A COMPARATIVE STUDY EXAMINING THE DIFFERENCE BETWEEN THE OFFENSIVE PRODUCTION OF THE -5 LENGTH TO WEIGHT COLLEGIATE BASEBALL BAT AND THE -3 LENGTH TO WEIGHT COLLEGIATE BASEBALL BAT

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ABSTRACT

JASON ALAN HOWELL: A Comparative Study Examining the Difference Between the Offensive Production of the -5 Length to Weight Collegiate Baseball Bat and the -3 Length to Weight Collegiate Baseball Bat (Under the direction of Ed Shields)

This study examined offensive production statistics for NCAA Division I baseball for the eight years pre and eight years post NCAA rule change that regulated the size, weight and exit ball batted velocity of collegiate baseball bats. Our study empirically examined five offensive baseball statistical categories in order to determine if the rule change by the NCAA mandating a change in bats accomplished the goal of reducing college baseball's offensive output. A direct comparison of the -5 and -3 bat was made for 275 Division I Collegiate Baseball Programs from 1991-2006. All teams used an unregulated -5 collegiate bat from 1991-1998 and a regulated -3 bat from 1999-2006. The results yielded trend lines for each of the statistical categories for the eight years pre and eight years post rule change for the intercollegiate baseball bat. We concluded the NCAA rule change helped to accomplish its intention: to reduce offensive production.

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PREFACE

As a Division I Collegiate Baseball Player and a former Professional within the Boston Red Sox organization I played during the era of the -5 collegiate baseball bat, -3 collegiate baseball bat and then experienced the professional wooden baseball bat. Ending my career as a player and starting one as a coach I remembered scores and stats of those late years with the -5 bat and the early years with the -3 collegiate baseball bat. Recalling my collegiate playing experience and the transition/adjustment period that seemed to take place while adapting to the new (heavier/smaller barreled) bats, I wondered if college baseball's statistics evolved and changed back to those prior to the NCAA rule regulating the bat. Thanks to the help and resources of my graduate program at UNC-Chapel Hill, I have had the opportunity to research and evaluate not only the two bats but also the time period in which they existed. Not only have I had the chance to research a topic of interest but study one that will aid me in my career. I hope this study will help show some trends pre and post the 1999 rule change while at the same time offer some insight to the changing technology that is equipment within college athletics.

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CHAPTER I

INTRODUCTION

Derived from and based on the English game of Rounders, the first recorded baseball game was played in 1846 when Alexander Cartwright's Knickerbockers lost to the New York Baseball Club at Elysian Fields in Hoboken, New Jersey (The History of Baseball, 1997). The games alleged inventor, Alexander Cartwright, published what was then a set of rules governing the play of the Knickerbocker Club of New York in 1845 but later was adopted and widely known as the rules of the game of baseball (The History of Baseball, 1997).

In 1947, the first National Collegiate Athletic Association (NCAA) baseball championship, "The College World Series," was played in Omaha, Nebraska (Past CWS Champions, 2007). The competition was played with wooden bats and was held between The University of California and Yale University. The outcome yielded a California 8-7 victory, thus igniting the first of 59 collegiate championships to have been played and decided in Omaha, Nebraska's Rosenblatt Stadium.

The collegiate debut of the aluminum bat was not until 1974. It's initial use, however, did not have a significant effect on the offensive aspect of the game (Kuppig, 2001). It was not until 1984 when Easton introduced its Black Magic baseball bat that the use of metal baseball bats sparked a revolution in the use of sport technology (Kelly, 2000). According to Amherst College Head Coach and former NCAA Rules Committee member Bill Thurston, the game's offensive performance began escalating in the mid- 1980s And ultimately made a tremendous jump in power numbers during the 1990s (Kuppig, 2001). The change in technology and increased offensive production created controversy among the ranks in college baseball regarding the use of advanced aluminum bats and the possibility of a conversion back to wooden bats.

The first "Abat" summit with the NCAA Baseball Rules Committee and executives of aluminum-bat manufacturers was held in the summer of 1994 (Kelly, 2000). Although there were no rule changes during the meeting, it became evident that manufacturers had the ability to manipulate the size and weight of the baseball bats created. The 1998 College World Series (CWS) marked a number of important events leading up to new regulation changes regarding college baseball and bat standards. During the CWS, the University of Southern California outlasted Arizona State University 21-14 after a four hour-long Championship Game. The 35 run epic capped off a decade of offensive growth and a College World Series in which 32 NCAA offensive records were broken (Kupping, 2001).

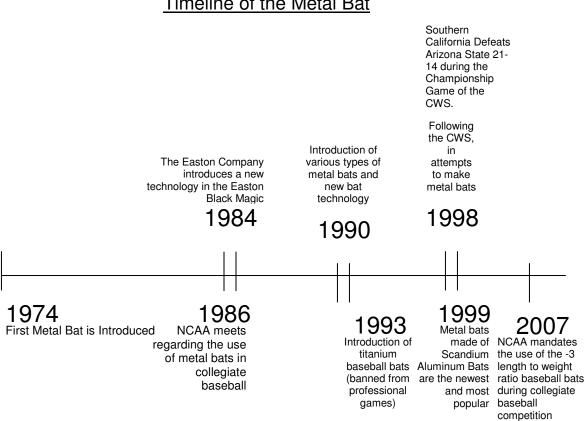
Following this landmark collegiate baseball season, the NCAA Executive Committee gave final approval for specific changes used by NCAA member schools in their intercollegiate baseball programs in an attempt to make metal perform similarly to wooden bats (Renfro, 1998). Despite attempts at earlier start dates, the new standards became effective on August 1, 1998. In accordance with the rule changes, the NCAA implemented a two-pronged, and later three-pronged test for college baseball bats. Test one included changing the maximum weight-length difference from five to three ounces. Test number two called for a reduction in the diameter of the bat barrel to go from 2 3/4 inches to 2 5/8 inches and test three agreed to a maximum batted ball exit velocity speed of 93 miles per hour.

Additionally, even though not mandatory for conference play, the NCAA switched its official ball from Wilson to Rawlings.

Following the rule change, manufacturers were required to submit their bats for certification to an independent study group in order to measure the size, weight and batted-ball exit speed (Renfro, 1998). The NCAA Executive Committee believed that the change in bat regulations would create a competitive balance between offense and defense within the game of college baseball (Rowe, 1998). Additionally, the committee felt that "technological innovations – rather than players' skills – were impacting the outcome of the games at an increasing rate," thus viewed the increase as a threat to the integrity of the game of baseball (Rowe, 1998, p. 29).

"The NCAA is a membership organization of colleges and universities that participate in intercollegiate athletics. The primary purpose of the Association is to maintain intercollegiate athletics as an integral part of the educational program and the athlete as an integral part of the student body. Activities of the NCAA membership include formulating rules of play for NCAA sports, conducting national championships, adopting and enforcing standards of eligibility and studying all phases of intercollegiate athletics" (Rowe, 1998, p. 30).

FIGURE 1. Timeline of the Metal Bat



Timeline of the Metal Bat

Statement of Purpose

This study examined offensive production statistics for NCAA Division I baseball for the eight years pre and eight years post NCAA rule change that regulated the size, weight and exit ball batted velocity of collegiate baseball bats for the purpose of comparing the effect of the -5 bat to that of the -3 bat on selected offensive production. A range of offensive categories were examined based on team statistics including batting average, runs per game, home runs, slugging percentage, strikeouts per 9 innings and earned run average during the time of the -5 bat compared to that of the -3 bat. Offensive production statistics were analyzed to determine whether the usage of the -3 bat has decreased the offensive power numbers produced in collegiate baseball since the 1999 change in NCAA baseball bat regulations.

FIGURE 2. Change From the -5 to the -3 Bat

Change from -5 to -3 Bat became effective Aug 1, 1998 First season of play with the -3 bat: 1999

2006	8	
2005	7	
2004	6	
2003	5	
2002	4	
2001	3	4
2000	2	
1999	Year 1 Post Change	
	<u> </u>	
	Year 1 Pre Change	
1998	Year 1 Pre Change 2	
1998 1997	Year 1 Pre Change 2 3	
1998 1997 1996	Year 1 Pre Change 2 3 4	
1998 1997 1996 1995	Year 1 Pre Change 2 3 4	
1998 1997 1996 1995 1994	Year 1 Pre Change 2 3 4 5	
1998 1997 1996 1995 1994 1993	Year 1 Pre Change 2 3 4 5 6	

Research Questions

Of special note, for each research question, significant difference does not refer to the typical "statistically significant" difference. A significant difference for the purposes of this study was what is determined to be a significant or important difference in selected offensive statistics from the perspective of NCAA Division I college baseball coaches. The basic research question: Is there a difference in selected offensive production statistics between those observed with the -5 bat (1991-1998) and those observed with the -3 bat (1999-2006)? Specifically, we addressed the following questions:

- Did each offensive production statistic change significantly from 1998 (last year with -5) to 1999 (first year with -3)?
- 2. Did the eight-year mean for each offensive production statistic for 1999-2006 change significantly from the eight-year mean for 1991-1998?
- 3. Is the trend line for each offensive production statistic for 1999-2006 different than the trend line for 1991-1998?
 - A. How many years passed after the change from -5 to -3 before a significant change took place?
 - B. If a significant change took place, was the change short-term, or was the change lasting?

