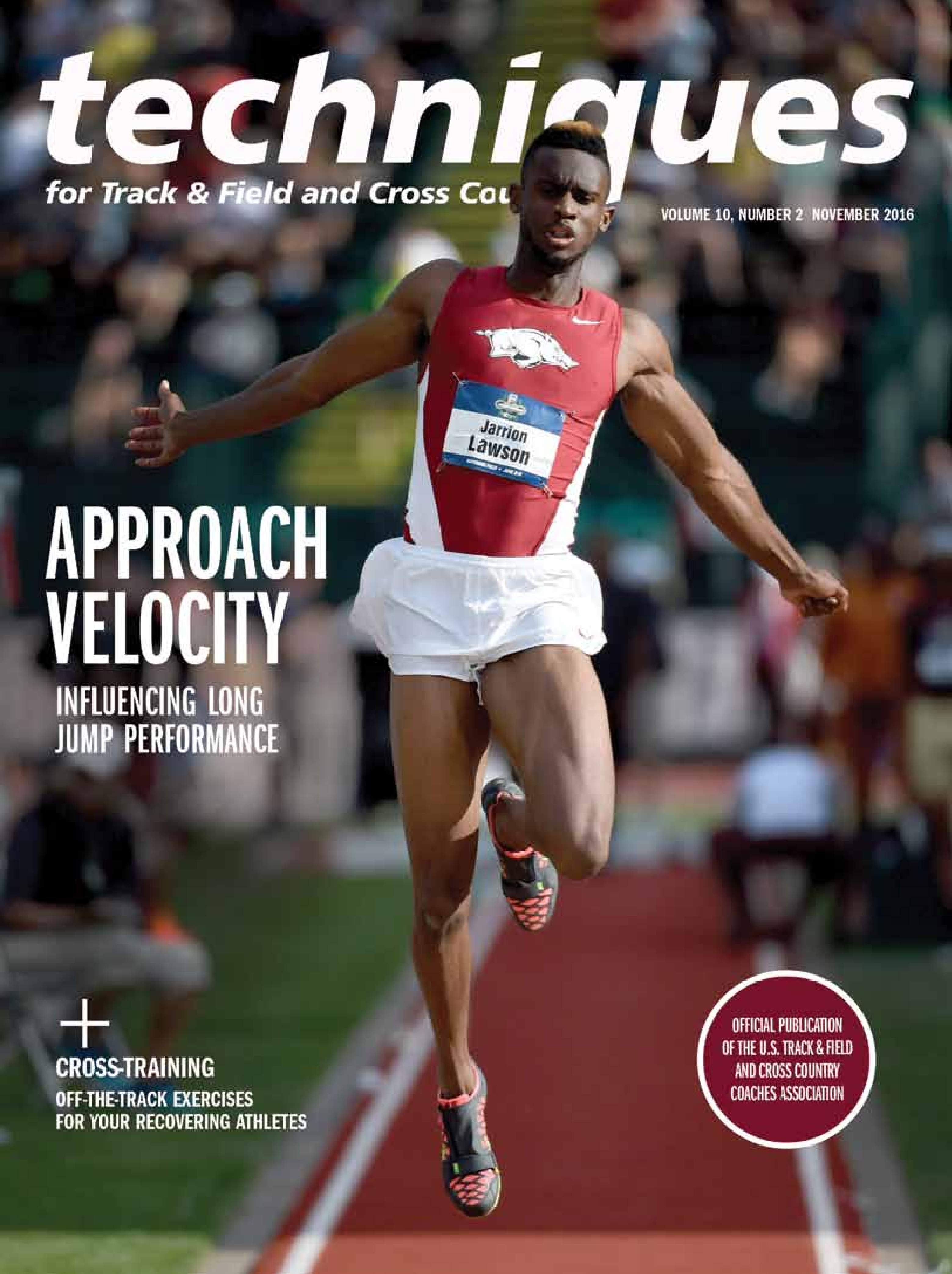
# techniques

for Track & Field and Cross Country

VOLUME 10, NUMBER 2 NOVEMBER 2016




## APPROACH VELOCITY

### INFLUENCING LONG JUMP PERFORMANCE

+

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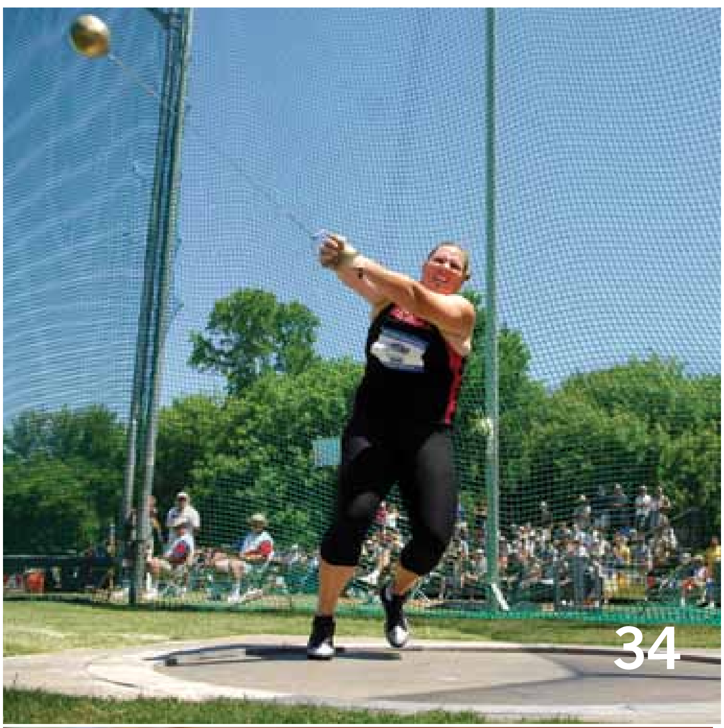


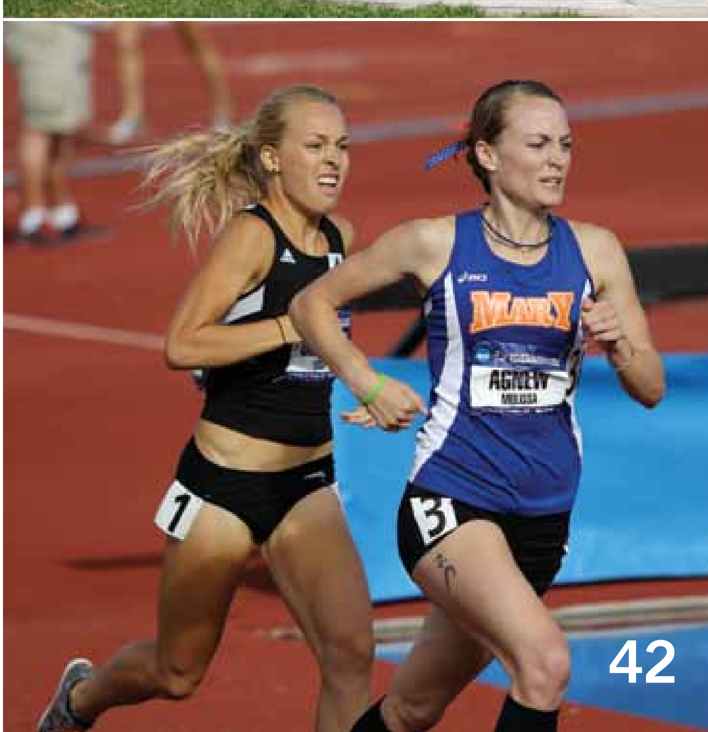


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Photograph courtesy of Kirby Lee

# A LETTER FROM THE PRESIDENT

With the cross country season winding down, we're getting that much closer to the 2016 USTFCCCA Convention in Orlando. I sincerely hope that you will be able to join your colleagues for four days of learning, sharing ideas and socializing.

