game. This statistic, first presented by W. Thompson [7], is constructed as follows: for any phase of the game (for example, assists), each player's standardized score, a_i , is transformed, as

$$z_i = (a_i - \bar{x})/s$$

where a_i is the i th player's (48-minute) standardized score for assists, while $\bar{x}$ is the sample mean and s the sample standard deviation among all players' standardized scores for assists. Players who have not been in the game some minimum length of time, say 6 minutes, should not be included in the procedure, in order to avoid absurdities. Thompson has shown that, if n items (player scores) are used in computing $\bar{x}$ and s , and if those items can be assumed to be a random sample from a normal distribution (the entire NBA), then

$$t_i = \sqrt{n-2} z_i / \sqrt{n-1-z_i^2}$$

follows a Student's *t* distribution with $n-2$ degrees of freedom. Furthermore, this statistic is much more robust against extreme values of standardized scores than the corresponding normal statistic would be, and additionally takes into account the small sample sizes used in computing $\bar{x}$ and s . Once given a player's *t* score and the number of players used, the percentile for that player's performance in that skill area can be computed or looked up in a table of the cumulative Student's *t* distribution. The percentile, a number between 0 and 100, should reflect where the player would fall among all NBA players in that skill, based on his performance in the game analyzed. Once a complete table of percentiles is compiled, it is an easy matter for a coach to compare any two players on either team in any skill, or to compare the performance of any player in any two phases of the game, or even to compare performances over several games.

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A demonstration of the usage of a complete table of percentiles for a game played by the Seattle Supersonics is given in Figures 3 and 4. Each percentile is rounded to the nearest whole number. Note also that a compilation has been made, in the OVERALL part of the table, of the mean of each player on the Supersonic team in that particular game. Of course, if a coach wishes to weight the phases of the game differently, a player's overall performance will be given by

$$P = \sum_{j=1}^m w_j p_j / \sum_{j=1}^m w_j$$

where w_j is the comparative weight assigned to skill j and p_j the percentile for skill j , $j = 1, 2, \dots, m$.

On the basis of percentiles for any game or series of games, a coach may gain valuable insight into this players' comparative skills, how to improve them and when to use them. The players themselves, by looking at their own performance measures and the weights attached to them, may realize what they must do to contribute better or a balanced team effort.

4. SAS USAGE TO SUPPORT CLARITY

Numerous illustrations will be provided at conference time of the usage of SAS (particularly SAS/GRAPH and SAS/QC) to demonstrate the ability to clarify comparisons between players' performances, team performances, etc. Examples like those in Figures 5 through 9 will be discussed as well as others (handouts will be provided at conference time) including usage of the SAS/QC software to gain another dimension of insight into player and team performances. The discussion will be kept tutorial in nature with an intent to provide first-time users of SAS/QC an introductory look into the capabilities of this module of the SAS package.

5. COMMENTS

The player performance evaluation approach described in this paper has already been utilized on an official basis by a couple of professional teams. Percentile scores for each player in each phase of the game are reviewed by coaches of both teams, and their response to the amount of information displayed by the percentile tables have been enthusiastic. Especially valued by the coaches are the abbreviated percentile tables computed at the half-time of each game, reflecting player performance during the first half of action. These computations are easily carried out in plenty of time for evaluation by a coach in a short period of time.

Although a number of sports have been mentioned for which the analysis described here should be applicable, the game of basketball seems ideally suited for such a breakdown by game skills. It is one of the few games (another being volleyball) in which, during the course of the game, each player is capable of tallying on any one of

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the statistics being recorded. In baseball, not everyone can be a pitcher; in football, only the defense is capable of a pass interception. Thus, for these and other sports, a more complex system of player performance evaluation will have to be devised.

