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Mathematical applications

in sport

Research Project

Submitted to the Council of the College of Mathematic department at Salahaddin University-Erbil in Partial Fulfilment of the Requirements for the Degree of BSc.in Mathematic

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‘In the name of God the Merciful’ ‘Oh Allah, Increase in Knowledge’

Quran: Surah Taha 20:114

Certification

I certify that this project was prepared under my supervision at the Department of Mathematic, College of education, Salahaddin University in partial requirements for the degree

Supervisor

Assist. Lect. Suham Hamad Awla

"In view of the available recommendations, I forward this project for debate by the examining committee."

Assist. Lect. Suham Hamad Awla

College of education

Department of Mathematic department

Salahaddin University

Date:

Dedication

This paper is lovingly dedicated to our respective parents who have been constant source of inspiration. They have given us the drive and discipline to tackle any task and determination.

Without their love and support this project would have never been made possible.

Acknowledgements

We would like to acknowledge our gratitude for our supervisor, dr. Suham Hamad Awla, who has made the completion of this research possible and who has helped us the most throughout our project.

A special thank of ours goes to the teaching staff of our department starting from the head of department dr. Rashad rashed haje and the respectful others for their vital encouragement and support, their understanding and assistance, the constant reminders and much needed motivation, and for the help and inspiration they extended.

At last, but not the least, we would like to acknowledge our heartfelt gratitude and deep thanks to our families and friends who encouraged us.

Abstract

Mathematics as a subject is necessary at all stages because it plays an important role in the curriculum and subjects in schools and sports. In order to give a practical approach to mathematics and improve the quality of games. Mathematics plays a huge role in sports performance. Coaches keep trying. find ways to get the most out of their athletes, and sometimes they turn to math for help, This grant may include the best batting order for a team to maximize the number of hits it can score, the advantage of a scoring bonus when these jumps are made later in a program when fatigue There are also math problems inherent in the scoring system for some, The complex and subjective aspects of scoring in sporting events, Physical education is one component Public education as necessary for the development of physical instincts in human beings. He will be physically sound He will be mentally alert and healthy and will be more attractive in all walks of life, that's fine It is an established fact that no faculty of education can be considered modern unless it provides Physical Education Program, determined by physical events such as goals scored or the number of baskets made by the team or crossing the finish line in athletics and so on, Basketball players make use of many geometries Concepts.

Key word: mathematics, sport, physical education, games, basketball,

List of Content

Section one

Introduction

Everywhere we look, mathematics is there in our daily lives, whether it be in the form of basic addition or intricate algebra. Mathematics is used in many other professions, including sports and interior design as well as architecture. (Cairns,2000) This paper includes teaching resources that are especially focused on the idea of mathematics in sports, together with information on how to include this subject in the secondary education curriculum. One of the most difficult things about teaching, in my opinion, is connecting the content to the experiences of the students by using real-world situations. (Cairns,2000)

Higher level thinking and increased student involvement are therefore dependent on finding ways to connect the curriculum to the students' daily experiences and encouraging them to investigate applications in the real world. This lesson's objective is to help students understand and apply the Pythagorean, (Cairns,2000) Theorem by using it to relate to the dimensions of a baseball field and, subsequently, other sports fields and courts. A further way to extend this lesson is to investigate the projectile motion, acceleration, and velocity of baseballs, basketballs, and footballs. (Cairns,2004)

Original research on an aspect of sport through the lens of mathematical analysis. Topics may include but are not limited to team and player evaluations, officiating and adjudication of fairness, comparisons within and between conferences, use of technology to promote performance or health and safety, Education: Using sport to help promote understanding of mathematical concepts (Bray ,2003)

Section two
Mathematics and games

Mathematics plays a very important role in sports. While discussing a player's statistics, a coach's formula for drafting certain players, mathematics is involved. Even concepts such as the likelihood of a particular athlete or team winning, such case of probability, and maintain equipment are mathematical in nature. Let's begin by looking at the throwing of a basketball. (Saucier,2005)

If his throw is too high or too low, then it is a ball and the better still has at least three more opportunities to hit the ball. Similarly, when the batter hits the ball, he wants to hit the ball so that it will be as far away from any of the other players as possible if not outside of the ball field itself. The speed and height of the ball must be considered by the player to ensure that they will throw it properly. (Ratner,2011)The objective of the player is to shoot a ball through a hoop 46cm in diameter and 10 feet high at each end. To find out the velocity of the ball at which a player would need to throw the ball in order to make the basket we should find out the range of the ball when it is thrown at a 450 angle. Finally, in this paper we discuss about the applications and significance of Mathematics in various Sports and Games. (Ratner,2011)