As usual, recognition of achievements will be a big part of the convention. Another six deserving coaches will be inducted into the Hall of Fame, the most outstanding male and female collegiate track & field student-athletes will be recognized with the Bowerman Award and the National High School Cross Country and Track and Field Coaches of the Year will be recognized for their achievements over the course of the past year. The schools that earned the Program of the Year honor in their respective divisions will be recognized as well at some point during the convention. It truly is a wonderful opportunity for all of us to applaud the efforts of these men and women who make our sports so great.

It's not all socializing, however. The convention is our one opportunity each year to get together as a coaching community and try to formulate plans for the future of our sports. Certainly, the proposed changes to the cross country championship structure will be of great interest to the Division I coaches. In Division II, a hot topic of discussion will no doubt be the proposed overhaul of the qualifying process for Outdoor Track & Field. The coaches of Division III, the NAIA and NJCAA will have their own agendas to following during the four-day convention.

The convention is also a great place to interact with the vendors that support our organization. If you are in the market for new equipment, a new track, new training aids and uniforms, our sponsors and supporters have you covered. We are thrilled to welcome three new companies to the family of USTFCCCA Supporters in New Balance, Final Surge and BV Systems (LED Rabbit). Please make a point of stopping by the vendor booths to see what great products and services these companies have to offer.

Finally, I encourage each and every member of our association to get involved in the organization at some level. There are countless committees that work on behalf of each and every coach involved in our sports. If you'd like to get involved, make sure to let one of the officers of your respective division know that you would like to serve on one of these committees in some capacity. If you want to see our sports improve and prosper, then you should be willing to get involved to make that happen.

Best of luck with the rest of the Cross Country season and I hope to see you in Orlando.

**DAMON MARTIN**
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**Published by**
**Renaissance Publishing LLC**
**110 Veterans Memorial Blvd., Suite 123, Metairie, LA 70005**
**(504) 828-1380**
**myneworleans.com**

**USTFCCCA**
National Office
1100 Poydras Street, Suite 1750
New Orleans, LA 70163
Phone: 504-599-8900
Fax: 504-599-8909

Techniques (ISSN 1939-3849) is published quarterly in February, May, August and November by the U.S. Track & Field and Cross Country Coaches Association.  Periodical Postage Paid at New Orleans La and Additional Entry Offices. POSTMASTER: Send address changes to: USTFCCCA, PO Box 55969, Metairie, LA 70055-5969. 

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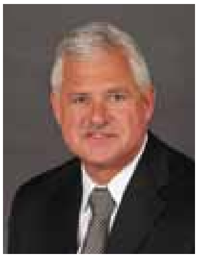

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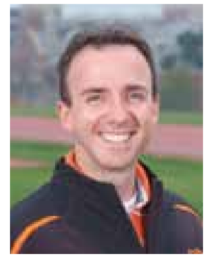

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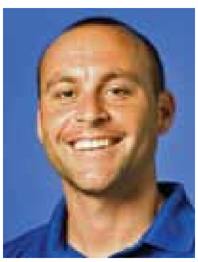

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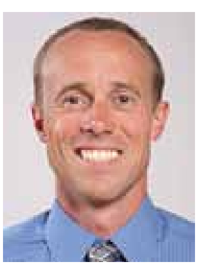

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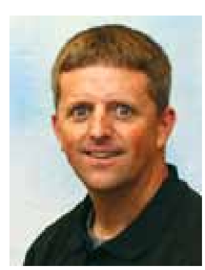

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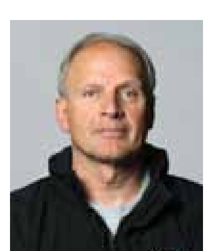

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# APPROACH VELOCITY

## THE FACTOR THAT MOST INFLUENCES LONG JUMP PERFORMANCE

**QUINCY HOWE**

There are many factors that influence the outcome of a long jump; board contact time, plant angle, takeoff angle, mid-support knee flexion angle, wind resistance and assistance, individual strength levels relative to weight, board accuracy, landing technique and its influence on lost distance, approach velocity and various other factors. Although all of the above factors may influence the outcome of the Long jump, there are some that have a very limited influence; whereas others play a major role in how far an athlete jumps.

Even though we are mostly aware that faster velocities attained on the runway typically yield further jump distance, my goal is to put hard numbers to this theory so as to support the hypothesis that increased approach velocity results in increased jump distances. I also seek to potentially eliminate some other factors that may or may not have as much to do with jump distance as previously thought.

Data collection at track and field events requires quite a bit of equipment and can be intrusive during a time when coaches, as well as athletes, rarely tolerate intrusion. As a result, there is a very limited number of these studies conducted, especially not in the midst of an actual competition.

Figure 1


Figure 2


The few studies that are out there typically use athletes at elite competitions like the IAAF World Championships or Olympic Games. These athletes are in the 99th percentile of participants in the long jump event. I believe that studying median performers in the event would yield results that would be more relatable to a wider population. This article will examine the later rather than the former, hopefully proving to be a useful tool for a broader spectrum of coaches to refer to when preparing their jumpers.

## METHODOLOGY

All jumps were recorded at 120 frames per second. The camera was placed 10m away from the takeoff board in line with the foul mark. All jumps were filmed with a panning action and jumpers were filmed laterally. Video from four male and four female collegiate long jumpers of varying ability and experience were analyzed for a total of 26 jumps.

The following are all the steps taken to collect data:

Approach velocity: four landmarks were measured along the runway, they were all measured from the long jump foul line. These marks were at 5.76 meters, 5.96 meters, 8.81 meters and 9.01 meters. These arbitrary marks were chosen because they were known marks on the runway that have already been established. In order to get an accurate measurement, the subject had to hit one of the four designated marks. From that point, frames were counted all the way to the touchdown on the takeoff board. Since we know that there are 120 frames every second, we can determine the elapsed time for a known distance thereby resulting in a velocity. This velocity is an average velocity of the last 3 or 4 steps of the long jump approach, depending on which landmark was hit during the approach. Trials were eliminated if an athlete did not hit one of the four marks previously designated above as well as not hitting any part of the 20cm takeoff board or foul jumps.

As a caveat, the calculated velocities using the above method were found to


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be 0.4 – 0.6 m/s faster than a traditional 11m-1m gated velocity using a Free Lap timing system. This was because the foot contacts during the last two steps fell ahead of the subject's COM. However, I felt the need to have a larger sample size for data collection. I also believe that even though the true approach velocity differed from the calculated velocity, the relationship within the study group remains consistent and can be related to other factors within this specific study group.