Understandably, it is not an easy matter to convince coaches of the utility of a statistical analysis of player game data. A tongue-in-cheek response by Bill Russell, previous coach and general manager of the Seattle Supersonics, may be representative of many first impressions to the idea: "When we get around to computerizing the game, and taking the emotion out, then all of this information will be very significant to feed the computer", [5]. However, once a coach is exposed to a means of comparing several players' performances in several skill areas over a number of games, he or she will usually begin to think of new ways in which the data can be used, whether in scouting for new players, checking out players on opposing teams, using key players in certain situations, or even in compiling ammunition to use at player contract time. As Bill Bertka, assistant coach to the Los Angeles Lakers, says: "In sports, the level of competition is so keen that you are always looking for that little edge, something that someone else is not going to do that's going to give extra", [1].

6. REFERENCES

- [1] Bill Bertka, *The New Orleans Times-Picayune*, (1975). October 26, 1975, New Orleans, Louisiana.
- [2] M.L. Goodman, "On the Incidence of the Swept Double-Headers", *The American Statistician*, **23**, (1969), pp. 15-17.
- [3] F. Mosteller, "Collegiate Football Scores, U.S.A.", *Jour. Amer. Stat. Assoc.*, **65**, (1970), pp. 35-48.
- [4] R.C. Porter, "Extra-Point Strategy in Football", *The American Statistician*, **21**, (1967), pp. 14-15.
- [5] Bill Russell, *The Seattle Times*, April 6, 1975.
- [6] M. Thompson, "On Any Given Sunday: Competitor Orderings with Maximum Likelihood Methods", *Jour. Amer. Stat. Assoc.*, **70**, (1975), pp. 536-541.
- [7] W.R. Thompson, "On a Criterion for the Rejection of Observations and the Distribution of the Ratio of Deviation to Sample Standard Deviation", *Ann. Math. Stat.*, **6**, (1935), pp. 214-219.

NATIONAL BASKETBALL ASSOCIATION

FRIDAY
DATE DECEMBER 26, 1980 OFFICIAL SCORES REPORT ATTENDANCE 5157
OFFICIALS: PAUL MIHALAK AND BILL SAAR TIME 8:09 - 10:00

VISITORS HOUSTON ROCKETS													PTS	REB	AST	STL	BLK	FOUL	PTS	REB	AST	STL	BLK	FOUL	PTS
50 Robert Reid	35	7	16	2	3	1	6	7	4	5	4	1	16												
45 Rudy Tomjanovich	30	7	12	2	2	2	0	2	5	3	0	1	16												
24 Moses Malone	36	14	21	5	6	2	12	14	0	2	0	1	33												
6 Tom Henderson	30	0	8	1	2	2	2	4	9	1	2	1													
00 Calvin Garrett	35	5	11	1	2	2	4	6	3	3	1	11													
30 Allen Leavie	15	3	6	1	2	1	0	1	1	0	1	7													
11 Major Jones	17	1	3	0	0	1	7	8	0	2	0	2													
23 Calvin Murphy	20	6	12	2	2	2	0	2	2	1	2	14													
5 Billy Paulitz	12	3	6	0	0	1	1	2	0	0	0	6													
10 Mike Dunleavy	5	4	5	0	0	1	1	2	0	1	0	8													
BILL WILLOWGABY	5	0	3	0	0	0	0	0	1	1	0	0													
TOTALS													240	50	103	14	19	15	33	48	25	19	10	114	

HOME DETROIT PISTONS													PTS	REB	AST	STL	BLK	FOUL	PTS	REB	AST	STL	BLK	FOUL	PTS
41 Terry Tyler	18	3	4	0	2	0	4	4	1	0	0	6													
35 Phil Hubbard	39	10	16	2	5	6	9	15	5	4	0	22													
54 Keat Benson	39	10	17	0	0	4	2	6	3	5	1	20													
34 Keith Herron	37	6	12	2	2	0	1	1	2	1	1	14													
15 Larry Wright	DID NOT DRESS																								
22 Larry Drew	32	3	10	1	2	0	2	2	1	3	3	7													
11 Bob Mc Aoon	30	6	19	3	5	3	7	10	4	3	1	15													
30 Ron Lee	28	0	1	1	2	0	4	4	8	4	4	1													
44 Paul Mokeski	9	2	5	0	0	1	2	3	0	3	0	4													
42 Wayne Robinson	8	1	1	3	4	0	1	1	0	0	0	5													
50 Norman Black																									
TOTALS													240	41	85	12	22	14	32	46	24	23	10	94	