The Sports and Games Department is responsible for the provision of recreational and competitive sports for both students and the members of staff in the university. The services in the Department of Sports and Games are a concerted effort of the technical (Games tutors and Coaches) and the administrative staff, as well as the other stakeholders. (Sargeant,2004)

Sports and Games Department offers an array of disciplines namely: rugby, basketball, handball, hockey, netball, tennis, athletics, swimming, table tennis, scrabble, and chess, swimming, cross country, taekwondo, karate, karate, cricket, and tug of war. These disciplines are replicated in all the colleges for effective and efficient services to our customers. (London,2006)

Mass participation in sports is encouraged through fun activities as well as intramurals which include inter-years, inter-halls, and inter-faculty sports competitions. The inter-campus build-up games and competitions form the baseline for competitive sports in the university.

On competitive performance, the Games tutors and the coaches continue to be instrumental in identifying and nurturing sports talent leading to exemplary performance in the national, regional and continental competitions. Athletes who qualify for world university games are immensely exposed to global competitions.(Schnall,2010)

MANDATE:

- To provide efficient and effective quality sport and recreational programmers for students at both Campus and University levels at recreational and competitive levels.
- To develop, expand and renovate Sports facilities and equipment.
- To maintain state-of-the-art sports facilities and equipment.
- To identify and nurture talents, train and coach sports techniques.
- To provide relevant information on the importance of exercise to staff and students.
- To provide innovative Sports services to students and staff in order to maximize their productivity, enhance teaching and learning and improve the quality of research.
- To advise the University in all matters related to Sports and Games services and infrastructure, development and implementation of the Sports and Games policy; and the general sports and games strategic direction in relation to the University's vision and mission. .(Schnall,2010)

directly to those who need it most.

We'll work closely with the government, dental and health professionals, manufacturers, the dental trade, national and local agencies, and the public, to achieve our mission of addressing the inequalities which exist in oral health, changing people's lives for the better. .(Schnall,2010)

Section three
Mathematics in playing tennis

Analyzing both types of tennis launchers it can be stated that better parameters and a greater control potential have mechanical launchers. The launching mechanism in the form of two rollers provides a great repeatability, increases the initial velocity and makes it possible to smoothly and accurately control the flying velocity of the ball. It can also spin the ball in a required manner. Mechanical launchers can control the throw better; in case of pneumatic machines the ball hit by the air jet rolls inside the outlet tube in an unpredictable manner. This introduces many problems making it difficult to control the throw and the flight of the ball and resulting in worse accuracy and repeatability of pneumatic machines. (Sayers, 1999).

To the authors' knowledge there are hardly no research articles concerning the problem of designing tennis ball launchers. Existing reports focus mainly on the aerodynamics of different flying sport balls (Alam, 2007), especially on the problem of calculating the Magnus force, determining drag and lift coefficients or on the problems of hitting or bouncing the ball in a required manner (Sayers, 1999). That is why we decided to create a simple mathematical model of the mechanical tennis launcher, to simulate its behavior, and establish the main principles of their designing.

The aim of the present work is to analyze the possibilities of improving the performance and training possibilities of mechanical launchers. By studying the mathematical basis of the throw and the flight of the ball the initial parameters for the required trajectory are determined. The parameters include: initial elevation and heading angles, rollers angle, rotational speeds and powers of the motors driving the rollers. These can be very helpful for the design of the new mechanical tennis ball launcher. (Sayers, 1999).

Drag force F is the component of the aerodynamic force appearing during the motion of the solid. It acts opposite to the direction of motion (Prosnak, 1970):

$$F_d = -\frac{1}{2} c_d \rho \pi r \, V V^2$$

where: is the drag force coefficient depending on the shape of the solid, ρ is air density, r is ball radius, and V – ball translational velocity.

Magnus effect lies in the generation of the lift force perpendicular to the translational velocity of the cylinder (or other solid of revolution, e.g. the ball) spinning in the surrounding fluid Rotating ball influences the surrounding air and makes it rotate too. On the other hand, the air pushing the ball in the translational motion flows AT one side of the ball at the same direction as the rotation of the ball. At this side the air is accelerated and its pressure drops, At the other side the flow direction of the air is opposite to the rotation. This decelerates the air and increases its pressure. Consequently, the pressure difference between the two sides of the ball evolves and changes the motion trajectory of the ball.

