



TRACKING TWO AND THREE OFFICIALS WITH A COMPUTER



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FIBA thanks the University Sport in Ljubljana, Slovenia for conducting the interesting research reported in this article. Their remarkable discoveries have proven to be valuable contributions to the discussion concerning FIBA rule changes, particularly those concerning the shot clock (30/24 seconds) and officiating (2 person/3 person) teams.

INTRODUCTION

In 2000 and 2003, FIBA introduced relevant changes in some segments of the Official Basketball Rules.

The most important changes were the reduction of time for passing the ball to the front court from 10 to 8 seconds, the reduction of time for attack from 30 to 24 seconds, and the continuation of play when the 24-second device signals and the ball touches the rim. The aim of these changes was to increase the speed of the players' movements, add to the attractiveness of the game, and create more suspense.

In the table below we compare several parameters of playing efficiency before and after the rule changes were introduced.

The data show that the goals were in fact reached.

Table 1

Differences in the number of attacks and some parameters of playing efficiency of national teams participating at FIBA World or European Men's Championships before and after the introduction of rule changes in 2000.

The absolute playing efficiency (the number of attacks and the number of scored points by a team in a game) increased after the implementation of the rule changes, while the relative playing efficiency (field goal percentage) remained almost at the same level despite the increased speed of the play. We assume that because of the rule changes and the subsequent increased speed of the play, the distance covered by the officials in a basketball game and the speed of their movement increased.

Namely, the distance covered by the officials in a game depends on the number of attacks of both teams, while their speed depends on the speed of both teams' movement, the speed of transition of the ball from backcourt to frontcourt, as well as the number of individual interruptions of a game: violations, fouls, time-outs, substitutions, and extra periods.

SHORT ANALYSIS OF POSITIONING AND MOVEMENT OF TWO AND THREE OFFICIALS

The mechanics of officiating determines the officials' positioning, movement, participation, and reactions during a game.

It enables officials to move efficiently, have a good view

TABLE 1

Championship	NATT	DIFF	PTS	FG%	FT%	TO	PF
WC 1998	81.6		71.5	44.7	65.8	13.7	21.3
WC 2002	91.1	9.5	83.6	44.6	73.2	14.2	23.2
EC U18 2000	80.0		69.1	45.3	70.7	14.9	20.8
EC U18 2002	89.4	9.4	75.9	43.3	68.1	14.2	20.8

Legend: NATT (number of attacks) = FGA2+FGA3+FTA/2+TO; DIFF - difference; PTS - points per game; FG % (field goal percentage) = (FGM2 + FGM3)/(FGA2 + FGA3); FT% (free-throw percentage) = FTM/FTA; TO - turnovers; PF - personal fouls

and control over the play, accurately perceive any violation of the rules, and communicate intelligibly with the participants in the game.

During a game, a two-man crew consists of a lead official and a trail official, taking alternately their officiating roles. The lead official moves ahead of the play, while the trail official moves with or slightly behind the play.

A three-man crew consists of a lead official, a center official, and a trail official, taking alternately their officiating roles. The lead official moves ahead of the play, the center official moves with it, and the trail official behind it.

The diagrams show that each of the officials in a two-man crew covers a greater distance than any of the officials in a three-man crew.

This means that the three officials reach their basic positions faster and are therefore able to concentrate better on the play than the two officials.

In a two-man crew, both the lead official and the trail official cover a longer distance during an attack than any of the offi-