Research Hypothesis

 There is a significant difference in offensive statistics seen between the -3 length to weight ratio collegiate baseball bat compared to that of the -5 length to weight ratio collegiate baseball bat.

- There is a significant increase in offensive statistical output from the time the -3 length to weight ratio collegiate baseball bat was introduced compared to the past 2006 NCAA Baseball season.
- 3. There is a significant difference between the offensive productivity seen in 1998 (the final year of the -5 bat) compared to offensive productivity displayed in 1999 (the first year of the -3 bat).

Definition of Terms

- 1. At-Bats: The total number of plate appearances minus walks and hit-by-pitches.
- 2. Batting Average: The total number of hits divided by the total number of at-bats.
- 3. Batted Ball Exit Speed: The speed of the ball coming off of the bat after impact.
- 4. Slugging Percentage: The total number of bases achieved by hitting and putting the ball into the field of play divided by the actual number of hits.
- 5. Runs-Batted-In (RBI): A run scored as a result of a hit; a bases filled walk, hit by pitch, awarded to first base due to interference; a sacrifice; or a signal-outfielders choice (not a double play.) (Official credit to a batter for driving in a run.)
- Total Bases: The total number of bases touched by an offense during a single game, multiple games or a season equals total bases.
- Earned-Run-Average (ERA): The average number of <u>earned runs</u> allowed by a <u>pitcher</u> per nine innings pitched.
- 8. Base Hit: The act of <u>safely</u> reaching <u>first base</u> after batting the ball into fair territory assuming the defense did not commit an error in the process.

- Signal Base Hit: A base hit that results in the batter reaching second base assuming no errors were committed.
- 10. Double: A base hit that results in the batter reaching second base assuming no errors were committed.
- 11. Triple: A base hit that results in the batter reaching third base assuming no errors were committed.
- 12. Homerun: A home run is a base hit in which the batter is able to circle all the bases, ending at <u>home plate</u> and scoring a run himself.
- Strike Outs Per Nine Innings: The average number of strikeouts per nine innings of play during a game.
- 14. Error: An error is an act, in the judgment of the <u>official scorer</u>, of a fielder misplaying a ball in a manner that allows a batter or baserunner to reach one or more additional bases, when that advance could have been prevented by ordinary effort by the fielder.

Assumptions

- 1. It is assumed that the bats being used by the NCAA team member institutions are those specified that meet the standards and regulations set forth by the NCAA.
- 2. It is assumed that even though teams might be using different brands of bats, the materials from which the bats are forged are similar in composition and make-up.
- 3. It is assumed that the competition level faced by each team is on the average comparable throughout each season studied.

- 4. It is assumed that the number of games played throughout the various seasons are comparatively close in number with each other.
- 5. It is assumed that the multiple different playing fields do not vary in size from year to year.
- 6. It is assumed that all other equipment such as balls and gloves are similar throughout college baseball aiding in an equal playing field.

Limitations

- 1. The data was measured in real life situations thus eliminating the opportunity for a control variable.
- The number of specific games and at bats vary from year to year. Noticeably, in 1998 the NCAA baseball post-season field expanded from 48 teams to 64 competing teams.
- 3. The data was collected during the college baseball playing season, a time period when college baseball coaches are their busiest.
- 4. Player development changes from year to year. Collegiate players exhaust their eligibility, mature, become older and move up in class. Additionally, the Major League Draft takes highly talented high school players as well as college juniors. The athletes who sign professional contracts affect the talent level seen in college baseball.

Delimitations

- The study is restricted to 275 Division I NCAA Collegiate Baseball Teams. Limiting
 a comparative study, Major League Baseball uses wood bats as opposed to college
 metal. Additionally, data cannot be drawn from high school or youth baseball
 programs because the weight and length restrictions placed on bats in those various
 leagues differ from those placed on the NCAA member institutions.
- 2. The study is limited to research done from 1991-2006.

Significance of Study

Due to regulations limiting bat weight and size, college baseball has been affected by technological advancements in baseball bat production. Since 1974, when the first aluminum bat was introduced into college baseball, the game has seen a significant increase in offensive production numbers larger in comparison to that seen in the Major Leagues and within the college game itself. This has created an ongoing debate regarding the use of metal bats in college baseball and has raised questions about preserving the tradition of the game, the effect of technological advances in bat manufacturing and college baseball's seemingly inflated offensive numbers. Initial arguments concerned the inflated offensive statistical numbers displayed in the championship game of the 1998 College World Series. Following the 1998 season new bat regulations were put into place ultimately limiting the velocity speed the ball could exit the bat upon contact. However, there is limited research analyzing the effect that equipment changes have had on the offensive production in college baseball.

NCAA baseball has precise rules not only regarding bats but also regulating equipment specifications. Attempting to promote an equal playing field, baseball bats,

gloves, pitching mounds and playing fields must adhere to strict policies that include material, size and weight standards. Because the rules of college baseball have been created to counteract advancing technology, the intention of this study is to evaluate college baseball's offensive production in relation to bat regulation changes.

The data collected from this study will be compared to provide a statistical analysis of the effectiveness of the NCAA regulation change intended to limit offensive production in the game of college baseball. Similar to these direct comparisons, conclusions will be reached by looking at statistical output from year to year and from individual years within college baseball during the time period of the -5 length to weight ratio baseball bat and the -3 length to weight baseball bat. Additionally, a significant value will be placed on the two comparisons and a conclusion will be drawn expressing impact and differences in the two bats' offensive production numbers. This study will aim to provide feedback displaying an offensive comparison of the -3 length to weight collegiate baseball bat and the -5 length to weight collegiate baseball bat.

CHAPTER II

REVIEW OF LITERATURE

The core purpose of the NCAA "is to govern competition in a fair, safe, equitable and sportsmanlike manner, and to integrate intercollegiate athletics into higher education so that the educational experience of the student-athlete is paramount" (NCAA.org, 2007, Paragraph 1). In order to help control and maintain a competitive playing atmosphere and ensure an equal playing field, the NCAA places specific guidelines and regulations on all equipment used during not only baseball and all NCAA championship sport competition.

Baseball is a sport built, examined and evaluated by statistical input, output and production. The game measures success not only by the number of wins and losses but also by a collection of data measuring percentages, probabilities and calculations. There has been previous research investigating season to season statistical offensive output, comparisons drawn and research done between aluminum and wooden baseball bats (Brown, 2002).

Trends in the research area, however, tend to lead to direct comparisons drawn between collegiate aluminum baseball bats and Major League Baseball (MLB) wooden bats. Additionally, evaluations have been done assessing individual season to season offensive production at both the Major League Baseball and collegiate level (mlb.com/stats/historical). However, these studies have simply been direct comparisons, failing to take into account outside variables. As well, the majority of these studies draw comparisons looking at one single season compared to that of another single season thus evaluating either a league or simple offensive numbers. Since there has not been a study directly comparing the Collegiate -5 length to weight ratio baseball bat to that of the -3 length to weight ratio baseball bat, the importance of this literature review is to evaluate the models used for baseball bat statistical testing drawing comparisons between seasons, individual bats and other equipment. The review will look at the statistical importance in baseball, comparisons between wood and aluminum baseball bats, the impact of aluminum baseball bats in college baseball and the impact of technology in other sports.

Statistical Importance

As stated earlier, baseball is a game centered on statistical evaluations. In the absence of a valid statistical study breaking down specific bat comparisons between college and professional baseball, it is simple to look at year end totals and directly compare the two levels. During the completion of the 2006 MLB Season Minnesota Twin Joe Mauer ended with a league high .347 batting average while the 2006 highest collegiate batting average was .493 (http://mlb.mlb.com/NASApp/mlb/stats). As well, in 2006 the MLB individual home run mark was set at 58 in 160 games while the single season individual home run collegiate mark was 24 in only 53 games (http://web1.ncaa.org/stats/StatsSrv/rankings).

Similar to these direct comparisons, conclusions will be reached by looking at statistical output from year to year and from individual years within college baseball during the time period of the -5 length to weight ratio baseball bat and the -3 length to weight baseball bat. Additionally, a significant value will be placed on the two comparisons and a conclusion will be drawn expressing impact and differences in the two bats' offensive production numbers.

Comparisons Between Wood and Aluminum Baseball Bats

With the aid of printed box scores and instant access due to the emergence of the Internet, baseball statistics are readily available. Simply by the click of the button, updated information from high school, college and professional baseball is available upon request. Therefore, new technology has allowed for comparisons to be made between teams, leagues and levels.

Hardball-Hardbat: A Call for Change from Aluminum to Wooden Baseball Bats in the NCAA (Kelly & Pedersen, 2000) Kelly and Peterson (2000) presented the argument that the NCAA should change from aluminum bats to wooden baseball bats. Safety was the presented reason for change specifically citing batted ball exit velocity of both wooden and aluminum baseball bats. Pointing to smaller size and weights of aluminum bats, Kelly and Pedersen (2000) referenced a 15 year period of collegiate baseball and the steady increase in batting averages during that time. As well, they alluded to multiple other offensive increases seen over the past 15 years of college baseball. Additionally, the article highlighted a former collegiate baseball player and, on the basis of the type of bat used, compared his senior college season and his first year as a professional. Kelly and Peterson (2000) found that due to the use of an aluminum bat the player had a more offensive productive senior season as opposed to the following wooden bat season.