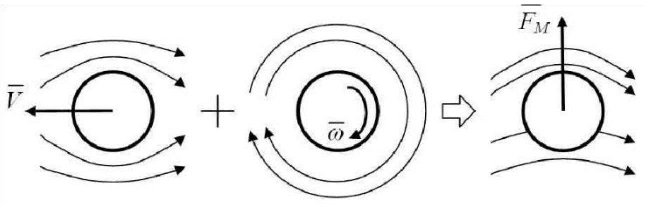


Fig.1. Magnus effect: Magnus force, translational, and rotational velocities

Lift force can be calculated, as (Prosnak, 1970):

$$F_l = \tfrac{1}{2}\, c\, r\, V V_l \pi\, \rho^2$$

Introducing rotational speed instead of the scalar linear velocity in Eq, the Magnus force for the ball can be presented, as:

$$F_l = \tfrac{1}{2}\, c\, r\, V_l \pi \rho^3 \times \omega$$

The values of the lift force and similarly of the drag force coefficients can be determined experimentally in a wind tunnel. (Alam et al., 2007) investigated different tennis balls for various translational and rotational speeds. They found out that the drag coefficient changes from 0,55 to 0,85, while the lift coefficient – from 0,30 to 0,70 if translational speeds ranging from 20 to 140 km/h and rotational speeds from 0 to 3000 rpm are considered.

By comparing the computational and experimental results they stated, that lift and drag forces depend not only on the speed of the ball, but also on the state (roughness) of its surface.

Similar results obtained Goodwill. (Goodwill, 2004) who in a wind tunnel investigated aerodynamic properties of a range of new and used tennis balls for a velocity range from 20 to 60 m/s. Mehta (Mehta, 1985, 2004) presented many visualizations and obtained sets of drag and lift coefficient values for different sports balls spinning in a wind tunnel. Sayers and Hill (Sayers, 1999) presented experimental results of drag and lift coefficients for stationary and rotating cricket balls. (Naumov, 1993)

compared numerical and experimental results of the research of the falling ball and determined the influence of the initial angular velocity on the deviation from the vertical.

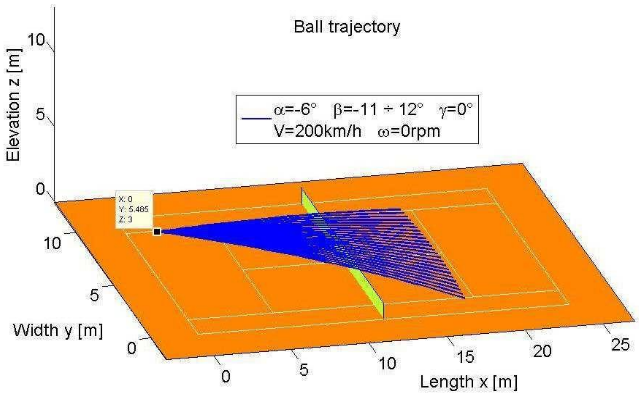


Fig. 2. Ball trajectories for different heading angles: 3D view

Although aerodynamics problems of the flying sport balls, especially the Magnus effect, have been studied by many researches, there is no acceptable solution and explanation to this problem up till now. Thus, in the present study the simplified model will be applied, in which no additional effects such as 3D air flow around the ball or the flow turbulence will be included. (Naumov, 1993)

Section four
Mathematics in football

is called Node and tie based network centralization, he calculates the sum of the differences between the highest scoring node and all other nodes, he then divides the sum by the largest possible sum of differences. Another technique, Weight centralization, is based on the fact that the most decentralized networks are the ones where all nodes interact with each other equally. The third technique, called Strength centralization basically uses the distribution of the number of ties that the nodes in a network have. (Carré,2005)

To most people, there is no obvious connection between football and mathematics. In the aftermath of a game, whether it was a dull draw with few highlights or a result in a world cup semifinal, not many would bring out their old calculus or statistics books in order to try and explain what happened. However, like everything else on this planet, football can be viewed through the eyes of mathematics. What many do not realise is that when discussing previous games and predicting upcoming games The theory that statistics and numbers play an important role in football is fundamental to the thesis of this paper. (Carré,2005)

Applying graph theory, it is possible to look at the passing structure for a team in any game as a weighted graph with nodes representing the players and edges representing the passes. Markov chains are used in order to find the eigenvector centrality for said graphs. Eigenvector centrality measures the influence of nodes in a graph. When applying mathematics to football, the eigenvector centrality provides a number which reveals how involved, or central, each player is for their team. A basic knowledge in football is assumed when reading this paper. However, advanced mathematical concepts will be thoroughly explained one by one and regarding the football part of the paper, well basically, scoring more goals than the opponents means the game has been won mathematics to make their statement. Betting agents use statistics in order to make sure their odds are the best... (Carré,2005)

Clubs use various data when making decisions on which players to buy, sell or keep for the upcoming season. There is mathematics involved in ranking players, clubs, and league Football, as it exists today, would not be possible without the mathematics that lies behind it.