BASIC MOVEMENT OF THE OFFICIALS WHEN THE BALL IS IN THE FRONT COURT

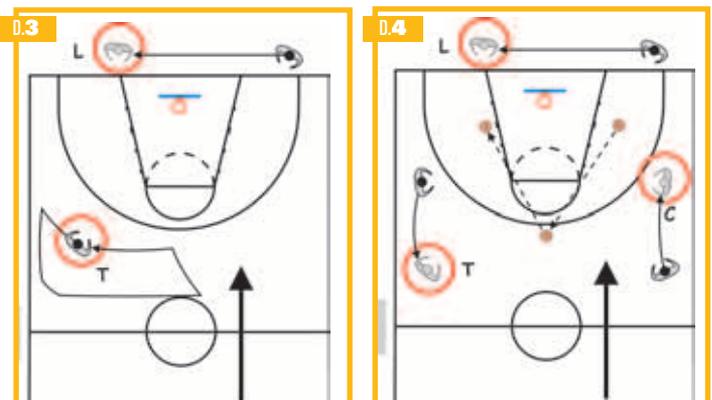
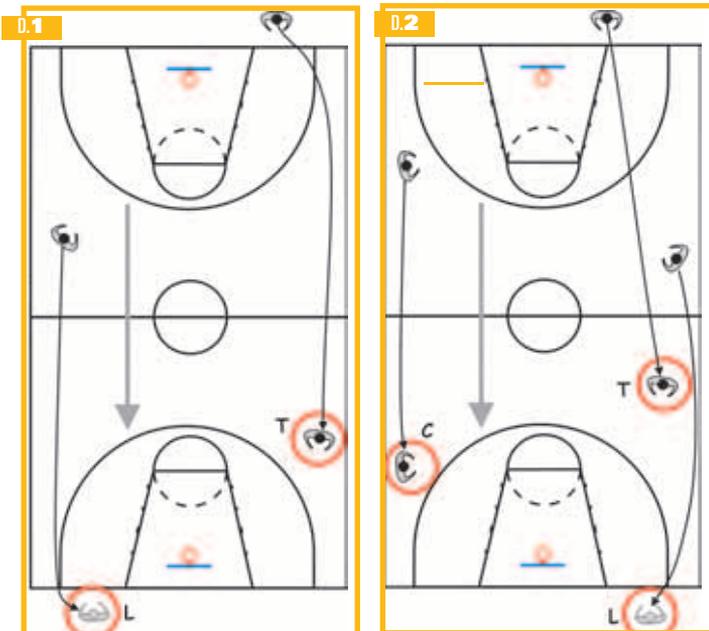
TWO OFFICIALS

When the ball is in the frontcourt, the officials move with regard to the players' movements as to maintain a (usually) diagonally opposite position. They constantly try to keep all the 10 players between them. The officials also move when the ball moves and after they call a violation or a foul.

The lead official moves along the end line. He moves between the three-point line to his left and the far edge of the restricted area to his right. The trail official moves within the imaginary line extending from basket to basket to his right and the free-throw line extended (diagr. 3).

THREE OFFICIALS

The three officials move with regard to the position and the movement of the ball. When the ball penetrates beyond the free throw line extended, the lead official moves to the ball side (L). His movement initiates the rotation of the other two officials: the center official moves to the trail position (T), while the trail official moves to the center position (C) - (diagr. 4).



BASIC MOVEMENT OF THE OFFICIALS DURING TRANSITION

TWO OFFICIALS

During transition, the new lead official (L) moves ahead of the play and on its right, while the new trail official (T) keeps slightly behind and to the left of the play.

After the transition, the officials usually position themselves diagonally opposite each other and strive to box-in all the ten players (diagr. 1).

THREE OFFICIALS

The trail official moves along the sideline (ball side) and ahead of the play to become the new lead official (L).

The center official moves with the play along the opposite sideline and remains center official (C).

The lead official moves along the trail official's sideline (ball side) and behind the play to become the new trail official (T).

After the transition, the officials assume and strive to maintain a wide triangle pattern that allows them to observe the play and its circumstances (diagr. 2).

cial in the three-man crew.

The lead official in a two-man crew covers a greater distance than the lead official in a three-man crew, while the trail official in a two-man crew covers a greater distance than either the center or the trail official in a three-man crew.

During an attack, the center and the trail official in a three-man crew may switch their roles and positions, while the trail official in a two-man crew covers the area from the free-throw line extended to the centerline by himself.