Even though very well represented by yearly data and consistent facts, the article lacked statistical evidence proving significance. Additionally, the article operated upon multiple assumptions. For example, the article assumed that a ball can be hit off of any part of an aluminum bat and still achieve a perfect hit. Next, the article obtained data from a 15 year period by simply looking at overall numbers and did not factor in other variables such as

player development, ballpark size or equipment changes. Finally, when the article cited the collegiate player's stats compared to those of his first season in professional baseball, the numbers, again, were the only variables examined without consideration for other limitations, such as talent level, consecutive games played or even overall competition age. Concluding, Kelly and Peterson presented a good argument for wooden bats over aluminum baseball bats, however, the argument can be improved through a study comparing offensive production between baseball bats.

"In recent years, baseball bat performance has come under scrutiny" (Drane, 2000, p.1). Due in large part to this scrutiny and what was perceived to be a dramatic jump in offensive production in college baseball, the NCAA implemented considerable changes to the specifications of the collegiate aluminum baseball bat. The basis for these changes was determined by a batted ball exit velocity standard set on each new regulation aluminum baseball bat. P.J. Drane, a mechanical engineer at the University of Massachusetts-Lowell, explains the results of moisture on wooden and aluminum baseball bats. The relevance of the article is its description of the NCAA's procedures regarding bat testing in order to make sure they meet the current standards set after the 1998 College World Series. Unfortunately, the tests did not show offensive production numbers or their relevance to a batted ball exit speed. However, the article explained how a machine is used to generate the same bat speed consistently. A consistent bat speed swing is an important concept that eliminated the human difference error and enabled measurements of ball velocity to be taken demonstrating the bats material make-up as the only variation variable. Even though the bulk of this article described the effects of moisture on various bat types, the fact that each college baseball bat must meet the same criteria allows the -5 length to weight ratio baseball bat to be directly

compared to the -3 length to weight bat with the absolute assumption that during the individual bats era, each one was held to the same standard without outside material deviation.

The Impact of Aluminum Baseball Bats in College Baseball

"Every year, millions of Americans travel to ballparks throughout the country to pay homage to the game long regarded as the national pastime. One of the primary reasons baseball continues to maintain its strong following is that the modern game has endured little change since the days of Shoeless Joe Jackson, Babe Ruth, Ty Cobb and Lou Gehrig. At the end of the day baseball is still a game of four bases, three outs, and nine players per side. Yet that is not to say that baseball has been immune to technological advances" (Wilmont, 2006, p. 353).

Multiple articles and press releases have been written regarding the impact of aluminum baseball bats within college baseball. The majority of these articles all tend to relay similar messages expressing safety issues and the speed at which the ball comes off of the metal surface of the bat.

For example, an article by Dr. Drane Kupping discussed the debate regarding the use of aluminum bats in college (Kupping 2001). Kupping (2001) cites the history of aluminum bats in college baseball dating back to 1974. Since that time period, he expressed how offensive production numbers have increased as time has gone by. However, the information was simply stated and inconclusive without giving yearly statistical data. Additionally, in the article the 1998 collegiate batting average of .306 was stated and measured to the .297 average of 1999. The article demonstrated a difference, however it fails to mention if the

difference was significant or if other variables could have played a part in the slight fall in batting average.

Unfortunately, the Kupping article did not use statistical evidence to support its findings. Even though offensive numbers can be examined and compared up and down, without a definite test involving guidelines, parameters and significance, a factual and definite conclusion cannot be reached. Additionally, the majority of these studies looked at comparisons between individual offensive numbers from year to year and failed to consider the specific time period of the -5 and the -3 length to weight ratio baseball bats. Concluding, even though a difference can be seen from year to year between offensive production numbers, a study needs to be done directly comparing relevant data during the specific time period of the -5 and -3 length to weight baseball bats.

Regarding the issue of safety, Wilmont's 2006 article examined the advancing technologies in baseball bat production as a possible future liability issue. Disregarding stats or offensive production numbers, the article focuses on how the bats affect the game, why aluminum bats, and liabilities as an overview.

Despite not using statistical output, the article attempted to compare the use of aluminum baseball bats to that of their wood counterpart. The article cited a study done by Amherst College that tracked the performance of ninety-two college baseball players in the summer Cape Cod League. The Cape League is a summer baseball league comprised of the nations top collegiate baseball players selected by the individual team general managers and coaches. Seventy percent of those players participating in the league batted over three hundred in their college season using aluminum bats while only nine percent were able to achieve that same level of performance in the summer using wood.

Similar to Wilmont's law article, a physics article by Dr. Daniel Russell out of Kettering University, *How Have Aluminum Bats Changed Baseball*, uses Cape Cod statistics comparatively to that of a regular college season (2007). However, this particular article went into further detail explaining and showing through charts and graphs breakdowns of strikeouts per nine innings and home runs per game between the two seasons. Unfortunately, the article did not discuss how the data was collected or analyzed thus only showed a trend without significance.

The studies discussed made an interesting point by arguing aluminum production over wood production. However, like many of the other studies done and evaluated, the Russell study failed to take into consideration that the individual players were going up against the best pitchers college baseball had to offer while in the Cape Cod League. As well, other variables such as consistent games, field size and fatigue after an already long collegiate season were not mentioned as inconsistent variables.

The Impact of Technology in Other Sports

Like baseball, tennis has undergone changes due to technology that can be traced to economic improvement and changes.

"The past three decades have been a time of explosive economic change in the labor markets of America's major professional sports. Dramatic increases in firm revenues have combined with increases in players' property rights in their own services to make multimillion-dollar salaries common place in baseball, basketball, and football." (Galenson, 1992, p. 127). Galenson's Study, *The Impact of Economic and Technological Change on the Careers of American Men Tennis Players*, 1960-1991 examined the economic impact and change in men's tennis during a three decade period.

The article focused on two specific factors, age and salaries, to demonstrate a trend or change in men's tennis over the thirty-year period (1992). Charts and graphs were utilized to illustrate the means of both age and salaries over the three decades as well as a year by year break down of national rankings in relation to the two factors.

Attempting to explain the trends demonstrated in the article relied on the evolution of tennis equipment, specifically the racket. Similar to the baseball bat and golf club, tennis began with using wooden equipment. Since the 1960s, the wooden racket evolved to metal, aluminum and now to what is known as a graphite shaft. As well, with the change in material came a change in the racket head size, ultimately growing with each new decade (Galenson, 1992).

After tracing the evolution of tennis equipment, the article relayed the information imputing it into the data showing age, national ranking and salary. Galenson, through charts and graphs, concluded that due to advanced technology as time passed by players were able to compete at older ages, thus able to stay nationally competitive longer and ultimately make more money throughout an extended career (1992).

Even though the -5 length to weight ratio compared to the -3 length to weight ratio baseball bat study is not looking at technology aiding in prolonging a career, it is important to note other sport advances due to technology and be aware how these changes have affected their specific sport production. These changes show what kind of effect an unregulated or controlled piece of equipment can have on a sport as well as how outside

variables not taken into consideration can throw off the -5/-3 length to weight ratio comparison study.

A final study by Dana Sorensen, *The Statistical Impact of the Louisville Slugger 'Catalyst' Bat on the 2005 Division I Collegiate Softball Season* (2006), is the most applicable study because it also compares collegiate bats and statistical offensive output. Instead of investigating an equipment change in baseball, Sorensen centered the study around comparing new composite bat technology to that of previous softball bat metals in thirteen offensive statistics. The results of the study indicated that changes in the bat produced higher totals in home runs, slugging percentage, and batting averages. The relevance of this study further indicates the changing technology in equipment and the impact those changes have on collegiate athletics.

Summary of Relevant Research

The research done on statistical production within the game of baseball is by no means limited. Multiple articles and simple direct comparisons within and between college, high school and Major League Baseball can be done over the Internet. Previous research shows that there are statistical differences or cites reasons why there is a difference in the offensive production between wood and aluminum baseball bats (Kelly, 2001). Additionally, the article, *The Effects of Moisture Content and Workhardening on Baseball Bat Performance*, explains the NCAA's method for testing to make sure each bat produced for college baseball meets the exact same criteria, while *The Impact and Technological Change in the Careers of American Men Tennis Players*, 1960-1991 is an article that depicts the impact changes of equipment improvements in another sport.

Previous research has relied on the understanding that all aluminum bats are created equal, examined offensive production from different eras in baseball or compared aluminum bat statistics to wooden bat statistics. Therefore, it is evident through previous research that specific research and testing with significant results comparing the offensive production of the -5 length to weight ratio baseball bat and the -3 length to weight baseball bat still needs to be done. Upon drawing those results, a conclusion can be determined stating if the NCAA bat regulation change after the 1998 season was effective in reducing offensive production in college baseball.