The theory that statistics and numbers play an important role in football is fundamental to the thesis of this paper. Applying graph theory, it is possible to look at the passing structure for a team in any game as a weighted graph with nodes representing the players and edges representing the passes. Markov chains are used in order to find the eigenvector centrality for said graphs. Eigenvector centrality measures the influence of nodes in a graph. When applying mathematics to football, the eigenvector centrality provides a number which reveals how involved, or central, each player is for their team.

A basic knowledge in football is assumed when reading this paper. However, advanced mathematical concepts will be thoroughly explained one by one and regarding the football part of the paper, well basically, scoring more goals than the opponents means the game has been won, are processes where the state vector for each iteration is a probability vector showing the probability for that event after a certain number of iterations. State vectors at different times are related by the equation (Je Young Choi,2005)

$$\boldsymbol{x}\,(\boldsymbol{k} + 1) = \boldsymbol{Px}(\boldsymbol{k})$$

where $P = [p_{ij}]$ is a stochastic matrix, a matrix where each column is a probability vector showing the probability that a system which is in be in state j at time $t = 1$ will be in state i at time $t = k + 1$. P is the transition matrix.

In many cases, after a number of iterations, the state vector remains the same no matter how many more repetitions are being made. This vector is called the steady-state vector.

The movement of the goat modelled by a Markov chain with a transition matrix P is represented below

$$P = \begin{bmatrix} 0 \frac{12}{20} \frac{8}{20} \\ \frac{11}{22} 0 \frac{11}{22} \\ \frac{9}{19} \frac{10}{19} 0 \end{bmatrix}$$

Eigenvector Centrality

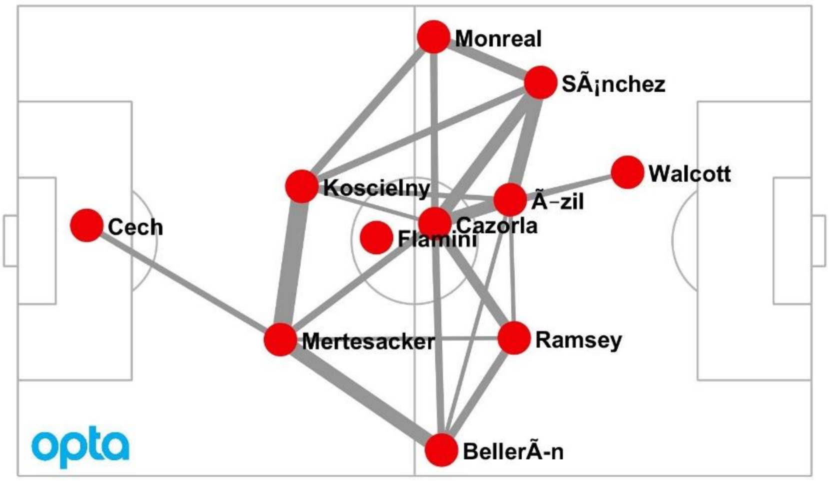
The eigenvector of *A*, an (*n* × *n*) matrix, is a vector *x*, if *Ax* is a scalar multiple of *x* for some scalar *λ*. The scalar *λ* is the eigenvalue of *A*. That is; $Ax = \lambda x$.

For any node in a system, connections with a node that is more central in that system, will add a higher score to the node than edges to and from a less, central node.

The centrality of node *i* can be denoted by x_i and calculated with the equation.

$$x_i = \frac{1}{\lambda} \sum_{j=1}^{n} B_{ij} x_j$$

Presented below are three passing graphs showing the structure of Arsenal's, and Sunderland's passing respectively, Edges are produced between players only if six or more passes have been completed between them. Each player is positioned in the position that was their average position for passing and receiving passes. Leicester's passing graphs in the same three games are available for comparison. (Je Young Choi,2005)



Section five
Mathematics in playing volleyball

The spike is the most commonly used and the most powerful offensive weapon in the game of volleyball, so any new knowledge that helps athletes improve spiking effectiveness will develop the game. Bio mechanists have been trying to improve athletes' performances since biomechanics evolved in the 1970s, and the results have been very successful (Samson,1975). However, few papers in the literature have dealt with the trajectory of the spiked volleyball (Coleman, 1983).