This short and simplified analysis of officials' movements during a basketball game shows that the loading of the officials in a two-man crew is greater than the loading of the officials in a three-man crew.

Our two goals were to establish the differences between an official in a two-man crew and an official in a three-man crew in terms of:

- ▼ Time of rest and moving
- ▼ Distance covered in four speed classes (walk, slow run, medium-fast run, and fast run).

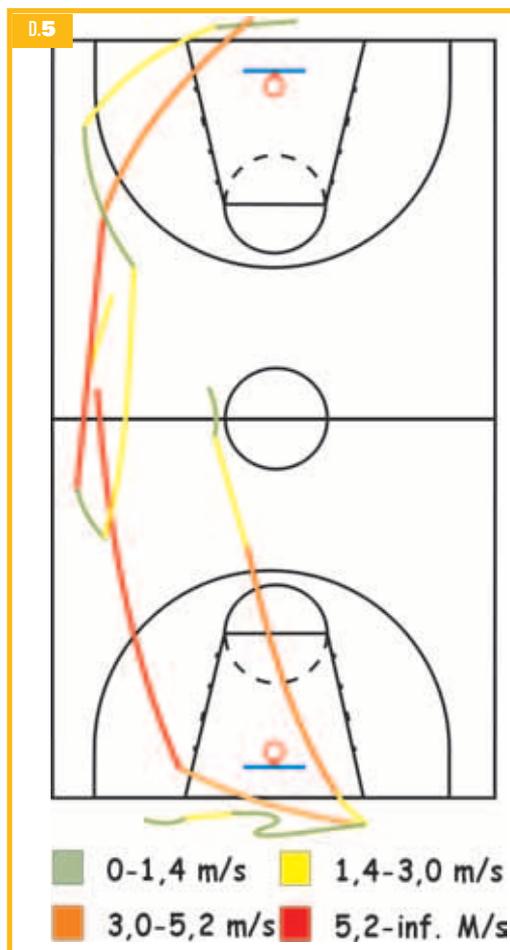
CHARACTERISTICS OF THE GAMES DURING WHICH THE OFFICIALS' MOVEMENTS WERE TRACKED

The movements of Slovenian officials were tracked during two games of the 1.A Slovenian Basketball League Play-off in the 2002/2003 season.

The first game between the teams of Slovan Ljubljana and Pivovarna Lasko was officiated by two officials.

The second game between the same two teams was officiated by three officials. Both games were officiated by four FIBA referees, two of them officiated the first game, and one of them officiated the second game together with two new officials (table 2).

The data show that the games do not differ greatly in terms



of basic variables of playing efficiency.

We already mentioned that the players' playing efficiency affect the distance covered by the officials and the number of their interventions.

A comparison between the parameters listed above and the average values of all the games at the FIBA 2003 European Championship for Men reveals that the results of our two games were slightly above the FIBA 2003 European Championship average in terms of playing efficiency variables.

This means that the results may be generalized to a certain extent.

TRACKING OF REFEREE'S MOVEMENTS DURING A BASKETBALL GAME WITH COMPUTER SIGHT

In both games, the data for all three variables were collected through SAGIT, a software program for tracking players or officials during a game. It is designed on the basis of computer sight technology.

SAGIT was developed at the Faculty of Electrical Engineering in Ljubljana, in co-operation with

the experts from the Faculty of Sport in Ljubljana.

Data were collected in the following way.

A SVHS video camera was fastened to the ceiling of a sports hall above each side circle.

Each video camera covered one half of the playing court. These two video cameras and two co-ordinated SVHS video recorders recorded both games.

Both video recordings were then computerised.

They were digitized using special software and merged in a uniform digital record.

An operator then used the SAGIT software to track the officials' movements.