REMARKS:													PTS	REB	AST	STL	BLK	FOUL	PTS	REB	AST	STL	BLK	FOUL	PTS
REID	1	MC. AOOD	1																						
PAULTZ	2	DREW	1																						
MALONE	1	LEE	1																						
TOMJANOVICH	2	HUBBARD	1																						
JONES	1																								
TOTALS													25	31	35	23									114
TOTALS													31	41	22	27									94

Figure 1

THE ROCKETS
VERSUS
WASHINGTON

GAME NO.... 14

TEAM STATISTICS

	THE ROCKETS					WASHINGTON				
	QUARTER				TOTALS	QUARTER				TOTALS
	1	2	3	4		1	2	3	4	
POSSESSIONS.....	22	27	24	23	96	28	29	27	24	108
POSSESSIONS CONVERTED..	10	13	11	13	47	11	12	16	13	52
PRCNT POSSESSIONS CONV	45.45	48.15	45.83	56.52	48.96	39.29	41.38	59.26	54.17	48.15
FAST BREAKS ATTEMPT.....	3	1	2	1	7	5	1	4	1	11
FAST BREAKS CONV.....	0	0	1	0	1	0	1	3	1	5
PRCNT FAST BREAKS CONV	0.00	0.00	50.00	0.00	14.29	0.00	100.00	75.00	100.00	45.45
NO. OPP. TURNOVERS.....	4	11	7	5	27	4	8	7	6	25
OPP. TURNOVERS CONV....	2	3	1	1	7	3	1	2	2	8
PRCNT OPP. TURNOVERS...	50.00	27.27	14.29	20.00	25.93	75.00	12.50	28.57	33.33	32.00
FGA LT 5 FEET OUT.....	6	6	4	7	23	5	4	8	3	20
FGM LT 5 FEET OUT.....	1	2	3	3	9	1	2	5	2	10
PRCNT FGM LT 5 FT OUT..	16.67	33.33	75.00	42.86	39.13	20.00	50.00	62.50	66.67	50.00
FGA BTWN 5 AND 15.....	8	4	10	7	29	9	6	4	9	28
FGM BTWN 5 AND 15.....	4	2	2	2	10	4	3	2	4	13
PRCNT FGM BTWN 5 AND 15	50.00	50.00	20.00	28.57	34.48	44.44	50.00	50.00	44.44	46.43
FGA BEYOND 15 FT.....	11	11	14	10	46	15	14	15	8	52
FGM BEYOND 15 FT.....	3	5	3	7	18	5	4	4	3	16
PRCNT FGM BEYOND 15 FT.	27.27	45.45	21.43	70.00	39.13	33.33	28.57	26.67	37.50	30.77
SET PLAYS CALLED.....	6	8	7	5	26	7	7	5	4	23
SET PLAYS CONV.....	4	5	3	4	16	4	5	4	4	17
PRCNT SET PLAYS CONV.....	66.67	62.50	42.86	80.00	61.54	57.14	71.43	80.00	100.00	73.91