Many papers on the trajectory of a spinning sphere are available in the literature (Bear-man, Harvey, 1976). However, experimental studies of spinning spheres have been limited to the measurement of Magnus and drag forces on the shape of the ball's trajectory in games such as tennis, baseball, and golf (Erlichson, 1983).

Magnus effect, was named for a German engineer, G. Magnus, who first described the lateral deflection of a spinning cylinder and sphere. The Magnus force, defined as the force that causes the deflection of spinning objects, is often referred to as lift in the literature. However, it acts in a direction perpendicular to the axis of spin, which may yield a force in a direction other than vertical. Therefore, the two terms are not interchangeable. (Erlichson, 1983).

The first and most systematic experimental determination of the forces acting on a spinning baseball was conducted ، a spinning baseball with known rate of rotation was dropped across a horizontal wind tunnel in which the velocity of the air was known, and the deflection of the ball's path due to spin was measured. Using the measured lateral deflections, Briggs calculated the necessary lateral forces. Briggs reported that the lateral force was proportional to the product of the square of the wind tunnel speed (V^2) and the rotation rate of the ball.(briggs,1959)

However, classical inviscid flow theory (White, 1986) for a two-dimensional body with circulation predicts a force on the body proportional to flow velocity (V) and circulation or spin by analogy, one would expect that the Magnus force on a spinning sphere would also be proportional to on golf balls and Watts and Ferrer (1987) on baseballs have found the Magnus force to be proportional.

While these results appear contradictory, it is important to note that most ball games involve Reynolds numbers (Re) that lie in the vicinity of the so-called drag crisis (White, 1986). The drag coefficient for spheres drops sharply at around Re = 4 * 10^5 due to transition between laminar and turbulent flow. For example, a volleyball travelling at 30 m * s-l in air at I atmosphere and 20 ^{o}c has a Reynolds number of 4 * $10^{5.}$ Since flow effects are generally proportional to V in laminar flow and V^2 in turbulent flow, one might expect the results to be strongly dependent on the particular flow conditions including such factors as Reynolds numbers and the surface characteristics of the sphere. (Erlichson, 1983).

Thus, it is important to perform tests for the particular geometry and flow conditions associated with a spiked volleyball. As detailed later in this paper, such measurements provided a correlation for the Magnus force on the spinning ball, which is used in these predictions. Various mathematical approaches are available to calculate the trajectory once the various forces are known (Froehlich, 1983).

Two-Dimensional Trajectory Equations model for the trajectory may be developed based on the coordinate system shown in Figure la, if we assume that the axis of rotation of the ball is horizontal. This is a reasonable assumption, since purely horizontal rotation represents an optimum spike. The ball is subject to Magnus (M), drag (D), and gravitational forces (mg) as shown in Figure 1b. The directions of both the Magnus and drag forces depend on the direction of travel of the ball. Their magnitudes may be expressed as

$$M = C_M \omega^a V^b$$

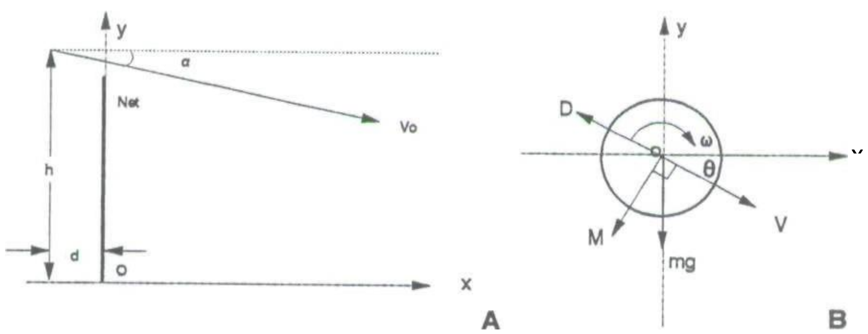


Figure 1 — (a) Volleyball court in a two-dimensional Cartesian coordinate system with the initial conditions of a spiked volleyball. (b) The three forces to which a spiked volleyball reacts.

$$D = -copAv^2$$

where CM, a, and b are constants determined empirically as described later in the paper. CD is the drag coefficient equal to 0.5 based on Re around 4 $10^{5,}$ and p is the density of the air (White, 1986).