TABLE 2: OTHER CHARACTERISTICS OF BOTH GAMES

GAME Variable	1ST GAME - 2 OFFICIALS			2ND GAME - 3 OFFICIALS			EC2003 Average
	Slovan	Lasko	1st Game Average	Slovan	Lasko	2nd Game Average	
Attacks	88	91	89.5	89	86	87.5	85.3
Points	89	83	86	76	92	84	77.6
Field Goal Attempts	60	58	59	63	52	57.5	58.9
Turnovers	11	13	12	12	12	12	14.1
Free-Throw Attempts	34	40	37	28	44	36	24.5
Fouls	32	29	30.5	29	27	28	24.2

During both games, the distance covered by the officials and the time of their movement were tracked in terms of five speed classes: rest (0.0 m/s), walk (from 0.0 m/s to 1.4 m/s), slow run (from 1.4 to 3.0 m/s), medium-fast run (from 3.0 to 5.2 m/s) and fast run (above 5.2 m/s).

An example of the recorded tracking of an official's movements in terms of four speed classes is given in the diagr. 5.

RESULTS OF TRACKING

The data in the tables show the average values of the analysed variables for officials in a two-man crew (2) and those for officials in a three-man crew (3) during a game.

During the game, an official in a two-man crew covered a distance

CONCLUSIONS

The results confirm the assumption that officiating a basketball game in a two-man crew is more demanding in terms of physical condition than officiating in a three-man crew.

The official in a two-man crew has to move faster and for a longer period of time.

Thus, he covers quite greater distances and has less time to rest. Both decrease the concentration of an official.

This means that he has less time to orientate in space, and consequently, his perception of players' incorrect movements is less efficient.

Therefore, FIBA's decision to introduce three-man officiating in its top competitions in the future is absolutely legitimate.

TABLE 3: DISTANCE COVERED BY OFFICIAL BY SPEED CLASS

Variable	Unit	No. of Officials	Rest	%	Walk	%	Slow Run	%	Med.-Fast Run	%	Fast Run	%	All Runs	%	Walk + All Runs	%
Distance	M	2	0	0	2196	32.4	2340	34.5	1869	27.6	368	5.4	4577	67.6	6773	100
		3	0	0	1982	37.5	2061	38.9	1083	20.5	166	3.1	3309	62.5	5291	100

ce (walked and ran) of 6,773 m. He ran 4,577 m in various speeds (67.6 % of the total distance covered) and walked 2,296 m (32.4 % of the total distance covered).

An official in a three-man crew walked and ran 5,291 m. He ran 3,309 m in various speeds (62.5 % of the total distance covered) and walked 1,982 m (37.5 % of the total distance covered).

The official in a two-man crew covered a greater distance in all the three speed categories of running (table 3). The largest difference was in the medium-fast run category (776 m). These results confirm the conclusions of the analysis of basic movements of officials in two- and three-man crews.

Quite similar are the data regarding the time an official moved (at various speeds) during a game (table 4). The official in a two-man crew spent 85.1 minutes of the game moving (94.9 % of the total time), and rested for 4.5 minutes (5.1 % of the total time).

The official in a three-man crew moved for 78.9 minutes (88.8 % of the total time) and rested for 9.9 minutes (11.2 % of the total time).

The official in a two-man crew spent more time running (29.4 minutes, or 32 % of the total time) than the official in a three-man crew (22.9 minutes, or 25.8 % of the total time).

The same applies also to the time of movement in all the three speed categories of run.



TABLE 4: TIME OF OFFICIALS' MOVEMENTS BY SPEED CLASS

Variable	Unit	No. of Officials	Rest	%	Walk	%	Slow Run	%	Med.-Fast Run	%	Fast Run	%	All Runs	%	Walk + All Runs	%	Rest + Walk + All Runs	%
Time	Sec	2	275	5.1	3344	62.1	1217	22.6	477	8.9	68	1.3	1763	32.8	5107	94.9	5381	100
		3	596	11.2	3362	63.1	1058	19.8	288	5.4	28	0.5	1374	25.8	4736	88.8	5332	100
Time	Min	2	4.6		55.7		20.3		8.0		1.1		29.4		85.1		89.7	
		3	9.9		56.0		17.6		4.8		0.5		22.9		78.9		88.9	