Figure 2

INDIVIDUALS ORDERED

FOR EACH
PHASE OF GAME
SEATTLE

MINUTES		FT. SHGT.		FT. SHGT.		FT. SHGT.	
WATTS	94	TOLSON	99	BROWN	97	BROWN	97
SEALS	45	JOHNSON	84	LOVE	93	LOVE	93
GREEN	46	BROWN	71	OLEYHICK	65	OLEYHICK	65
BURLESON	43	WEATHERSPH	61	NORWOOD	62	NORWOOD	62
NORWOOD	41	GREEN	60	GREEN	54	GREEN	54
WILKERSON	36	BURLESON	47	SEALS	54	SEALS	54
JOHNSON	37	WATTS	45	WILKERSON	51	WILKERSON	51
WEATHERSPH	27	SEALS	44	JOHNSON	37	JOHNSON	37
TOLSON	20	WATTS	38	WEATHERSPH	31	WEATHERSPH	31
OLEYHICK	20	WILKERSON	16	JOHNSON	32	JOHNSON	32
LOVE	47	LOVE	10	WATTS	10	WATTS	10
	47	OLEYHICK	6	TOLSON	4	TOLSON	4
OFF. REB.		DEF. REB.		ASSISTS		ASSISTS	
TOLSON	96	WEATHERSPH	96	WATTS	99	WATTS	99
JOHNSON	82	BURLESON	80	OLEYHICK	75	OLEYHICK	75
BURLESON	82	GREEN	60	WILKERSON	47	WILKERSON	47
GREEN	80	TOLSON	42	BROWN	50	BROWN	50
NORWOOD	57	LOVE	51	JOHNSON	37	JOHNSON	37
WEATHERSPH	37	SEALS	50	GREEN	37	GREEN	37
LOVE	36	WILKERSON	37	NORWOOD	36	NORWOOD	36
SEALS	36	NORWOOD	32	BURLESON	29	BURLESON	29
WILKERSON	36	WATTS	22	TOLSON	28	TOLSON	28
BROWN	11	JOHNSON	19	SEALS	28	SEALS	28
WATTS	9	BROWN	17	LOVE	34	LOVE	34
OLEYHICK	7	OLEYHICK	10	WEATHERSPH	30	WEATHERSPH	30
STEALS		SCORING		OVERALL		OVERALL	
JOHNSON	37	TOLSON	98	TOLSON	74.2	TOLSON	74.2
WATTS	26	BROWN	95	JOHNSON	61.5	JOHNSON	61.5
BROWN	26	JOHNSON	60	BURLESON	60.0	BURLESON	60.0
TOLSON	55	BURLESON	55	WEATHERSPH	54.1	WEATHERSPH	54.1
WILKERSON	43	SEALS	51	BROWN	54.0	BROWN	54.0
BURLESON	43	WEATHERSPH	51	WATTS	53.4	WATTS	53.4
NORWOOD	37	WATTS	39	GREEN	51.0	GREEN	51.0
LOVE	26	OLEYHICK	37	NORWOOD	43.2	NORWOOD	43.2
WEATHERSPH	25	GREEN	33	WILKERSON	41.7	WILKERSON	41.7
SEALS	17	NORWOOD	31	SEALS	41.6	SEALS	41.6
OLEYHICK	17	WILKERSON	15	OLEYHICK	33.0	OLEYHICK	33.0
GREEN	13	LOVE	7		28.5		28.5