The horizontal and vertical components of the total force on the ball are

$$Fx = -CM0\ddot{Y}V\,sin9 - -CDpAV^2cos9$$

$$FY = —mg — CMOYV\,cos9 + —CopAV^2sin9.$$

Noting that the velocity components are (Figure 1)

$$x = Vcos9$$

$$V2 = \; + \acute{Y}2$$

and applying Newton's second law (EF = ma), one obtains two equations for the acceleration components of the ball with respect to time:

$$\ddot{X} = \frac{C_M\omega^a\dot{Y}(\sqrt{\dot{X}^2+\dot{Y}^2})^{b-1}}{\ } - \frac{\frac{1}{2}C_D\rho A\dot{X}\sqrt{\dot{X}^2+\dot{Y}^2}}{\ }$$

$$\acute{Y}=-g-\frac{C_M\omega^a\dot{X}(\sqrt{\dot{X}^2+\dot{Y}^2})^{b-1}}{\ } - \frac{\frac{1}{2}C_D\rho A\dot{Y}\sqrt{\dot{X}^2+\dot{Y}^2}}{\ }.$$

These nonlinear ordinary differential equations are readily solved numerically to obtain X and Y, the position of the ball, using a Runge-Kutta scheme, given initial conditions for position and velocity.

The volleyball court is considered in a 3-D coordinate system in the following way: The left side line is the X axis, the central line is the Y axis, and the left antenna and its extension are the Z axis, as shown in Figure 2a, with the origin at the intersection of the left side and the central lines.

Since the spin axis of a spiked volleyball is horizontal, its trajectory will lie within a vertical plane because all three forces acting on that ball are in the same plane We will let the Y axis of the 2-D frame be coincident to the Z axis of the 3-D frame; rotate the plane, in which the trajectory exists, counterclockwise about the Z axis by an angle (P); then translate the plane to the position with a spiking point at A (Xo, Yo) (Figure 2b). Thus, the 3-1) equations may be obtained as

$$X_{3D} = -X_{2D}\sin\beta$$

$$Y_{3D} = X_{2D}\cos\beta$$

$$Z_{3D} = Y_{2D}.$$

These are not fully three-dimensional equations, because the ball never leaves the plane in which it moves initially, since the spin axis of the volleyball was fixed to horizontal in order to create pure topspin. In future work the model should be expanded to include the general case of orientations of rotation axes in order to accommodate problems such as sidespin. (Tang,2005)

The derived mathematical model cannot be applied to situations in volleyball until the unknowns in the model have been determined and the model properly validated. The following experiments were aimed at these purposes. (Tang,2005)

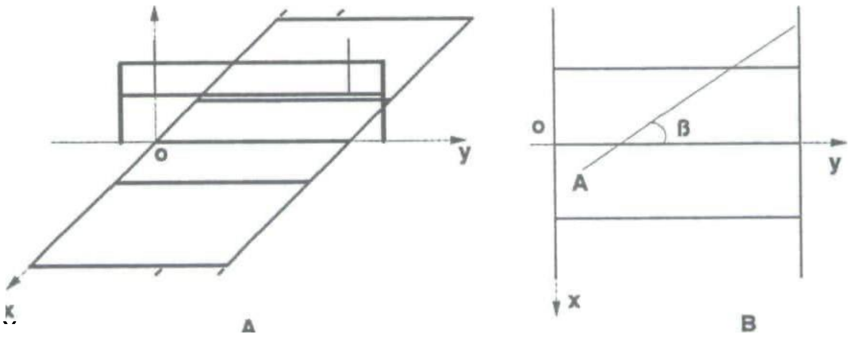


Figure 3 — (a) Volleyball court in a three-dimensional Cartesian coordinate system. (b) Top view of a volleyball court with the projection of a trajectory of a spiked volleyball.

Linear and Angular Velocities of a Spiked Volleyball. To assure that the wind tunnel testing was carried out under appropriate conditions, both the linear and angular velocities of a spiked volleyball had to be determined. (Tanner,2013)

Section sex
Mathematics in playing basketball

Although not always realized, mathematics plays a very important role in sports. Whether discussing a player's statistics, a coach's formula for drafting certain players, or even a judges score for a particular athlete, mathematics is involved. Even concepts such as the likelihood of a particular athlete or team winning, a mere case of probability, and maintain equipment are mathematical in nature. (Tormos,2003)

Let's begin by looking at the throwing of a basketball. Now, we can use the equation

$$f(x)=\left(\frac{-16}{v_o^{2}\cos^{2}\alpha}\right)x^{2}+(\tan\alpha)x+h_o$$

to help figure out the velocity at which a basketball player must throw the ball in order for it to land perfectly in the basket. When shooting a basketball, you want the ball to hit the basket at as close to a right angle as possible. For this reason, most players attempt to shoot the ball at a 45^o angle. To find the velocity at which a player would need to throw the ball in order to make the basket we would want to find the range of the ball when it is thrown at a 45^o angle. (Tormos,2003)