**Example:**

**V – approach velocity in m/s**
**F – video frames**
**D – distance in m**
**Fr – Frame rate in frames per second**
**T – time**

**V = D ÷ (F/Fr)**
**V = D ÷ T**

**Board contact time:** Similar to collecting data for the approach velocity, frames were counted from touchdown to toe-off of the takeoff board. This number was then used to calculate the ground contact time.

**Example: T = F ÷ Fr**

Plant angle: A freeze frame was analyzed and the plant angle was taken from the hip to the ankle joint and the ground. (See figure 1)

**Midstance angle:** I denoted midstance for this study as the frame in which both knees are in line with each other during the support phase of the takeoff leg. At this point, the knee flexion angle of the take-off leg is pulled from hip to knee to ankle joints. (See figure 2) It has shown that most of the subjects had their greatest knee flexion at this point in the jump.

**Adjusted jump distance:** All the data collected came from actual competitions. Therefore I was limited by the confines of meet rules and procedures. As a result, in order to collect real jump distances as well as measured jump distances, I had to formulate a grid at the jump board. The grid had five measurements: 0, 5, 10, 15 and 20 cm, which spanned the entirety of the jump board. These numbers were then added to the corresponding measured jumps for an actual jump distance. There is an inherent margin for error since the numbers are pulled from a video but this margin is negligible, and I don't believe it affected the outcome of this study.

## RESULTS

Table 1 shows all of the collected data.

## CONCLUSION

**Approach velocity vs adjusted jump distance:** The results found in this study yielded a strong relationship between approach velocity and actual jump distance. Referring to figure 3, you can see that the correlation between the two is positive and quite obvious.

Using the equation of range of a projectile in flight, we can show that flight distance is most influenced by the takeoff velocity which is a vector of the approach velocity. (See example 1)

**d** is the jump distance
**v** is the takeoff velocity
is the angle of takeoff



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**Table 1**

| Subject | Approach Velocity m/s | board contact times | Plant angle | Mid stance angle | Measured distance | distance from foul line | Adjusted distance | Meet |
|---|---|---|---|---|---|---|---|---|
| A1 | 9.79 | 0.13 | 52 | 137 | 7.17 | 0 | 7.17 | RMC |
| A2 | 10.33 | 0.13 | 51 | 136 | 7.03 | 0.05 | 7.08 | RMC |
| B1 | 10.65 | 0.13 | 57 | 127 | 6.96 | 0.05 | 7.01 | PM14 |
| A3 | 10.82 | 0.13 | 56 | 133 | 6.8 | 0.2 | 7 | PM14 |
| A4 | 10.22 | 0.13 | 57 | 133 | 6.87 | 0.05 | 6.92 | PM15 |
| A4 | 9.95 | 0.13 | 54 | 133 | 6.83 | 0.05 | 6.88 | PM14 |
| C1 | 9.68 | 0.13 | 62 | 140 | 6.86 | 0 | 6.86 | PM14 |
| A6 | 10.84 | 0.13 | 50 | 119 | 6.59 | 0.15 | 6.74 | PM14 |
| C2 | 9.57 | 0.12 | 64 | 142 | 6.69 | 0.05 | 6.74 | RMC |
| D1 | 9.4 | 0.13 | 63 | 127 | 6.68 | 0.05 | 6.73 | PM14 |
| D2 | 9.4 | 0.13 | 63 | 132 | 6.66 | 0.05 | 6.71 | PM14 |
| C3 | 10.1 | 0.13 | 61 | 121 | 6.59 | 0.1 | 6.69 | PM14 |
| C4 | 9.43 | 0.12 | 64 | 139 | 6.67 | 0 | 6.67 | RMC |
| D3 | 9.27 | 0.13 | 62 | 119 | 6.45 | 0.05 | 6.5 | PM14 |
| E1 | 9.29 | 0.13 | 62 | 133 | 5.96 | 0.15 | 6.11 | PM15 |
| E2 | 9.61 | 0.13 | 60 | 130 | 5.87 | 0.15 | 6.02 | PM15 |
| E3 | 9.6 | 0.13 | 61 | 140 | 5.67 | 0.2 | 5.89 | PM15 |
| F1 | 8.91 | 0.13 | 54 | 143 | 5.66 | 0.1 | 5.76 | RMC |
| F2 | 8.92 | 0.14 | 58 | 127 | 5.64 | 0 | 5.64 | RMC |
| F3 | 9.01 | 0.14 | 61 | 135 | 5.47 | 0.15 | 5.62 | RMC |
| F4 | 8.83 | 0.14 | 60 | 137 | 5.52 | 0.05 | 5.57 | PM14 |
| G1 | 8.48 | 0.12 | 57 | 154 | 5.5 | 0 | 5.5 | RMC |
| G2 | 8.35 | 0.13 | 66 | 155 | 5.43 | 0.05 | 5.48 | RMC |
| F5 | 8.59 | 0.13 | 58 | 143 | 5.33 | 0.1 | 5.43 | PM14 |
| G3 | 8.55 | 0.13 | 59 | 131 | 5.33 | 0.1 | 5.43 | PM14 |
| H1 | 8.55 | 0.12 | 71 | 140 | 5.33 | 0.05 | 5.38 | RMC |
| AVG | | 0.129615385 | 59.34615385 | 134.8461538 | | | | |

**Example 1**

$$d = \frac{v^2 \sin 2\theta}{2g}\left[1 + \left(1 + \frac{2gh}{v^2 sin^2\theta}\right)^{1/2}\right]$$

**Example 2**

$$d = \frac{v^2 \sin 2\theta}{2g}[constant]$$

**Example 3**

$$d = \frac{v^2 \sin 2\theta}{constant}[constant]$$

$$d = v^2 \sin 2\theta$$

**g** is the acceleration due to gravity

**h** is the change in takeoff height and landing height of the center of mass

Looking at the above equation, **h** will remain the same for an individual jumper, give or take a few cm regardless of takeoff velocity or take of angle, provided that the jumper is executing a competition level approach run. For this reason, the h can be considered a constant regardless of the other variables. Acceleration due to gravity can also be considered a constant variable as well since its change is minuscule at 9.81 m at sea level and 9.77 m on the top of Mount Everest. This reduces the above equation to below: (See example 2)

Looking at the reduced equation, it can be seen that takeoff velocity is raised to the power of 2, thereby being the greatest driving factor in determining jump distance d. There is the variable of takeoff angle that will also influence jump distance. Therefore, even though there is a correlation between takeoff velocity and jump distance, I am not yet ready to say that there is causality.