CHAPTER III METHODOLOGY

This purpose of this study was to examine offensive production statistics for NCAA Division I baseball for the eight years pre and eight years post NCAA rule change that regulated the size, weight and exit ball batted velocity of collegiate baseball bats for the purpose of comparing the effect of the -5 bat to that of the -3 bat on selected offensive production statistics. The study examined a range of offensive variables based on team statistics including batting average, runs per game, home runs, slugging percentage, strikeouts per nine innings and earned run average during the era of the -5 bat compared to that of the -3 bat. The analysis of offensive production statistics is used to determine whether the usage of the -3 bat has decreased the offensive power numbers produced in collegiate baseball since the 1999 change in NCAA baseball bat regulations.

Subjects

This study analyzed offensive statistical data from all Division I baseball programs from 1991-2007. During the specified years, a maximum number of 275 Division I baseball programs were examined representing each of the 30 Division I conferences. Additionally, all 275 Division I head baseball coaches were surveyed requesting feedback involving offensive statistical information. The data being collected from 1991-1998 corresponds to the -5 length to weight ratio baseball bat era; while data collected from 1999-2006 represents the -3 length to weight ratio baseball bat era. The data were collected from pertinent databases maintained by the NCAA. This study focused on offensive production from Division I baseball programs because they represent the highest level of collegiate competition.

Instrumentation

The overall offensive performance of the teams was based on five dependent variables: batting average, runs per game, home runs, slugging percentage, strike outs per nine innings and earned run average. To gain an understanding of what a statistical offensive significance is in the game of College Baseball, was sent out to all 275 Division I Head Baseball Coaches. The survey requested their feedback on what represents a significant change in the five statistical categories used in the study. Furthermore, this study was based on information collected from individual Division I baseball programs, compiled by the NCAA on a daily, weekly, monthly and yearly basis. Baseball program statistics have been collected and archived by the NCAA since 1970. Advances in technology, especially the Internet, have allowed team output to become more accessible in a timely manner through the NCAA's official website. Additionally, a survey was distributed to all 275 Division I Head baseball coaches. The survey consisted of questions inquiring about what would be a significant flux, up or down, in the six dependent variables described earlier. Finally, archived offensive statistical information totaled yearly was supplied by the Director of Baseball and Football at the NCAA, Damian Leech.

Procedures

Data for this study were collected through responses gathered from the coaches survey as well as by using archival methodology. The data concerning past NCAA Baseball statistics were collected using the NCAA's official spring sport/baseball statistical website and information provided by Mr. Leech. The website and information includes all of the dependent variables selected and totaled in accordance with their respective year.

To determine if there was a significant difference in offensive statistics between the -3 length to weight ratio collegiate baseball bat compared to that of the -5 length to weight ratio collegiate baseball bat during the nine years prior 1999, archived information collected from the NCAA was compared to data gathered through the survey sent out to the 275 Division I baseball Head Coaches. Additionally, the same method of direct comparison was applied to examine the offensive production from the first year the -3 length to weight ratio collegiate bat was introduced through the past 2007 NCAA Baseball season. Finally, the information provided by the head coaches was used for comparison and applied in order to analyze the difference between the offensive productivity in college baseball between the 1998 college baseball season and the 1999 college baseball season.

Statistical Analysis

Due to the unique nature regarding what is considered a significant change in college baseball statistics, for each research question, significant difference does not refer to the typical "statistically significant" difference in the traditional research model. A significant difference for the purposes of this study is what is determined to be an important difference in selected offensive statistics from the perspective of NCAA Division I college baseball coaches. Although traditional data analysis may show that statistics are significant, it is the

opinion of the coaches of the game that determine whether any differences are actually important in the "real world".

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to explain the offensive statistical impact between the -5 length to weight ratio collegiate baseball bat and the -3 length to weight ratio collegiate baseball bat. There were a total of 275 Division I baseball programs during the time of the study. Each program had to abide by the same bat rule standards set forth by the NCAA regarding length to weight ratio. There were five offensive categories examined (batting average, runs per game, home runs, strikeouts per 9 innings, and earned run average). The subject time frames were split into two: 1991 through 1998 and 1999 through 2006. The statistics gathered from the two time periods were compared both on an annual basis within the eight years and subsequently as two eight-year units (before bat change and after bat change.)

Descriptive Statistics

The complete descriptive statistical breakdown for each of the sixteen years examined can be found in Tables 1, 3 and 4. Comparatively, Table 2 displays the descriptive statistics for the mean median, mode, middle, minimum and maximum found within the Division I NCAA College Baseball Coaches' Survey of what is a significant change.

Table 1 exhibits the statistics for each of the five categories as they were seen in the years prior to and after the bat change. The Batting Average variable for the first eight-year

frame examined ranged from .288 to .306. The year 1993 represents the lowest average, while 1998 shows the highest. The -3 Collegiate Baseball Bat time period yielded a mean Batting Average of .295 while the -5 Collegiate Baseball Bat period showed a .294 mean Batting Average. Additionally, the Batting Average variable for the second eight-year frame examined ranged from .290 to .303 with 2005 having the lowest and 1999 showing the highest statistical Batting Average year.

The total Runs Per Game variable for the first eight-year frame examined ranged from 6.08 to 7.12 with a mean of 6.45. The lowest total of Runs Per Game occurred in 1993, while 1998 yielded the highest Run Per Game total. The total Runs Per Game variable for the second eight-year frame examined ranged from 6.11 to 1999 with a mean of 6.37. The lowest total number of Runs Per Game occurred in 2003, while 1999 yielded the highest runs per game total.

The Home Run total variable for the first eight-year frame examined ranged from 0.680 to 1.060 with 1992 being the lowest and 1998 the highest. The mean for Home Runs during 1990-1998 was .789, while 1999-2006 revealed a mean of .785. The Home Run total variable for the second eight-year frame examined ranged from .680 to .950 with 2006 being the lowest and 1999 the highest.

The Strikeouts Per Nine Innings variable for the first eight-year frame examined ranged from 6.210 to 7.070, with 1991 showing the lowest and 1998 having the highest Strikeout Per Nine Inning total. The mean for the first eight years was 6.529 and 6.828 for the second eight years. The Strikeouts Per Nine Innings variable for the second eight-year frame examined ranged from 6.62 to 7.12 and showed 1999 having the lowest total and 2006 revealing the highest.

The Earned Run Average variable for the first eight-year frame examined ranged from 5.1 to 6.12 with 1992-93 having the lowest and 1998 showing the highest. The means for the two time periods were 5.398 and 5.410. Additionally, the Earned Run Average variable for the second eight-year frame examined ranged from 5.13 to 5.94 with 2005 having the lowest and 1999 showing the highest statistical batting average year.

	BATTING	RUNS PER	HOME	EARNED	STRIKEOUTS
	AVG	GAME	RUNS	RUN AVG	PER NINE
2006	0.291	6.15	0.68	5.14	6.62
2005	0.29	6.14	0.7	5.13	6.75
2004	0.291	6.17	0.77	5.29	6.86
2003	0.291	6.11	0.74	5.23	6.79
2002	0.296	6.45	0.83	5.49	6.84
2001	0.296	6.44	0.81	5.5	6.85
2000	0.297	6.53	0.8	5.56	6.79
1999	0.303	6.93	0.95	5.94	7.12*
1998	0.306*	7.12*	1.06*	6.12*	7.07
1997	0.304	7	0.96	5.93	6.94
1996	0.294	6.48	0.77	5.47	6.66
1995	0.289	6.2	0.7	5.19	6.49
1994	0.29	6.24	0.69	5.16	6.36
1993	0.288	6.08	0.72	5.1	6.27
1992	0.291	6.18	0.68	5.1	6.23
1991	0.294	6.3	0.73	5.11	6.21

FIGURE 3. Descriptive Statistical Offensive Breakdown

* Represents Record High

Significance

In order to answer the three hypotheses proposed, a direct comparison was used on the five dependent variables. The two time frames from 1990-1998 (time period one) and 1999-2006 (time period two) were directly compared to each other for each of the dependent variables. As well, during 1999-2006 the six dependent variables were compared to one another within that specific time frame. Statistical significance was first defined by gathering data from NCAA Baseball Coaches measuring what they would consider a significant increase or decrease in baseball statistics. Using those benchmarks as defined by coaches, the year-to-year numbers were deemed either statistically significant or not significant.

For each set of offensive statistics examined, 275 Division I Head Baseball Coaches were surveyed requesting their opinion of what variation up or down represented a significant change in each of the five offensive categories. The survey yielded a 16% response rate with the mean of each category stated in Table 2. For the purposes of this study, the Mean of the responses will be used to define a "significant change."

	BATTING AVG	RUNS PG	HOME RUNS	K'S PER 9	ERA
Min	0.005	0.25	1	0.25	0.075
Max	0.050	5.00	30	6.00	3.000
Mean	0.022	1.85	17.59	2.30	0.940
Median	0.020	2.00	20	2.00	1.000
Mode	0.020	2.00	20	2.00	1.000
Stand. Dev.	0.011	1.13	7.70	1.32	0.583

FIGURE 4. Division I Coaches Response Summary

*The numbers 25,25,30 and 50 were removed from K's Per 9 and ERA due to being unrealistic figures in the game of baseball.

Research question one asks if each offensive production statistic changed significantly from 1998 (last year with -5) to 1999 (first year with -3).