Figure 3

PHASES OF GAME ORDERED

FOR EACH
INDIVIDUAL PLAYER
SEATTLE

FT. SHGT.		FT. SHGT.		FT. SHGT.		FT. SHGT.	
WATTS	99	BROWN	97	BROWN	97	BROWN	97
ASSISTS	99	FT. SHGT.	97	FT. SHGT.	97	FT. SHGT.	97
STEALS	96	SCORING	95	SCORING	95	SCORING	95
SCORING	39	STEALS	76	STEALS	76	STEALS	76
PG. SHGT.	38	PG. SHGT.	71	PG. SHGT.	71	PG. SHGT.	71
DEF. REB.	31	ASSISTS	50	ASSISTS	50	ASSISTS	50
FT. SHGT.	10	DEF. REB.	17	DEF. REB.	17	DEF. REB.	17
OFF. REB.	9	OFF. REB.	11	OFF. REB.	11	OFF. REB.	11
BURLERSON		BURLERSON		BURLERSON		BURLERSON	
DEF. REB.	96	DEF. REB.	91	DEF. REB.	91	DEF. REB.	91
OFF. REB.	82	SCORING	51	SCORING	51	SCORING	51
FT. SHGT.	56	FT. SHGT.	50	FT. SHGT.	50	FT. SHGT.	50
SCORING	53	PG. SHGT.	44	PG. SHGT.	44	PG. SHGT.	44
PG. SHGT.	43	OFF. REB.	36	OFF. REB.	36	OFF. REB.	36
STEALS	43	ASSISTS	34	ASSISTS	34	ASSISTS	34
ASSISTS	39	STEALS	17	STEALS	17	STEALS	17
NORWOOD		NORWOOD		NORWOOD		NORWOOD	
FT. SHGT.	62	STEALS	97	STEALS	97	STEALS	97
PG. SHGT.	60	PG. SHGT.	84	PG. SHGT.	84	PG. SHGT.	84
OFF. REB.	57	OFF. REB.	82	OFF. REB.	82	OFF. REB.	82
STEALS	37	SCORING	60	SCORING	60	SCORING	60
ASSISTS	37	ASSISTS	47	ASSISTS	47	ASSISTS	47
PG. SHGT.	36	PG. SHGT.	23	PG. SHGT.	23	PG. SHGT.	23
DEF. REB.	33	DEF. REB.	19	DEF. REB.	19	DEF. REB.	19
SCORING	31	SCORING	19	SCORING	19	SCORING	19
WILKERSON		WILKERSON		WILKERSON		WILKERSON	
ASSISTS	47	FT. SHGT.	97	FT. SHGT.	97	FT. SHGT.	97
STEALS	55	PG. SHGT.	84	PG. SHGT.	84	PG. SHGT.	84
FT. SHGT.	55	OFF. REB.	82	OFF. REB.	82	OFF. REB.	82
PG. SHGT.	37	STEALS	37	STEALS	37	STEALS	37
DEF. REB.	36	ASSISTS	47	ASSISTS	47	ASSISTS	47
OFF. REB.	36	PG. SHGT.	23	PG. SHGT.	23	PG. SHGT.	23
PG. SHGT.	16	DEF. REB.	19	DEF. REB.	19	DEF. REB.	19
SCORING	16	SCORING	19	SCORING	19	SCORING	19
OLEYHICK		OLEYHICK		OLEYHICK		OLEYHICK	
ASSISTS	75	FT. SHGT.	99	FT. SHGT.	99	FT. SHGT.	99
PG. SHGT.	65	DEF. REB.	51	DEF. REB.	51	DEF. REB.	51
SCORING	37	OFF. REB.	37	OFF. REB.	37	OFF. REB.	37
STEALS	17	STEALS	26	STEALS	26	STEALS	26
DEF. REB.	10	ASSISTS	26	ASSISTS	26	ASSISTS	26
OFF. REB.	7	PG. SHGT.	10	PG. SHGT.	10	PG. SHGT.	10
PG. SHGT.	6	SCORING	7	SCORING	7	SCORING	7