(See example 3)

$v^2$ will always yield a higher number. For example, practical numbers for are 0-45 degrees, yielding numbers of 0-1. Whereas

**Figure 3**

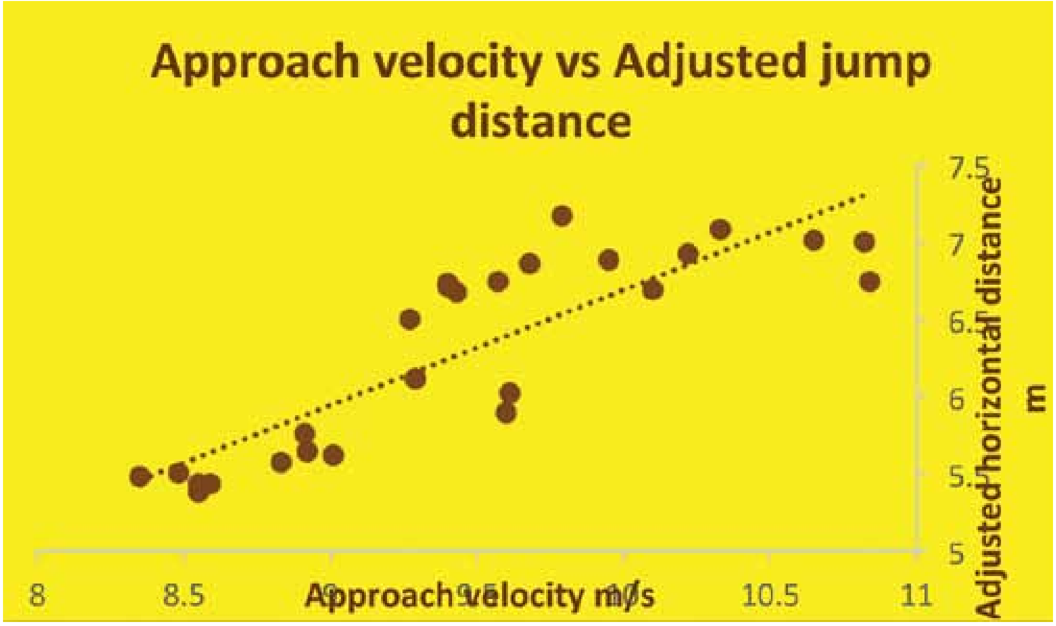
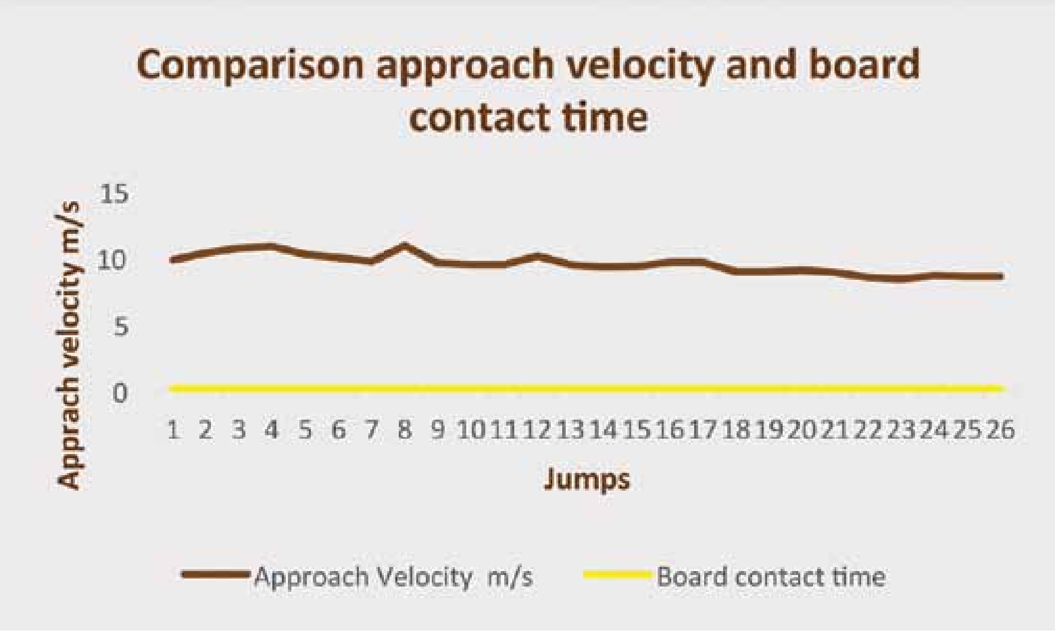



**Figure 4**




having practical numbers in this study of 8.35 to 10.84, yielding numbers of 69.72 to 117.51.

See Figure 3

Board contact time: Looking at board contact times across the spectrum of gender and jumping ability, I found that there was not a significant difference in these times. They ranged from 0.12s to 0.14s but was overwhelmingly 0.13s. The same results can be seen in relation to approach velocities. (See Figures 4 and 5)

Plant angles: Over the 26 jump attempts, with actual jump distances ranging from 5.38m to 7.17m and across genders, the difference in plant angles were negligible and averaged out to 59.12 degrees, 60.58 degrees for women and 58.29 degrees for men. Cross referencing these numbers with elite jumpers, the same 2-degree average difference was observed in this sample set.