The results, outlined in Table 3, showed that no Division I College Baseball Statistical Changes between the 1998 and 1999 Seasons were significant. The changes in Batting Average (.003% decrease), Runs Per Game (.19 decrease), Home Runs Per Game (.11 decrease), Earned Run Average (.18) and Strikeouts Per Nine Innings (.05 increase) were not statistically significant. However, even though none of the changes between the 1998 and 1999 seasons' offensive categories examined were deemed statistically significant, it is notable that each of the three batting categories did drop and the two defensive pitching stats increased between the two years. Also notable is the fact that even though not significant statistically, 1998 represented the Highest National Batting Average, Highest Run total and the most Home Runs Per Game. Additionally, 1998 yielded the Highest National Earned Run Average since College Baseball started archiving national statistics in 1970, while 1999 represented the highest Strikeouts Per Nine Inning total.

Variable	1998	1999	Difference	Significant Change Value	Significant Change?
Batting Average	0.306	0.303	-0.003	.023	Ν
Runs Per Game	7.12	6.93	-0.19	2.7	Ν
Home Runs	1.06	0.95	-0.11	* .31	Ν
Earned Run Average	6.12	5.94	-0.18	.971	N
Strikeouts Per 9 Innings	7.07	7.12	0.05	#.099	N

FIGURE 5. Descriptive Statistical Offensive Breakdown (1998-1999 Sig. Change)

* value was figured by taking the coaches response for significant change in the number of home runs per season (17.1) divided by the number of games played in a regular season (56) # value was figured by taking the coaches response for significant change in the number of strikeouts per season (5.51) divided by the number of games played in a regular season (56)

Research hypothesis one stated that there was a significant difference in offensive statistics between the -3 length to weight ratio collegiate baseball bat compared to that of the -5 length to weight ratio collegiate baseball bat. Additionally, research hypothesis three stated that there is a significant difference between the offensive productivity seen in 1998 (the final year of the -5 bat) compared to offensive productivity displayed in 1999 (the first year of the -3 bat). However, according to the college coaches surveyed, even though there was a change seen between the two collegiate baseball bats the changes were not large enough to be considered significant in reality. Therefore, we reject the hypothesis that there will be a significant difference in offensive statistics between the -3 length to weight ratio collegiate baseball bat compared to that of the -5 length to weight ratio collegiate baseball bat and we reject the hypothesis that there is a significant difference between the offensive productivity seen in 1998 compared to the offensive productivity displayed in 1999.

Research question two asked if the eight-year mean for each offensive production statistic for 1999-2006 (-3 length to weight ratio collegiate bat) changed significantly from the eight-year mean for 1990-1998 (-5 length to weight ratio collegiate bat). The results of this study showed that the mean of some Division I College Baseball Statistical changes within the two eight-year means were not significant. As stated earlier, Table 4 shows the eight-year mean for each of the five categories (Batting Average, Runs Per Game, Home Runs Per Game and Earned Run Average) during the two nine year periods examined. Additionally, Table 4 shows the significant change value while stating if a significant change did or did not take place.

Variable	1991-1998 Average	1999-2007 Average	Difference	Significant Change Value	Significant Change?
Batting Average	0.295	0.294	-0.001	.023	N
Runs Per Game	6.450	6.370	-0.080	2.700	Ν
Home Runs	0.789	0.785	-0.004	* .310	N
Earned Run Average	5.398	5.410	0.012	.971	Ν
Strikeouts Per 9 Innings	6.529	6.828	0.299	# .099	Y

FIGURE 6. Descriptive Statistical Offensive Breakdown (Mean Sig. Change)

* value was figured by taking the coaches response for significant home runs per season (17.1) divided by the number of games played in a regular season (56) # value was figured by taking the coaches response for significant strikeouts per season

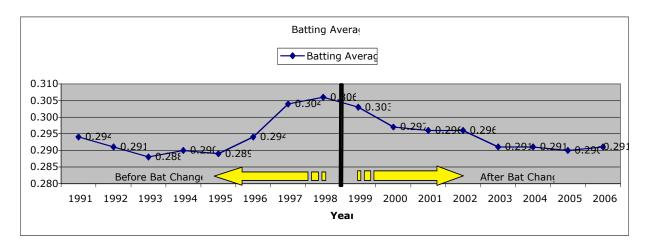
(5.51) divided by the number of games played in a regular season (56)

Research Question Three asked the question if the trend lines of each of the five categories showed a change in offensive production. Charts 4-1 through 4-5 show these trend lines as they are applied to each of the five categories.

Table 4 shows that the -3 length to weight collegiate bat Batting Average mean was .294 while the -5 length to weight collegiate bat Batting Average mean was .295. College coaches' stated that a .023 change in Batting Average represented a significant change in reality, thus concluding that the eight-year mean of the two bats did not reveal an offensive statistical change.

Chart 4-1 represents the trend line of collegiate baseball batting averages from 1991-2006. The trend line shows a 1991 collegiate batting average of .294 and a 2006 batting average of .291. Since 1991, the -5 time period, the batting average had a steady climb until reaching its pinnacle of .306 in 1998. Also, it is notable that 1998 set the NCAA single season batting average record. Post 1998, the -3 time period, the collegiate batting average had a steady decline until reaching the end of the study in 2006. Therefore, by looking at the years from 1991-1995 and 2003-2006 it can be seen that the two trend lines have reached somewhat of a resemblance. Concluding, in reference to collegiate batting averages, the equipment regulation change from the -5 length to weight collegiate baseball bat and the -3 length to weight collegiate baseball bat has successfully leveled off college baseball offensive production.

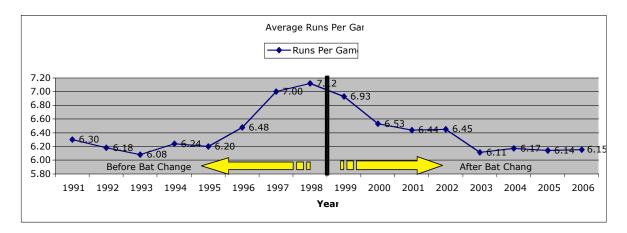




The second statistical category looked at was Runs Per Game. Table 4 shows that the -3 length to weight collegiate bat Runs Per Game mean was 6.37 while the -5 length to weight collegiate bat Runs Per Game mean was 6.45. College coaches' stated that a 2.7 change in Runs Per Game represented a significant change in reality, thus concluding that the eight-year mean of the two bats did not reveal an offensive statistical change.

Chart 4-2 shows the trend line of collegiate baseball runs per game from 1991-2006. The trend line shows the 1991 collegiate runs per game average of 6.30 and a 2006 runs per game average of 6.15. The 1998 season represented an NCAA record in runs scored per game with a mark of 7.12, the result of a steady climb in production seen from 1992 up until that point. After 1998, the -3 time period, the collegiate runs-per game average has been on a steady decline until reaching the end of the study in 2006. Therefore, by examining the years from 1991-1995 and 2001-2006 it can be seen that the two trend lines share similarities. Concluding, in reference to collegiate runs scored per game, the equipment regulation change from the -5 length to weight collegiate baseball bat and the -3 length to weight collegiate baseball bat has successfully leveled off college baseball offensive production.





The third statistical category looked at was Home Runs Per Game. Table 4 shows that the -3 length to weight collegiate bat Home Runs Per Game mean was .785 while the -5 length to weight collegiate bat Home Runs Per Game mean was .789. College coaches' stated that a .31 change in Runs Per Game represented a significant change in reality, thus concluding that the eight-year mean of the two bats did not reveal an offensive statistical change.

Similar to the previous charts, Chart 4-3 displays the trend line of collegiate baseball homeruns from 1991-2006. The home run trend line shows a 1992 collegiate homerun average of .730 homeruns per game and a 2006 homerun average of .680 homeruns per game. Since 1991, the -5 time period, the batting average had a steady climb until reaching its peak of 1.06 in 1998. In 1998, the mark of 1.06 home runs per game set the NCAA single season record for home runs per game. Post 1998, the -3 time period, the collegiate batting average had a steady decline until reaching the end of the study in 2006. Similar to the trend displayed with batting average, by looking at the years from 1991-1996 and 2001-2006 it can be seen that the two trend lines have reached somewhat of a resemblance. Therefore,

regarding collegiate home runs, the equipment regulation change from the -5 length to weight collegiate baseball bat and the -3 length to weight collegiate baseball bat has successfully leveled off college baseball offensive production.

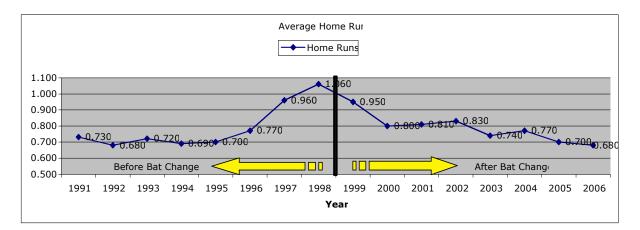


FIGURE 9. Average Home Runs Trend Line

The fourth statistical category looked at was Earned Run Average. Table 4 shows that the -3 length to weight collegiate bat Earned Run Average mean was 5.41 while the -5 length to weight collegiate bat Earned Run Average mean was 5.40. College coaches' stated that a .971 change in Runs Per Game represented a significant change in reality, thus concluding that the eight-year mean of the two bats did not reveal an offensive statistical change.