Figure 4

GAME-BY-GAME PERFORMANCE FOR BEHAGEN

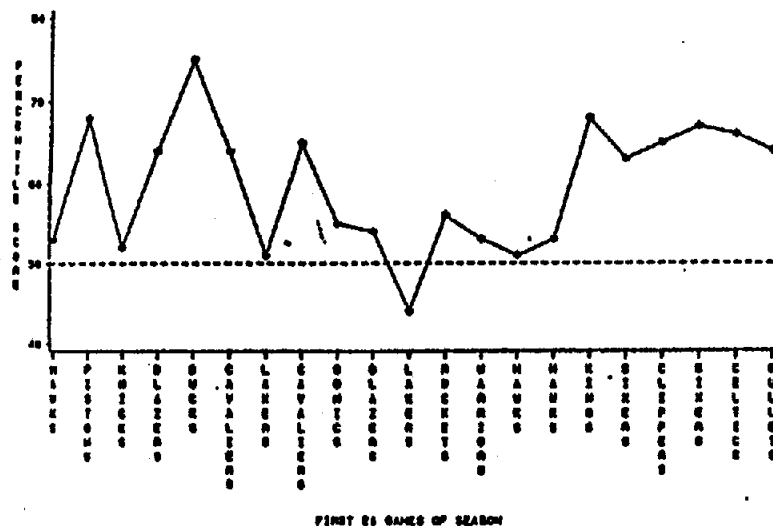


Figure 5

PLAYER COMPARISONS

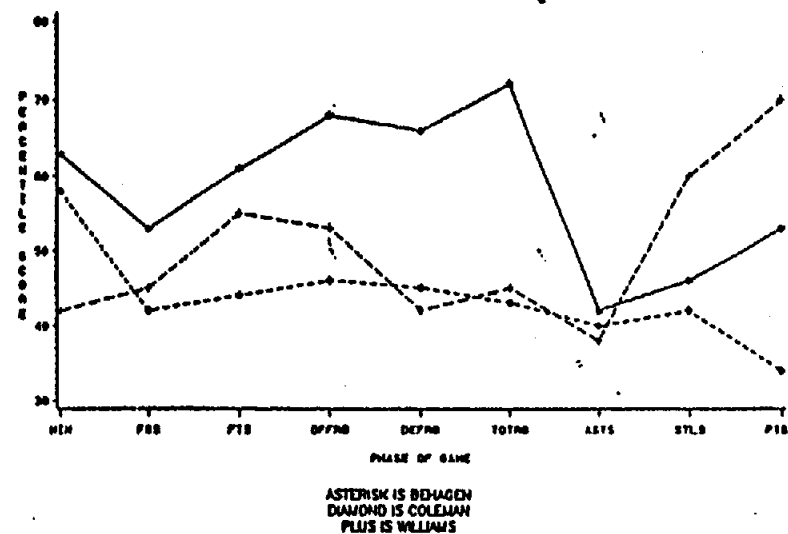


Figure 6

```

OPTIONS DEV=HP7116A;
DATA ONE;
INFILE BEHAGEN;
INPUT GAME 1 $END;
LABEL SCORE='PERCENTILE SCORE';
LABEL GAME='FIRST 31 GAMES OF SEASON';
PROC FORMAT;
VALUE $PH '$1'-'HAWKS'
          '$2'-'PISTONS'
          '$3'-'KNICKS'
          '$4'-'BLAZERS'
          '$5'-'BUCKS'
          '$6'-'CAVALIERS'
          '$7'-'LAKERS'
          '$8'-'CAVALIERS'
          '$9'-'SONICS'
          '$10'-'BLAZERS'
          '$11'-'LAKERS'
          '$12'-'ROCKETS'
          '$13'-'WARRIORS'
          '$14'-'HAWKS'
          '$15'-'HAWKS'
          '$16'-'KNICKS'
          '$17'-'SIXERS'
          '$18'-'CLIPPERS'
          '$19'-'SIXERS'
          '$20'-'CELLARS'
          '$21'-'BULLETS';
PROC PLOT;
PLOT SCORE/GAME/VREF=50 LVREF=1;
SYMBOL1 V=STAR 1=JOIN L=1;
FORMAT GAME $PH;
TITLE1 C=BLACK P=SIMPLEX H=3 'GAME BY GAME PERFORMANCE FOR BEHAGEN';
    
```

Associated Program

```

OPTIONS DEV=HP7116A;
DATA;
INFILE PHASE;
INPUT PHASE 1 BEHAGEN COLEMAN WILLIAMS;
LABEL BEHAGEN='PERCENTILE SCORE';
LABEL PHASE='PHASE OF GAME';
PROC FORMAT;
VALUE $PH '$1'-'MIN'
          '$2'-'PBS'
          '$3'-'PTS'
          '$4'-'OFFRB'
          '$5'-'DEFNB'
          '$6'-'TOTNB'
          '$7'-'ASTS'
          '$8'-'STLS'
          '$9'-'PIS';
PROC PLOT;
PLOT BEHAGEN*PHASE COLEMAN*PHASE
      WILLIAMS*PHASE/OVERLAY;
CAXIS=BLACK CTEXT=BLACK;
FORMAT PHASE $PH;
SYMBOL1 C=BLACK V=STAR 1=JOIN L=1;
SYMBOL2 C=BLACK V=DIAMOND 1=JOIN L=2;
SYMBOL3 C=BLACK V=PLUS 1=JOIN L=3;
TITLE1 C=BLACK P=COMPLEX H=3 'PLAYER COMPARISONS';
FOOTNOTE1 C=BLACK P=SIMPLEX H=1 'ASTERISK IS BEHAGEN';
FOOTNOTE2 C=BLACK P=SIMPLEX H=1 'DIAMOND IS COLEMAN';
FOOTNOTE3 C=BLACK P=SIMPLEX H=1 'PLUS IS WILLIAMS';
RUN;
    
```