See Figures 6 & 7

**Figure 5**

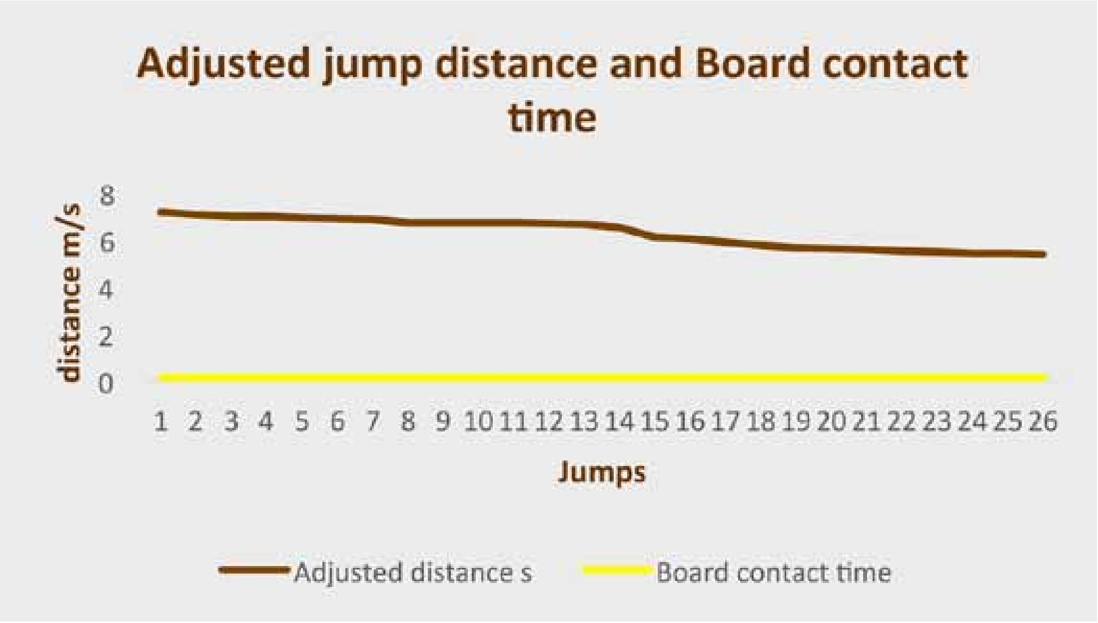



**Figure 6**

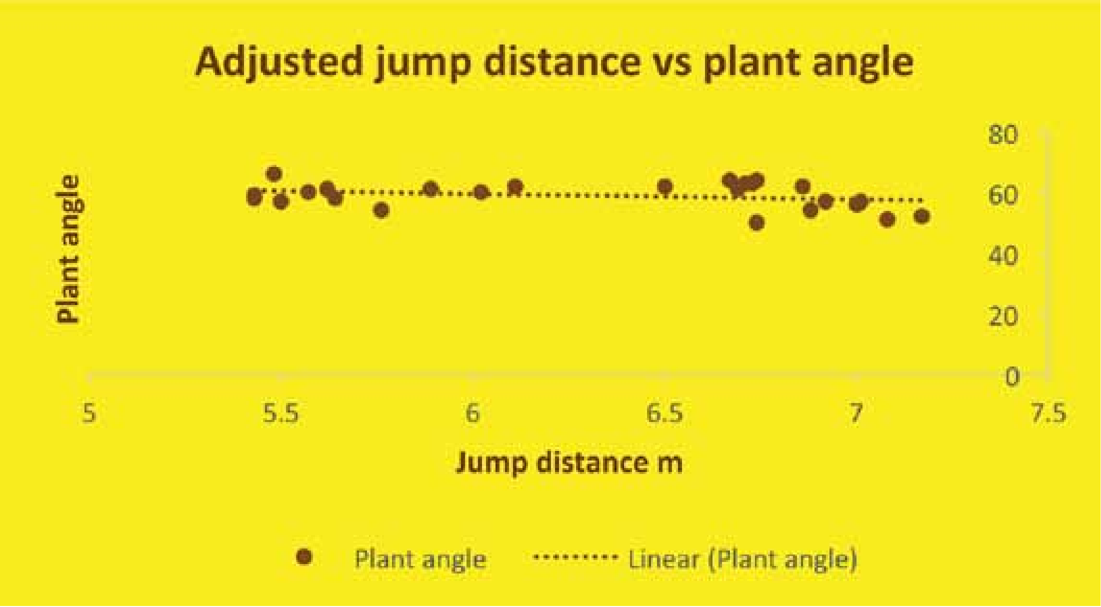


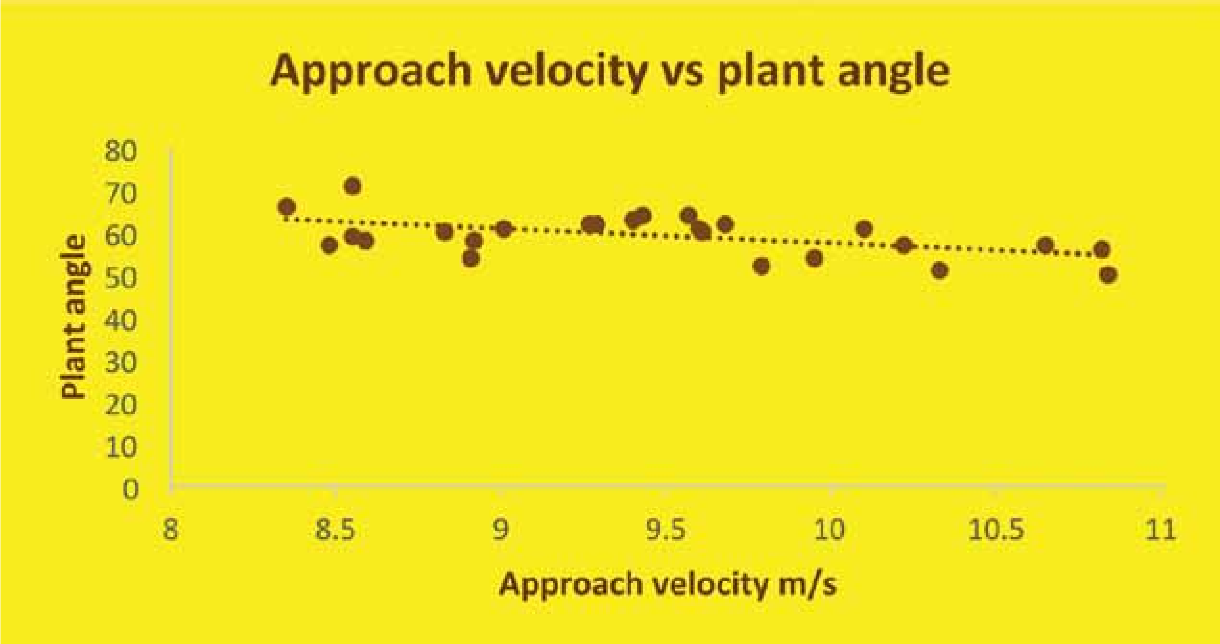

Figure 7 Midstance angle: this was denoted by the greatest flexion angle before takeoff. It was observed that these numbers weren't significantly different across genders and ability levels as well.

See Figures 8 & 9

**OPINION**

Midstance angle: I believe that the midstance knee flexion before takeoff is a byproduct of the approach velocity, plant time and plant angle. I don't think that it is something that can be coached and improved to result in better jump distances. Figures 8 and 9 above already show that regardless of jump distances, the change in knee flexion is nominal. It is definitely data that cannot be easily collected analyzed and relayed back to the athlete in a training session or in competition in a timely manner. It would be my suggestion that this data set be left alone and

**Figure 7**




not used when training long jumpers. It has shown that there is a range that has to be obtained in order to achieve successful jumps.

Board contact times: The difference between elite jumpers and non-elite competitors is as small as .02s. The data that I collected had an average of 0.13s with the range being .11s - .14s. At the IAAF World Championships 2009, the elite jumpers at that competition had an average contact time of 0.12 for men and 0.13s for women. There is definitely a range that absolutely needs to be attained in order to attain successful longer jumps. It is my opinion that being able to attain contact times of between 0.11 and 0.13s is absolutely crucial, but force generated and the direction of that force generation, as well as the transfer to vertical velocity, will have a greater influence on the jump distance than board contact times.

Since the results have shown that the ground contact times across age, gender and ability level in this study remained essentially constant, then it would be reasonable to assume that the force produced and the direction of that force production would have a much greater variance which could influence jump distance.

A follow-up study with force plates at the jump board could shed a great deal of light on the influence of force production.

Plant Angle: Similar to midstance angle, this is also a byproduct of approach velocity as well as ultimate step distance from the takeoff board. The average plant angle for the 26 trials was 59.18 degrees. There was not much of a trend relative to approach velocity or jump distance. I believe that anthropometric differences in leg length among the 8 athletes may have contributed to the slight changes in angles.

Knowing that an optimum plant angle is crucial to a successful jump and knowing that its relationship closely coincides with ultimate step distance, I would devise a penultimate step 'strike zone' during training, so that each athlete is able to hit an optimum position for each individual that is unique. This is typically 1.85m for women and 2m for men. This is a starting point and definitely has to be adjusted to suit each athlete's approach speed as well as their leg length (hip to heel).

Approach velocity: From the data collected, as well as the projectile in flight equation, we can see that approach velocity has the greatest influence on jump distance. If there is a hierarchy of importance when preparing for the event, acceleration and takeoff velocity must be the top of the list. Across the ability levels as well as gender, greater approach velocity in turn resulted in greater jump distance. We also have to remember that during takeoff, velocity has a horizontal component as well as a vertical component. Even though this study did not touch on the vertical component of velocity, we can assume that a higher vertical component of velocity will also yield longer jump distances. This in and of itself can fuel another lengthy study.