Looking at baseball's offense from a pitching standpoint, Chart 4-4 displays the trend line of collegiate baseball earned run averages (ERA) from 1991-2006. The ERA trend line shows a 1991 collegiate ERA of 5.10 and a 2006 ERA of 5.14. Since 1992, the -5 time period, ERA's have gone up until reaching a new NCAA all time high of 6.12 in 1998. After 1998, the -3 time period, the collegiate batting average had a steady decline until reaching the end of the study in 2006. Similar to the other trend lines displayed, ERA's from 1991-1995 and 2003-2006 have reached a resemblance. Therefore, regarding college ERA's, the

equipment regulation change from the -5 length to weight collegiate baseball bat and the -3 length to weight collegiate baseball bat has successfully leveled off college baseball offensive production.

FIGURE 10. Earned Run Average Trend Line

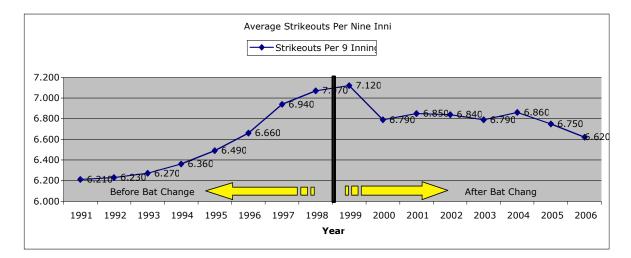


The fifth statistical category examined was Strikeouts Per Nine Innings. Table 4 shows that the -3 length to weight collegiate bat Strikeouts Per Nine Innings mean was 6.828 while the -5 length to weight collegiate bat Strikeouts Per Nine Innings mean was 6.529. Using what number College coaches' deemed significant in reality for strikeouts in a season divided by the number of regular season games played in a college season, a .099 change in Strikeouts Per Nine Innings represented a significant change. Therefore, the eight-year mean of the two bats did reveal an offensive statistical change.

The thought behind examining this statistic came with the expectation that if an equipment change intended to weaken offense it would in turn benefit pitching. Chart 4-5 displays the trend line of strikeouts per nine innings seen from 1991-2006. The strikeouts per nine innings trend line shows a 1991 collegiate strikeout per nine inning average of 6.21 and a 2006 strikeouts per nine innings average of 6.62. These two numbers display a change that

benefited pitching while the trend line also shows an all time high of strikeouts per nine innings in 1999 of 7.12 per game. Even though not as close in relationship as the previous four charts, an increase in numbers occurs up until 1998 and then a decrease with a flattening out pattern occurring toward the tail end of the study. Therefore, regarding college baseball's strikeouts per nine innings average, the equipment regulation change from the -5 length to weight collegiate baseball bat and the -3 length to weight collegiate baseball bat has successfully leveled off college baseball offensive production.

FIGURE 11. Average Strikeouts Per Nine Innings Trend Line



Research hypothesis two stated that there is a significant increase in offensive statistical output from the time the -3 length to weight ratio collegiate baseball bat was introduced compared to the past 2006 NCAA Baseball season. Charts 1-5 represent the trend lines for each of the 5 statistical categories during the two bat periods. Following the trend lines from 1999-2006 there is no significant increase in any of the statistical categories examined. Therefore, we reject the hypothesis that there is a significant increase in offensive statistical output from the time the -3 length to weight ratio collegiate baseball bat was introduced compared to the past 2006 NCAA Baseball season.

Charts 4-6 through 4-10, displayed below and pulled from Table A-4, go into a bit more detail with the offensive statistical output for the 16 year time period. The charts show each one of the offensive categories examined with the specific numerical change from year to year. The changes in these trend lines reveal that the years most closely surrounding the bat change had the greatest jumps in numbers. This phenomenon would lead to the assumption that the NCAA has accomplished it's goal with the leveling of changes as time gets further from the bat-change year.

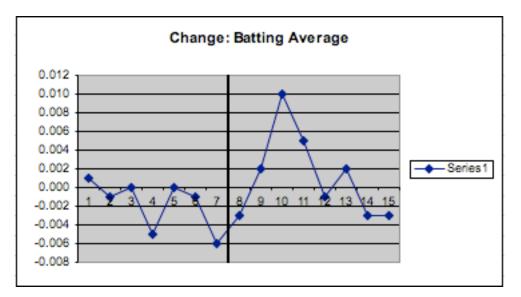


FIGURE 12. Batting Average Year to Year Change

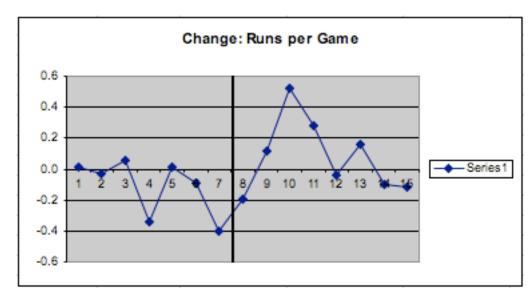


FIGURE 13. Runs Per Game Year to Year Change

FIGURE 14. Home Runs Per Game Year to Year Change

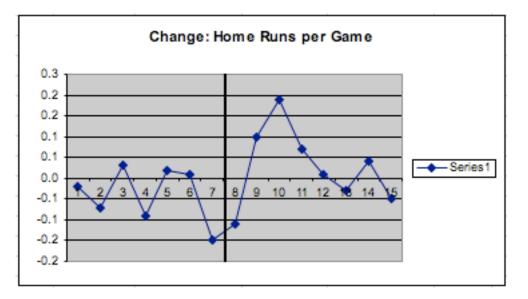


FIGURE 15. Earned Run Average Year to Year Change

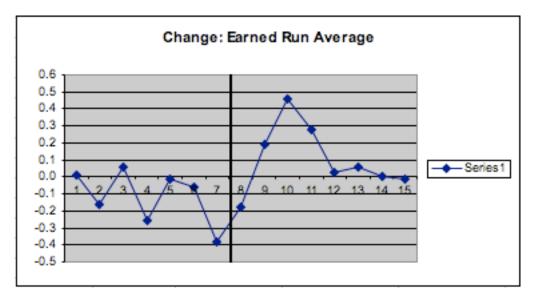
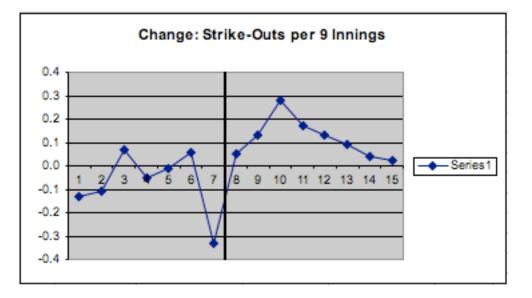


FIGURE 16. Strikeouts Per Nine Innings Year to Year Change



CHAPTER V

DISCUSSION

Introduction

From the data collected and the results of the direct comparison between the five offensive categories during the college baseball time period from 1991 to 2006 there is an abundance of information showing the statistical impact displayed between the -5 length to weight ratio collegiate baseball bat and the -3 length to weight ratio collegiate baseball bat. In baseball, where mere tenths of points can be the results of numerous at bats, hits or pitches, defining significance from a statistical standpoint can be difficult. However, when looking at each offensive category individually and comparing them using graphs and charts within the two time periods, the impact of the two bats and their effect on the collegiate game of baseball can be seen and measured.

As discussed in chapter one, when the NCAA made the new rule regulating the size, weight and batted ball exit speed of collegiate baseball bats they cited the explosive increase in offensive production as the reason for the change. The hope for the new rule was that a standard metal bat with specific restrictions would react more similarly professional wood bats and thus reduce or level the increasing offensive numbers produced in college baseball. The basic research question of the study asks if there is a difference in selected offensive production statistics between those observed with the -5 bat (1990-1998) and those observed with the -3 bat (1999-2006)? Specifically, three other questions were addressed in attempts to answer if the -3 collegiate bat had the desired effect the NCAA had hoped for with the

change. The third question, referring to the direct comparison of the two bats individual time frame, is the one that best helps display and explain exactly what kind of impact the new bat specification has had on college baseball over the past seven years. Additionally, even though the means of the two eight year time periods are not shown (Research Question One), the trend lines displays Research Question Two, thus showing the last year of the -5 length to weight collegiate baseball bat (1998) compared to the first year of the -3 length to weight collegiate baseball bat (1999).

At the conclusion of the study, it was anticipated to find a dramatic decrease in each of the statistical categories examined during the merge of the two time periods. After the decrease, during the period of the -3 length to weight collegiate baseball bat, it was also anticipated that the numbers would gradually increase from year to year until eventually flattening back into a trend found in the early 1990's and the -5 length to weight collegiate baseball bat. However, what was seen through the trend lines, was a gradual increase to a peak (the final year of the -5). Then, instead of a dramatic drop in production, a gradual decrease into almost mirror like time period numbers was displayed with leveling on both ends. Speculation could point to the minute change in bat standards creating a situation where the statistics changed gradually to level off in the latter years of the study.