Associated Program

BEHAGEN VERSUS ALL TEAMS

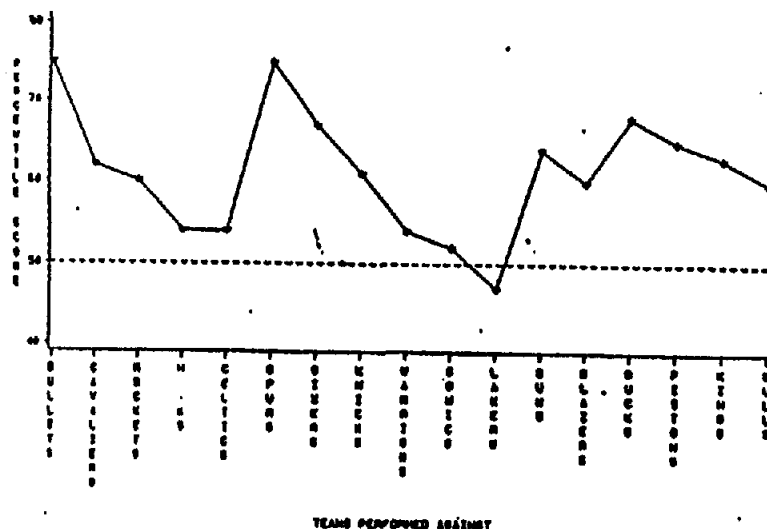


Figure 7

```

GOPTIONS DEV=HPF000A;
DATA UNF;
INFILE DEHAGAM;
INPUT TEAM $ SCORE;
LABEL SCORE='PERCENTILE SCORE';
LABEL TEAM='TEAM PERFORMED AGAINST';
PROC FORMAT;
VALUE INAM '1'- 'WILKETS'
      '12'- 'CAVALIERS'
      '13'- 'ROCKETS'
      '14'- 'HAWKS'
      '15'- 'CELTICS'
      '16'- 'SPURS'
      '17'- 'PISTONS'
      '18'- 'KNICKS'
      '19'- 'WARRIORS'
      '20'- 'JONICS'
      '21'- 'LAKERS'
      '22'- 'BUNS'
      '23'- 'BLAZERS'
      '24'- 'BUCKS'
      '25'- 'PISTONS'
      '26'- 'KINGS'
      '27'- 'BULLS';
PROC PLOT;
PLOT SCORE*TEAM/VREF=40 LVREF=2;
SYMBOLS V=STAR I=JUM L=I;
FORMAT TEAM INAM;
TITLE1 C-BLACK F-SIMPLEX H=2 'DEHAGEN VERSUS ALL TEAMS';
RUN;