This study has confirmed what the hypothesis originally stated that big approach velocities result in big jump distances. So run fast, plant hard and fast, and jump far!

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**Figure 8**

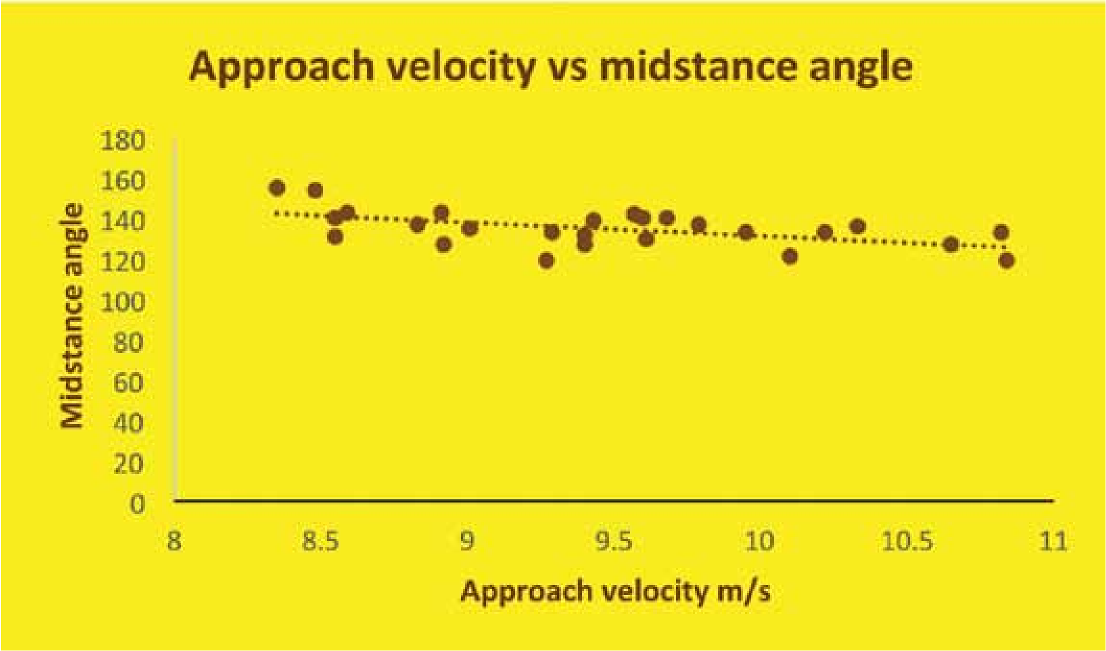
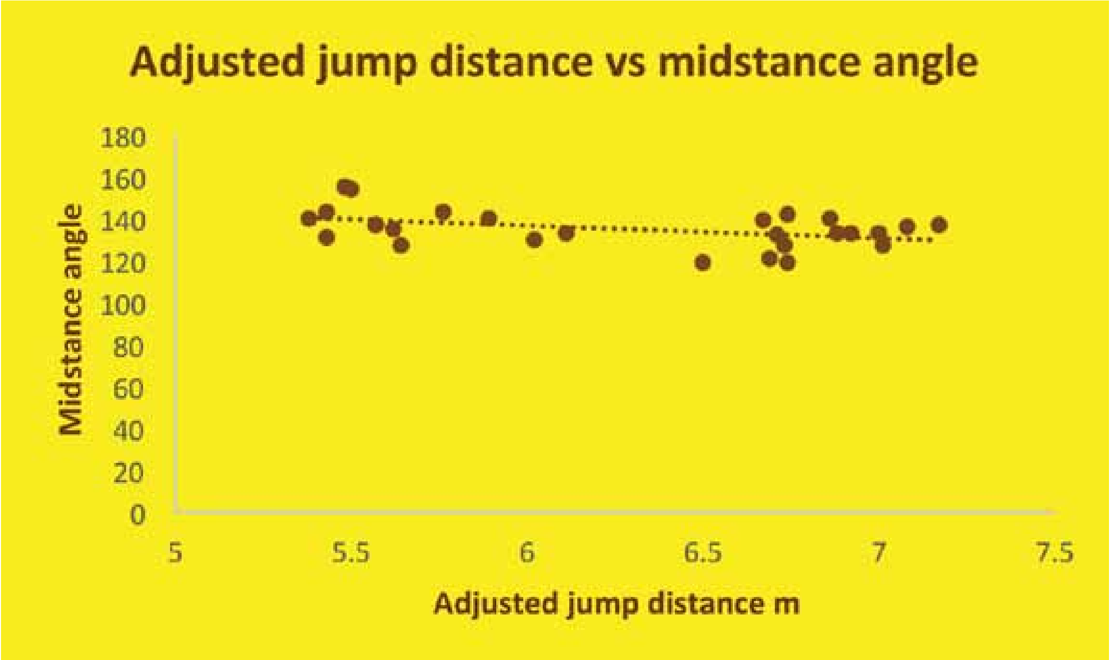



**Figure 9**

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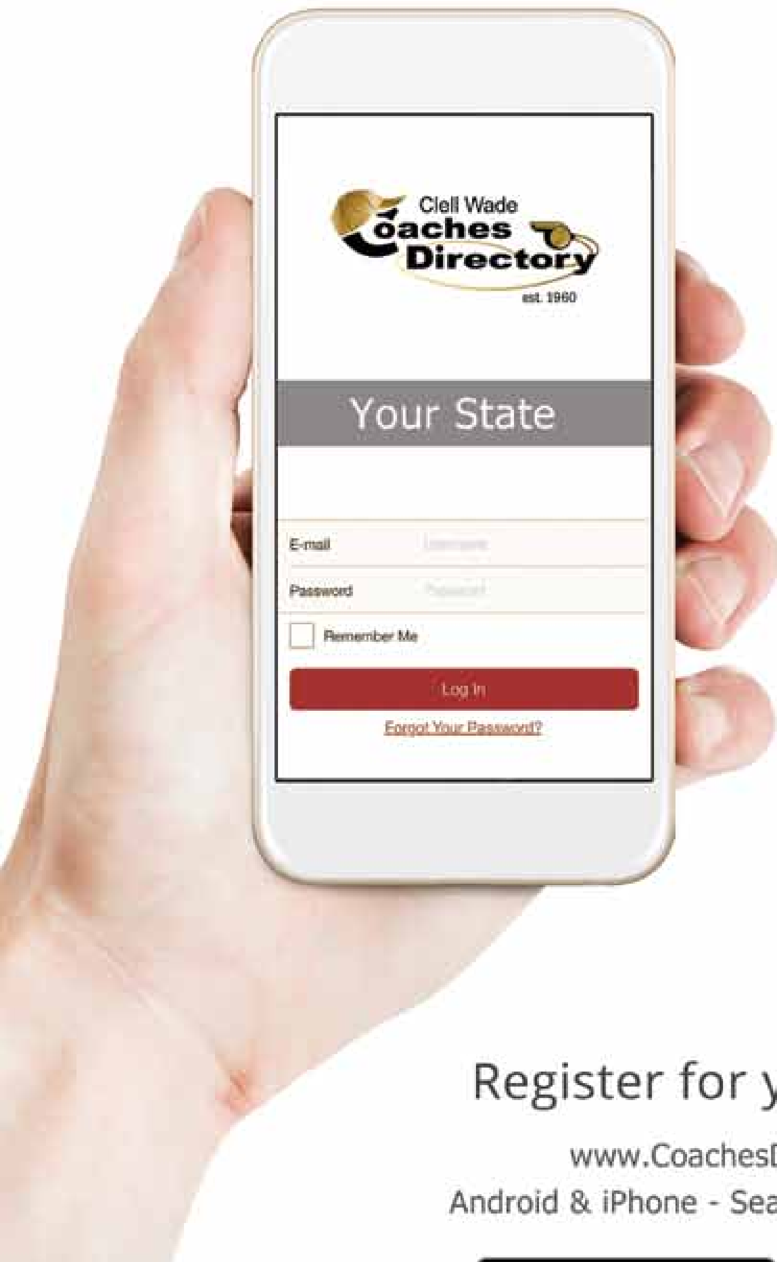