Recommendation for Further Study

The concern of the NCAA was the offensive explosion seen in the 1998 season and an increasing trend in offensive numbers leading up to that 1998 season. As well, with increased offensive numbers and better bat technology came the NCAA's fear of

injuries due to increasing batted ball exit speeds. Table 5-1 represents additional factors that the Division I NCAA Baseball Coaches' deemed possible factors that could also be represented as significant to the increase in college baseball's offensive production. The factors are sorted according to the number of coaches claiming significance as well as to the degree of significance compared to that of the equipment change.

FIGURE 17. Additional Offensive Factors

ADDITIONAL FACTORS LEADING TO OFFENSE PRODUCTION IN COLLEGE
BASEBALL

SIGNIFICANTLY:	SAME	GREATER	LESS
FACTOR:			
STRENGTH AND COND.	3 coaches	1 coach	
BASEBALLS			1 coach
MLB DRAFTING LESS H.S. PLAYERS			1 coach
STERIODS			1 coach
K ZONE			3 coaches
BAT DIAMETER			1 coach
ALLOY CHANGE			1 coach
SCHOLARSHIP REDUCTION			1 coach
BETTER PITCHING		1 coach	
MORE 9 INN GAMES		1 coach	

Due to the limitations placed on the current study, the first change that could help future research and studies would be to release the same survey to College coaches during their fall season. The fall season is more practice and recruiting based and does not pose the distractions of games that could have possibly been a time deterrent causing coaches not to complete the initial study survey.

As well, other studies examining college baseball's offensive numbers could go back further in College Baseball's statistical archives and continue to compare numbers seen in the past to those that continue in the future. Similar studies comparing time periods and equipment changes could be conducted by narrowing the population from a national scale down to a regional, conference, or individual team. Additionally, the categories could be narrowed by taking each one individually and looking at them over the history of the NCAA referencing specific time periods where changes have taken place that could have as well influenced statistical change.

Future studies that could be conducted regarding the NCAA's bat regulation change would be to investigate injuries relating to the two bat's time periods. Citing the safety issue the NCAA suggested upon making the rule change from the -5 collegiate baseball bat to that of the -3 collegiate baseball bat, a study focusing on the injury aspect of the change could be conducted. The study could be simple, only referencing injuries occurring prior and post the change. However, an injury study could become much more specific tracking baseball hits, ground balls, fly balls and line drives and relating those results to those hits resulting to players hit, injured or hit and injured. An injury study could provide data perhaps not as much relating the two bats but more on lines of current player safety.

Finally, building off of the current study, additional information could be gathered focusing on the trend lines of the offensive statistics examining why the dramatic climb and decline in the numbers. As well, the question could be raised and answered of how

and why each of the trend lines for each of the time periods seem to level off and mirror one another.

Conclusion

1998 represented a pivotal year in the eyes of the NCAA. The year yielded records in four statistical categories at the end of the playing season and represented a year where 32 offensive records were broken during the NCAA Men's Baseball College World Series. With offensive numbers reaching all time highs and batted ball exit speeds reaching up to 110 mph, the NCAA stepped in to make a change in equipment, thus collegiate baseball bats. This study investigated the relationship between the -5 length to weight collegiate baseball bat and the last seven years prior to its ban by the NCAA, with that of the -3 length to weight collegiate baseball bat and its first seven years since the NCAA put in their new bat standards. Additionally, the study asked the question if the bat change had the desired effect of the NCAA by limiting the offensive numbers seen leading up to the 1998 season. The study included 275 Division I Baseball Programs and investigated five baseball statistical categories. The results indicated separate means for the two seven year time periods examined as well as a difference in statistical numbers between 1998 (the last year of the -5 bat) and 1999 (the first year of the -3 bat). However, the trend lines that were revealed by the five categories show similarities between the first years of the study and the final years of the study. These similarities show that even though reaching a peak and an eventual decline, as seasons have passed on and the bats have had a chance to make their mark, college baseball's statistical numbers have leveled off back to a standard seen prior the explosion of the -5 collegiate

baseball bat. In conclusion, the NCAA's equipment change set forth in 1999 regulating size and batted ball exit speed of collegiate baseball bats has resulted in the desired effect by balancing out offensive production within college baseball.

APPENDIX A

FIGURE 18 Year by Year Offensive Changes 1991-1998

Variable	Year	Ν	Average
Batting Average	1991	319	0.294
	1992	319	0.291
	1993	319	0.288
	1994	319	0.290
	1995	319	0.289
	1996	319	0.294
	1997	319	0.304
	1998	319	0.306
Runs Per Game	1991	319	6.30
	1992	319	6.18
	1993	319	6.08
	1994	319	6.24
	1995	319	6.20
	1996	319	6.48
	1997	319	7.00
	1998	319	7.12
Home Runs	1991	319	0.73
	1992	319	0.68
	1993	319	0.72
	1994	319	0.69
	1995	319	0.70
	1996	319	0.77
	1997	319	0.96
	1998	319	1.06
Earned Run Average	1991	319	5.11
	1992	319	5.10
	1993	319	5.10
	1994	319	5.16
	1995	319	5.19
	1996	319	5.47
	1997	319	5.93
	1998	319	6.12
Strikeouts Per 9 Innings	1991	319	6.21
	1992	319	6.23
	1993	319	6.27
	1994	319	6.36
	1995	319	6.49
	1996	319	6.66
	1997	319	6.94
	1998	319	7.07

FIGURE 19 Year by Year Offensive Changes 1999-2006

Variable	Year	Ν	Average
Batting Average	1999	319	0.303
2 2	2000	319	0.297
	2001	319	0.296
	2002	319	0.296
	2003	319	0.291
	2004	319	0.291
	2005	319	0.290
	2006	319	0.291
Runs Per Game	1999	319	6.93
	2000	319	6.53
	2001	319	6.44
	2002	319	6.45
	2003	319	6.11
	2004	319	6.17
	2005	319	6.14
	2006	319	6.15
Home Runs	1999	319	0.95
	2000	319	0.80
	2001	319	0.81
	2002	319	0.83
	2003	319	0.74
	2004	319	0.77
	2005	319	0.70
	2006	319	0.68
Earned Run Average	1999	319	5.94
	2000	319	5.56
	2001	319	5.50
	2002	319	5.49
	2003	319	5.23
	2004	319	5.29
	2005	319	5.13
	2006	319	5.14
Strikeouts Per 9 Innings	1999	319	7.12
	2000	319	6.79
	2001	319	6.85
	2002	319	6.84
	2003	319	6.79
	2004	319	6.86
	2005	319	6.75
	2006	319	6.62

FIGURE 20 NCAA Offensive Statistical Results

Average	es are per g	ame for each					1000		
		Avg.	Batting		Home Runs		Earned-Run	Strikeouts	Fielding
Year	Teams t	Games %	Average	Scoring	Per Game	Per Game	Average	Per 9 Innings	Percentage
1970	181	# 32.8	#.262	# 4.96	# 0.4	1.15	# 3.34	6.77	.948
1971	192	34.4	.267	5.28	0.46	1.16	3.47	6.92	.948
1972	202	34.1	.266	5.01	0.44	# 1.09	3.35	6.69	.949
1973	203	34.0	.266	5.07	0.42	1.13	3.46	6.60	.949
1974\$	187	38.4	.274	5.33	0.49	1.24	3.79	5.94	.949
1975	168	39.0	.273	5.38	0.50	1.30	3.76	6.13	.950
1976	194	41.9	.282	5.65	0.55	1.45	3.91	6.02	.950
1977	210	42.5	.286	5.83	0.62	1.34	4.22	6.11	.948
1978	213	42.9	.288	6.08	0.66	1.39	4.37	5.97	.947
1979	220	43.6	.289	6.09	0.62	1.49	4.42	5.72	.948
1980	211	44.6	.295	6.22	0.66	1.36	4.59	5.60	.948
1981	237	48.4	.300	6.52	0.74	1.49	5.05	# 5.51	# .946
9182	222	46.8	.298	6.39	0.69	* 1.52	4.95	5.56	.948
1983	225	44.8	.298	6.44	0.89	1.48	5.02	5.73	.948
1984	240	48.3	.295	6.41	0.78	1.42	5.06	5.94	.948
1985	250	51.9	.306	6.94	0.92	1.47	5.51	5.96	.948
1986	254	50.0	.301	6.79	0.89	1.48	5.42	6.10	.947
1987	263	48.9	.299	6.72	0.89	1.45	5.38	6.19	.949
1988	266	51.2	.297	6.53	0.84	1.38	5.29	6.28	.950
1989	259	49.9	.298	6.15	0.67	1.40	4.94	6.22	.953
1990	256	52.0	.290	6.07	0.66	1.41	4.88	6.09	.952
1991	262	52.6	.294	6.30	0.73	1.36	5.11	6.21	.952
1992	268	50.8	.291	6.18	0.68	1.36	5.10	6.23	.954
1993	271	50.1	.288	6.08	0.72	1.37	5.10	6.27	.953
1994	273	51.9	.290	6.24	0.69	1.36	5.16	6.36	.952
1995	271	53.1	.289	6.20	0.70	1.30	5.19	6.49	.953
1996	271	52.3	.294	6.48	0.77	1.30	5.47	6.66	.952
1997	273	53.1	.304	7.00	0.96	1.26	5.93	6.94	.951
1998	273	52.4	* .306	* 7.12	* 1.06	1.29	* 6.12	7.07	.952
1999	274	54.9	.303	6.93	0.95	1.30	5.94	* 7.12	.952
2000	281	54.8	.297	6.53	0.80	1.29	5.56	6.79	.954
2001	280	54.9	.296	6.44	0.81	1.24	5.50	6.85	.955
2002	282	55.1	.296	6.45	0.83	1.22	5.49	6.84	.955
2003	284	53.8	.295	6.11	0.83	1.15	5.23	6.79	.958
2003	285	55.3	.291	6.17	0.77	1.14	5.29	6.86	.959
2005	* 283	55.1	.290	6.14	0.70	1.19	5.13	6.75	.959
2005	* 285	* 56.2	.290	6.15	0.68	1.17	5.13	6.62	* .960
								bers of games p	

Division I Baseball Statistics Trends (1970-2006)

† Teams reporting statistics, not necessarily the total number of teams in the division; % Average numbers of games played by each team that year. \$ First Year Aluminum Bat; * Record high; # Record Iow.