```

Associated Program

TOP 20 PRODUCTIVITY PLAYERS IN THE NBA IN 1988

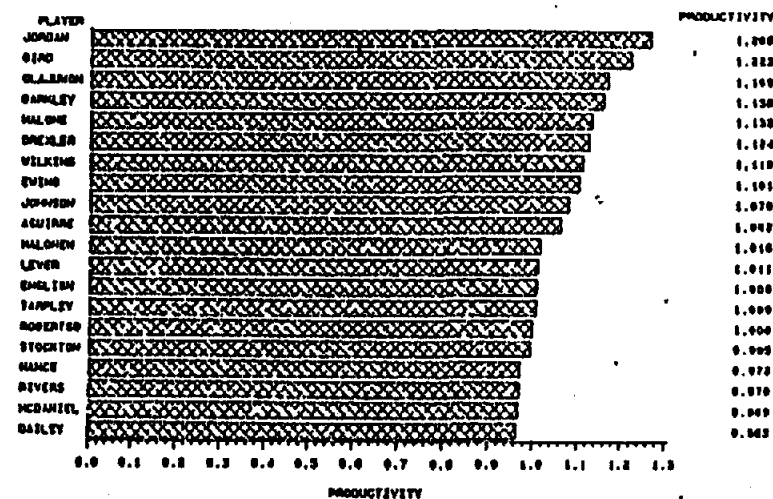


Figure 8

```

COPTIONS DEV=HIP747A;
DATA ONE;
LENGTH PLYN $ 12;
INFILE NAME;
INPUT TEAM1 PLAYER $ POS (1 GS MIN FG PQA PG) PQA PT PTA
OFF OFF AST PF DQ STL TO BLK PTS IN;
IF INH GE 100;
PROTIVITY=(OFF+DEF+AST+STL+OLN+PTS)/MIN;
PROC SORT;BY DESCENDING PROTIVITY;
DATA TWO;
SET ONE;
IF N.LE 20;
LABEL PROTIVITY=PRODUCTIVITY;
PROC GCHART;
HVAR PLAYER/SULIVAN-PROTIVITY OXIS-BLACK
CTEST-BLACK DESCENDING;
TITLE1 P-SIMPLEX C-RED N-1
TYPE NO PRODUCTIVITY PLAYERS IN THE NOA IN 1966;
RUN;

```

Associated Program

PRODUCTIVITY RANKINGS BY POSITION

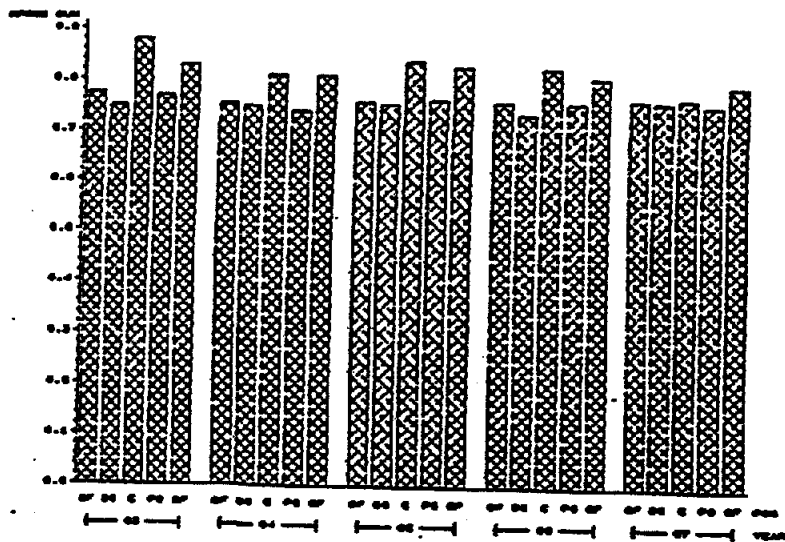


Figure 9

```

COPTIONS DEV=RTT12A VPOS=00;
DATA ONE;
INPUT YEAR TEAM PLAYERS POS G C PG SF PF DQ STL TOVR BLK PTS;
PGAS STM STA OTT DEF AST PF DQ STL TOVR BLK PTS;
IF MIN GE 000;
PRODUCTIVITY=(OFF+DEF+AST+STL+BLK+PTS)/MIN;
PROC SORT BY YEAR POS;
PROC MEANS NOPRINT; VAR PRODUCTIVITY; OUTPUT OUT=STAT;
MEAN=MPROD BY YEAR POS;
DATA TWOSET STAT;
LABEL MPROD='AVERAGE PRODUCTIVITY';
LABEL POS='POSITION';
PROC GCHART DATA=STAT;
VBAR POS/CHUP=YEAR CTEXT=BLACK COUTLINE=BLACK SUMVAR=MPROD;
PATTERNID=CHUP;
TITLE1 C=BLACK F=DUPLEX H=1 'PRODUCTIVITY RANKINGS BY POSITION';

```

Associated Program