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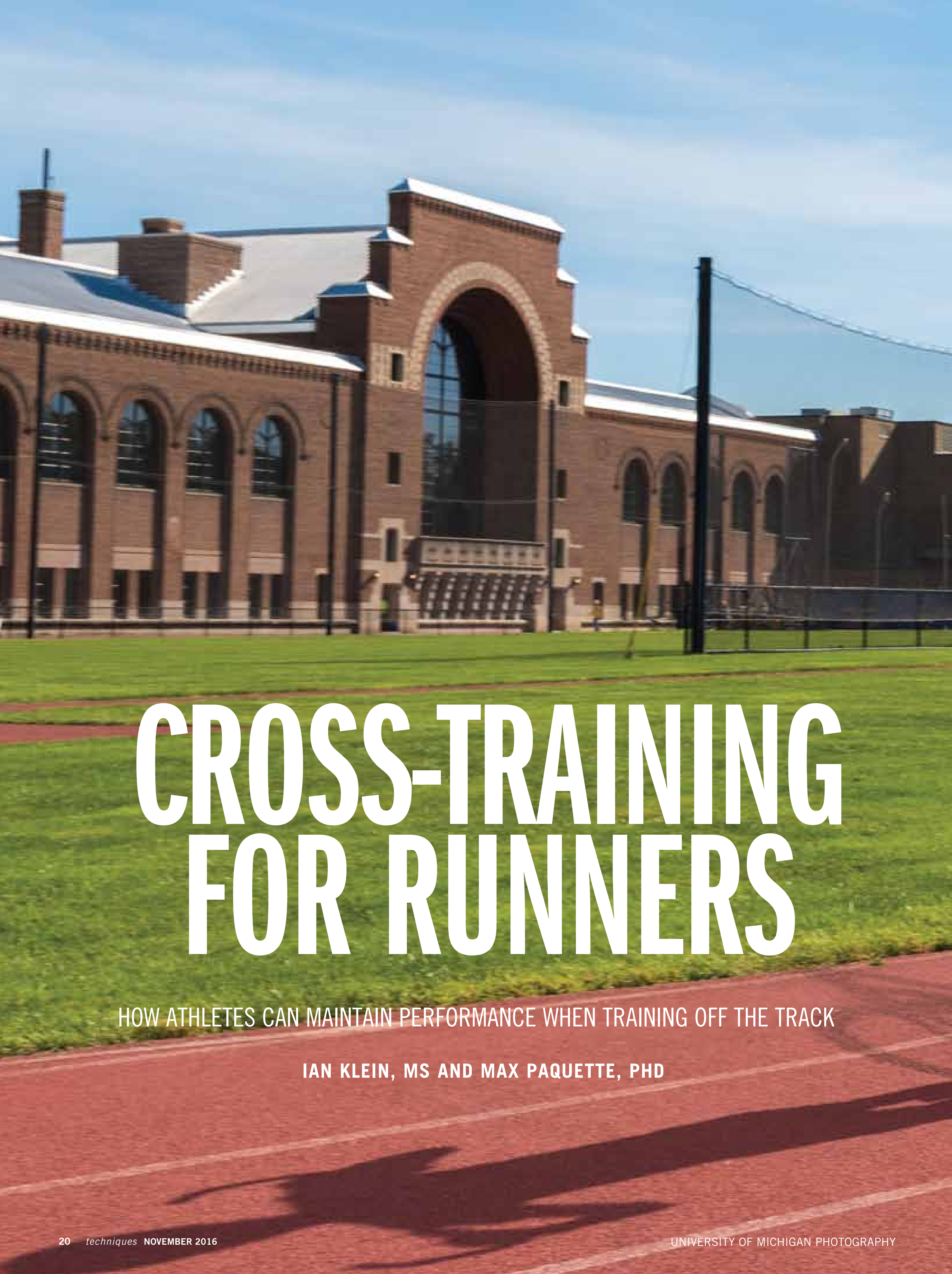

# CROSS-TRAINING FOR RUNNERS

## HOW ATHLETES CAN MAINTAIN PERFORMANCE WHEN TRAINING OFF THE TRACK

**IAN KLEIN, MS AND MAX PAQUETTE, PHD**

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ELLIPTIGO
GO

Running has long been one of the most popular, simplistic and enjoyable ways to exercise for all age groups. Running is a sport that can be practiced for a lifetime and provides benefits ranging from improved blood pressure, weight loss, mental health, muscle strength, heart and lung function, and of course, improved running performances. But despite these benefits, some evidence suggests that up to 79 percent of runners report injuries or pain in a one year period (van Gent et al., 2007). Overuse injuries make up the majority of these injuries and have been linked to the high impact nature of running (Hreljac et al., 2000 & Hreljac, 2004; Davis et al., 2016). For runners with a few years of training under their belt, missing a few weeks of training or having to skip some key workouts due to injury can greatly limit their success. Indeed, as little as two weeks of training cessation can have deleterious effects to a runner's aerobic fitness (Mujika, 2000; Doherty et al., 2003). At the elite level, since financial security comes with high levels of performance, missing important training periods due to injury can be quite costly. For this reason, many injured runners will continue training using cross-training modalities that do not exacerbate the symptoms or worsen the injury in order to prevent or attenuate the losses in fitness while unable to run.

## CROSS-TRAINING

Various types of low-impact cross-training modalities can help maintain aerobic fitness during periods of injury. Cross-training can also be used to supplement running training to increase training volume without the increased associated impacts of running. It may also be used to aid in the recovery process following heavy training periods or following strenuous training sessions, again, by avoiding large impact forces during running. Proponents of the "Go Big or Go Home" training philosophy have viewed the incorporation of cross-training in a training program as a less than optimal approach. However, scientific research has provided substantive evidence that cross-training can prevent or reduce the losses in fitness as a result of running training cessation. To use a recent anecdotal example, American long distance runner Emily Infeld qualified for the Olympic Games in two events (5,000m and 10,000m) after being diagnosed with a femoral stress fracture early in the year and having to take a substantial step back from her regular running training. Infeld spent many hours per week cross-training to maintain her fitness until she was able to resume her running-specific training in preparation for the U.S. Olympic Trials. Evidently, for some, cross-training has highly impactful training benefits. With numerous low-impact cross-training modalities available, runners and coaches often want to know what is the best form of cross-training for runners? We broke down the different modes of cross-training in two categories: 1) non-running-specific cross-training (i.e. movements are vastly different than running) and 2) running-specific cross-training (i.e. movements more closely replicate those of running).