	BATTING AVG	Change from Previous Year	RUNS PER GAME	Change from Previous Year	HOME RUNS	Change from Previous Year	EARNED RUN AVG	Change from Previous Year	STRIKEOUTS PER NINE INN	Change from Previous Year
2006	0.291	0.001	6.2	0.0	0.7	0.0	5.1	0.0	6.6	-0.1
2005	0.290	-0.001	6.1	0.0	0.7	-0.1	5.1	-0.2	6.8	-0.1
2004	0.291	0.000	6.2	0.1	0.8	0.0	5.3	0.1	6.9	0.1
2003	0.291	-0.005	6.1	-0.3	0.7	-0.1	5.2	-0.3	6.8	0.0
2002	0.296	0.000	6.5	0.0	0.8	0.0	5.5	0.0	6.8	0.0
2001	0.296	-0.001	6.4	-0.1	0.8	0.0	5.5	-0.1	6.9	0.1
2000	0.297	-0.006	6.5	-0.4	0.8	-0.2	5.6	-0.4	6.8	-0.3
1999	0.303	-0.003	6.9	-0.2	1.0	-0.1	5.9	-0.2	7.1	0.0
1998	0.306	0.002	7.1	0.1	1.1	0.1	6.1	0.2	7.1	0.1
1997	0.304	0.010	7.0	0.5	1.0	0.2	5.9	0.5	6.9	0.3
1996	0.294	0.005	6.5	0.3	0.8	0.1	5.5	0.3	6.7	0.2
1995	0.289	-0.001	6.2	0.0	0.7	0.0	5.2	0.0	6.5	0.1
1994	0.290	0.002	6.2	0.2	0.7	0.0	5.2	0.1	6.4	0.1
1993	0.288	-0.003	6.1	-0.1	0.7	0.0	5.1	0.0	6.3	0.0
1992	0.291	-0.003	6.2	-0.1	0.7	0.0	5.1	0.0	6.2	0.0
1991	0.294		6.3		0.7		5.1		6.2	
High	0.306		7.1		1.1		6.1		7.1	
Low	0.288		6.1		0.7		5.1		6.2	
Diff	0.018		1.000		0.400		1.000		0.900	

FIGURE 21. Year to Year Changes in Offensive Production

APPENDIX B

Email Letter to Div. I Baseball Coaches

Coach,

My name is Jason Howell, and I am the pitching coach at the University of North Carolina at Wilmington (UNC-W). Prior to my position at UNC-W, I served as the 3rd assistant at the University of North Carolina at Chapel Hill (UNC-CH) where I had the opportunity to learn in an excellent baseball environment. While at UNC-CH I enrolled in the Masters Degree program in Exercise and Sport Science, specializing in Sport Administration. I am now in the final phase of that degree program with only my research thesis left to complete... and it is with that project I seek your help.

Being a Division I collegiate baseball coach, I understand the time restrictions under which we constantly find ourselves. Therefore, what I ask of you should take no more than ten minutes of your time, it will not require you to look up, locate or find any information, and I think the findings will be of interest to you and all collegiate baseball coaches. To join the study is voluntary. Although there are no risks associated with participating in this study, you may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty. If you are a UNC employee, taking part in this research is not a part of your University duties, and refusing will not affect your job. You will not be offered or receive any special job-related consideration if you take part in this research.

The basic purpose of my research is to determine if the 1999 NCAA rules change from the -5 bat to a -3 bat had a significant impact on selected offensive college baseball statistics. While the notion of "statistical significance", derived mathematically and based upon laws of probability, is commonly applied to research analyses, I am most interested in significance, in the sense of importance, in the real world of collegiate baseball. With your knowledge and experience, along with 318 other coaches, you can help me determine what is indeed important. These findings can benefit us by learning the effects that bat-changes can have on offensive production.

Below is a link to an online secured survey service called Survey Monkey. This service hosts a survey which requires simple responses to only six questions about **team offensive production** numbers. Your responses will play a major role in my research, the results of which should be of interest and helpful to collegiate baseball coaches. If you're interested in the results, please include your email address and you can expect that I will send you any findings as a result of this study.

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact me as listed below. All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

In order to participate in this study, please click on the link below, which indicates that you consent to participating in this study: Thank you very much for your time.

Jason Howell, Pitching Coach The University of North Carolina at Wilmington Wilmington, NC <u>howellja@uncw.edu</u> 919-306-6109

Faculty Advisor: Ed Shields, UNC-CH

"I have read the information provided above. I have asked all the questions I have at this time. By clicking on the link below, I voluntarily agree to participate in this research study." <u>http://www.surveymonkey.com/s.aspx?sm=LxvhnCYCjtBdR54_2bkYPxQw_3d_3d</u>

APPENDIX C

Survey Questions Sent to Division I Coaches

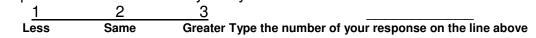
- 1. <u>Team Batting Average</u>: How many points (up or down) represent a significant, important change from one year to the next? _____
- 2. <u>Team Average Runs Per Game:</u> How many runs scored per game (up or down) represent a significant change from one year to the next?
- 3. <u>Team Home Runs:</u> How many Home Runs (up or down) represent a significant change from one year to the next? _____
- 4. <u>Team Slugging Percentage</u>: How many points (up or down) represent a significant change from one year to the next? _____
- 5. <u>Team Strike Outs Per 9 Innings</u>: How many strike outs (up or down) represent a significant change from one year to the next? _____
- 6. <u>Team Pitching ERA</u> How many points (up or down) represent a significant change from one year to the next? _____
- 7. Change/Factor:

Compared to the -5 to -3 bat change in 1999, the Impact of this change on the offensive production statistics in my study was:



8. Change/Factor:

Compared to the -5 to -3 bat change in 1999, the Impact of this change on the offensive production statistics in my study was:



9. Change/Factor:

Compared to the -5 to -3 bat change in 1999, the Impact of this change on the offensive production statistics in my study was:

 1
 2
 3

 Less
 Same
 Greater Type the number of your response on the line above

APPENDIX D

FIGURE 22 Results of Co BATTING	ollege Coaches' Sui	HÔME			
AVG	RUNS PG	RUNS	SLUG PER	K'S PER 9	ERA
0.05	4	10	0.1	6	2
0.025	2.5	25	0.1	5	1
0.01	2	20	0.1	3	- 1
0.015		15	0.05	3	0.75
0.05	30	20	0.01	3.5	2
0.025	3	20	0.075	3	1.5
0.04	2	1.5	0.1	2	0.5
0.01	2	20	0.015	50	0.5
0.02	0.5	20	0.05	2	50
0.025	1	20	0.075	4	0.5
0.015	2	1	0.05	2	1.5
0.015	1.5	1	0.02	1.5	0.5
0.03	2	25	0.075	1	1
0.02	1.5	25	0.08	3	1.5
0.03	2	20	0.05	2	0.5
0.04	3	20	0.1	5	2
0.01	0.5	10	0.1	2	0.5
0.015	5	15	0.1	5	3
0.025	0.25	7	0.025	0.25	0.25
0.02	3	15	0.045	3	1
0.005	0.5	8	0.01	2	0.33
0.03	4	25	0.05	5	0.75
0.015 0.03	1.5 0.5	15 25	0.05 0.15	1.5 2	1 0.075
0.03	2	15	0.04	3	1
0.05	1	20	0.075	1	1
0.025 0.03	2	30 20	0.03 0.01	2	1
0.012	4.5	20	0.15	3	0.25
0.02 0.02	2	15 15	0.5 0.05	2 50	1
0.025	2	20	0.5	2	1.5
0.02	2	20	0.1	3	1.5
0.04 0.02	3	25 20	0.075 0.05	2.5	1
0.02	2.5	20	0.03	2.5	1 1.5
0.02	0.75	20	0.04	3	0.5
0.01	0.5		0.02	2	0.5
0.02 0.025	1.5 2	20	0.03 0.04	2	0.6 1
0.025	2	30	0.1	2	2
0.01	3	10	0.02	25	1
0.023380952	2.707317073	17.1375	0.085952381	5.506097561	0.971346154

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