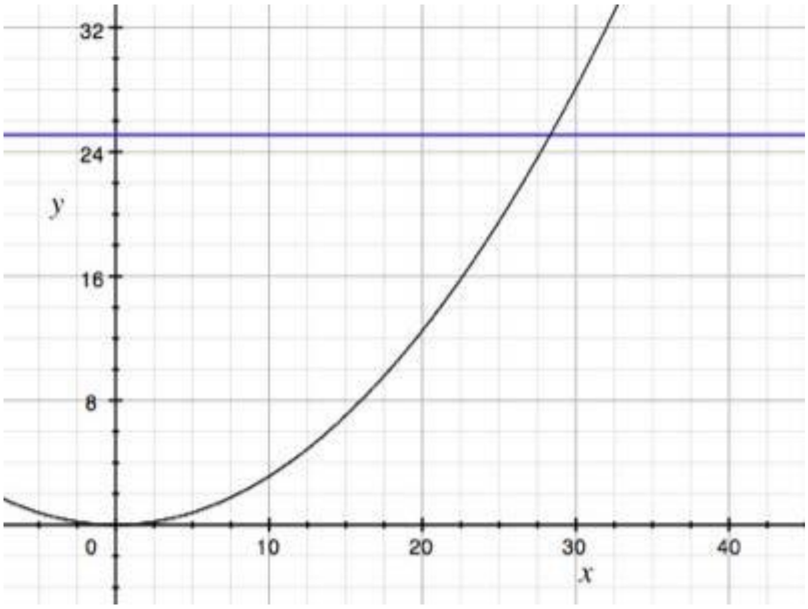
The formula for the range of the ball is

$$Range=\frac{v_o^{2}\sin(2\alpha)}{32}$$

But since the angle at which the ball is thrown is 45^o, we have

$$Range=\frac{v_o^{2}\sin(2\alpha)}{32}=\frac{v_o^{2}\sin(2\bullet 45)}{32}=\frac{v_o^{2}}{32}$$

Now, if a player is shooting a 3 point shot, then he is approximately 25 feet from the basket. If we look at the graph of the range function, we can get an idea of how hard the player must throw the ball in order to make a 3 point shot. (Tormos,2003)



So, by solving the formula knowing that the range of the shot must be 25 feet we have

$$25 = \frac{v_o^{\ 2}}{32}$$

$$v_o^{\ 2} = 800$$

$$v_o \approx 28.2843$$

So in order to make the 3 point shot, the player must throw the ball at approximately 28 feet per second, 19 mph.

Now let's look at the throwing and hitting of a baseball. The pitcher wants to throw the ball so that he will strike out the batter. If his throw is too high or low, then it is a ball and the better still has at least three more opportunities to hit the ball. Similarly, when the batter hits the ball, he wants to hit the ball so that it will be as far away from any of the other players as possible if not outside of the ball field itself. The players must take into consideration the speed and height of the ball to ensure that they will throw or hit it properly. (Tormos,2003)

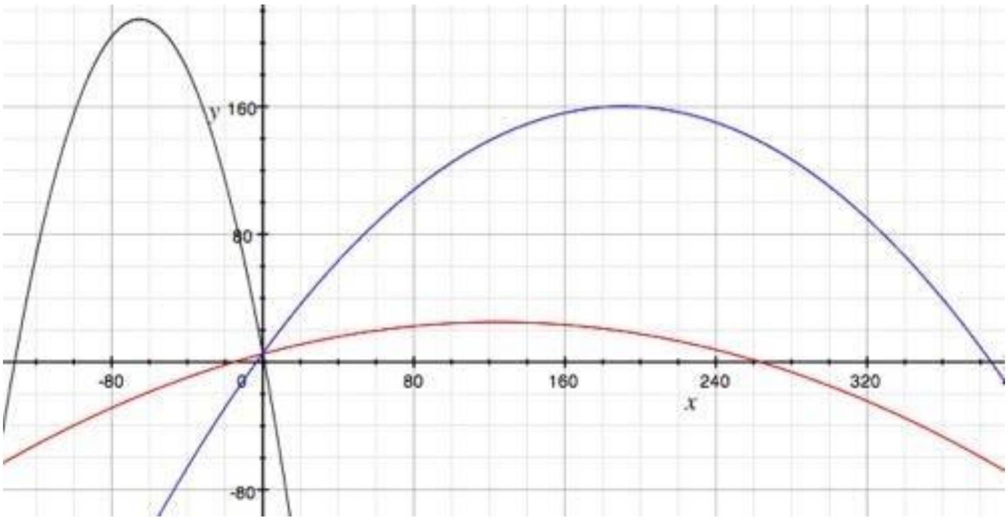
Here is the equation for finding the projectile motion of a baseball will travel:

$$f(x)=\left(\frac{-16}{{v_o}^2\cos^2\alpha}\right)x^2+(\tan\alpha)x+h_o$$

where all distances are measured in feet, ho is the height from which the ball is thrown, α is the angle at which the ball is thrown, vo is the speed at which the ball is thrown, and x is the distance that the ball travels. We can find the distance that the ball will travel by saying

$$y=\frac{{v_o}^2\sin(2\alpha)}{32}$$

Now, a batter would be more concerned with the range of the ball, wanting it to travel far enough to allow him to at least make it to first base safely. Let's look at several graphs of the range with different α's and a fixed vo and ho.



The black graph is when α = 30°, the blue graph when α = 45°, and the red graph when α = 60°. So we can see from the graph that an angle of 45° will send the ball the furthest. So, a batter would want to hit the ball as close to a 45o angle as possible, while a pitcher, who is more concerned about the ball veering off path, would want to throw the ball so the ball so that it would travel as close to a straight line as possible.

Now, let's say it is approximately 420 feet from home plate to the edge of a baseball field. The batter wants to hit the ball hard enough so that it will travel out of the field, over the approximately 7 foot wall at the back of the outfield. If the batter hits the ball at a 40° angle and the ball is approximately 5 feet in the air when struck, how hard must he hit the ball in order to have a home run? Remember, that in the projection equation, f(x) is the height of the ball, so now we have

$$7 = \left(\frac{-16}{v_o^{\ 2}\cos^2(40)}\right)420^2 + (\tan(40)) \bullet 420 + 5$$

$$\frac{-16 \bullet 420^2}{(7 - [\tan(40)] \bullet 420 - 5)\cos^2(40)} = v_o^{\ 2}$$

$$v_o^{\ 2} \approx 14128.4074$$

$$v_o \approx 118.863\, ft/\sec$$

Therefore, we have that the batter must his the ball at approximately 118 feet per second, which is approximately 81 mph, in order to hit a home run when he hits the ball at an angle of 40°.

We could also look at a sport such as bowling which many people consider to be quite simplistic. However, you must consider the angle of the ball and the velocity with which the ball is thrown when trying to get a strike. The path of a bowling ball, thrown in a straight line, can be represented by the following equation:

$$f(t) = \left(\frac{v_o}{r}\right)\left(1 - e^{-r \bullet t}\right)$$

where vo is the velocity of the ball, t is the time in seconds that the ball travels, r is a constant represents the friction, and g(t) is the distance in feet that the ball travels after t seconds.

Now, the length of a blowing lane is approximately 60 feet. Let's say that the friction caused by the bowling ball on the slick surface of the bowling lane is approximately 0.3 and the ball is rolled at approximately 15 mph, or 22 feet per second. Now if we graph this equation we have

Mathematics is also used in ranking players and determining playoff scenarios. From something as simple as using a matrix to the formulas used to determine a players or team's statistics, mathematics is an integral part of this system. For example, most sports have players draw numbers to see who they will be competing against. If there are 2^k contestants then all athletes participate in the first round of play, if not, then some of the participants enter during the second round of play.

where n is the number of contestants. Rankings are also an important aspect of sports. In sports such as tennis, when rating athletes, an integral estimator is used which is based on a player's performance in a series of matches over a certain period of time.

Even horse racing uses mathematics to rank the horses based on how well they have performed in previous matches, and these rankings go into determining the value of a horse when a bet is placed. Mathematics is very prevalent in sports, from the most complex of formulas to the simplest ideas such as betting.

Section seven
Conclusion

As a result of this research, we learned how mathematics is related to sports and how they were with the types of sports according to several rules and regulations we have explained with types such as football, handball, tennis, etc.

We explained the importance of mathematics to sports. For example, football did not have a very good relationship with mathematics, it only had a complementary relationship research critically and carefully analyzes the mathematical solution or solutions to determine appropriateness to the real world setting in which the problem was posed As a heuristic exercise the derivation of mathematical-statistical models that predict changes in human sporting performance both in the near and distant future occupies definitely the minds of mathematicians and statisticians and if “we get it right ”we will have a crystal ball into the future of sport. The problem is it just takes time to find out how good we are at solving such problems.

Section eight

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