## NON-RUNNING-SPECIFIC CROSS-TRAINING

The most popular forms of non-running-specific cross-training modalities include cycling, swimming and rowing. Cycling is a type of exercise most runners know how to do or have done in the past and, is easily accessible for most (i.e. most fitness gyms have stationary bicycles and many runners own bikes). Cycling-only training has been found to maintain aerobic fitness in recreational runners (Moroz et al., 1987), and when combined with running, cycling can improve running performance (Mutton et al., 1993; Flynn et al., 1998). However, the motion of cycling differs greatly from running as it places the knee and hip joints in much more flexed positions compared to running. These greater joint flexion positions during cycling change the contraction lengths of muscles involved. These different joint positions and muscle lengths, during cycling appear to subsequently alter stride mechanics and, torso, pelvis and hip motions immediately following cycling (Cala et al., 2009, Rendos et al., 2013). Further, prior cycling bouts reduces the 10 km running performance in triathletes (Tew, 2005) although, anecdotally, many triathletes have seemingly posted much better running times within a triathlon event compared to individual running races – we will leave that curious phenomenon alone for now. Although we observe changes in running biomechanics immediately following cycling, the long-term effects of cycling on running mechanics are unknown. Until we know more on these long-term effects, if runners choose to cycle as a mode of cross-training, it may be smarter to complete their run first (if they are uninjured) before cycling.

### SWIMMING HAS BEEN A GO-TO CROSS-TRAINING METHOD FOR MANY YEARS.

Swimming offers a non-impact exercise that rarely aggravates a runner's injuries. Nonetheless, from a biomechanical perspective, the specificity of swimming is the most unlike running. Swimming is performed in a horizontal position in a nearly weightless environment due to water's buoyancy forces. This greatly changes muscle recruitment patterns compared to running and underloads musculoskeletal tissue. This under-loading can, over time, reduce bone density which can increase the risk of skeletal stress fractures as a result of chronic tissue loading. For this reason, if runners are unable to run without pain, it may be more optimal to include weight-bearing cross-modality exercise such as cycling or elliptical training in addition to swimming. Scientific evidence on the impact of swimming training to improve running performance is limited. Some research shows that, due to increased stresses on the respiratory system, swimming training can improve running economy (i.e., "fuel economy") in non-runners (Lavin et al., 2015). In essence, the respiratory system becomes more efficient from swimming training and in turn, improves "fuel economy" during running. But frankly, if your runners are not the best swimmers, it may be more effective to have them cross-train using a different modality (for safety and frustration reasons).

Rowing ergometry (i.e., indoor trainer) is another cross-training alternative that is accessible for most. Rowing, unlike swimming, is performed under weight-bearing conditions and requires use of the upper and lower body muscles (Hosea & Hannafin, 2012). However, during rowing, as in cycling, the athlete is seated which does not stimulate the weight-bearing conditions on the legs as while running. The upper body pulling motion in combination with the lower body pushing motion engages back and upper

and lower limb muscles. These different motions compared to running may provide some aerobic benefits due to use of certain muscle groups that are minimally used in running.

Although cycling, swimming and rowing do not simulate specific running motions, they all provide aerobic benefits and strengthening of muscles that are generally under-utilized during running. This introduces some variability in training which can certainly have positive outcomes with regards to injury prevention in runners. One potentially harmful aspect of running is its repetitive nature which cyclically loads the same tissues at the same locations under large impact forces. Think about hitting a piece of wood with an ax continuously in the same location compared to changing the location of the strike. When you strike the piece wood in the same location, you will break it much more quickly than if you change your strike location. The same concept can be applied to running with regards to cyclical tissue loading. By incorporating cross-training that yield different movements compared to running may not necessarily be detrimental, at least from an injury risk perspective.

### RUNNING-SPECIFIC CROSS-TRAINING

The "Law of Specificity" states that an athlete will benefit from training that is specific to their sport. Time and energy spent training with non-specific cross-training for trained runners will have some positive effects (after all, some training is better than no training) but may not be as beneficial for a runner compared to more running-specific cross-training. Three "running-specific" modes of cross-training for runners include the stationary elliptical, elliptical bicycling and water running.

### STATIONARY ELLIPTICAL TRAINER

The stationary elliptical trainer was introduced in the early 1990s, and this exercise machine is found in almost all fitness centers and rehab facilities across the United States. It consists of two ellipse-moving pedals and although it is a weight-bearing exercise, it produces no impacts (i.e., no collision between the feet and pedal surfaces).

Research on stationary elliptical trainers in untrained college students shows similar metabolic cost (i.e., oxygen used during exercise) between treadmill running and elliptical exercise (Brown et al., 2010). This research suggests treadmill running and elliptical exercise have the same impact on running "fuel economy" in untrained non-running young adults. More recent research, however, shows lower "fuel economy" during elliptical exercise compared to treadmill running in men and women who ran at least 20 miles per week (Chester et al., 2016). This finding suggests that in (at least recreationally trained) runners, elliptical exercise may not provide as high aerobic stimulus as running, albeit, on a treadmill. In fact, four weeks of elliptical training only in high school runners resulted in lower 3,000m time trial performance compared to running training only (Honea, 2012). When elliptical training was used as supplemental training (i.e., easy run days replaced by elliptical training) in high school cross-country runners over a four-week period, changes in "fuel economy" and 3,000m performance following training were not different between supplemental elliptical training and running only (Paquette et al., 2016). These findings suggest that stationary elliptical training could be used instead of "easy" running miles in high school runners, if necessary (e.g., runners with history of injuries) but may not be an effective cross-training modality to maintain fitness without any running training. There is currently no available research on the effects of elliptical training in injured runners but runners with injury symptoms that are exacerbated by the ground impacts of running may obtain training benefits from elliptical exercise if they sustain a moderate to (mostly) high intensity during training.

Further, elliptical exercise yields lower limb biomechanics (movement) that are different than running. Specifically, elliptical exercise produces much larger quadriceps (Prosser et al., 2011; Rogatzki et al., 2012) and back extensor (Rogatzki et al., 2012) muscle activation along with continuous knee extension or straightening of the knee while weight-bearing as opposed to flexion or bending observed in running (Rogatzki et al., 2012; Chester et al., 2016). The straightening of the knee while weight-bearing is accomplished via concentric quadriceps muscle action, or shortening of muscle under tension. In contrast, the knee flexion during the weight-bearing portion of running is accomplished via eccentric quadriceps muscle action, or lengthening of muscle under tension. Although you may not be familiar with the term "eccentric quadriceps muscle action", you may be quite familiar with its effects on your quadriceps during a long run or marathon and more specifically, in the days following these runs. Eccentric muscle actions are much more damaging to muscle fibers compared to concentric muscle actions. As a result, eccentric muscle actions play a large role in the development of delayed onset muscle soreness, or DOMS. Since the muscle action is different, a return to running following extended periods of "elliptical training-only" may at first be quite "shocking" to lower extremity muscles such as the quadriceps. Coaches and runners should consider these biomechanical differences with regards to how quickly they can increase running volume when coming back from periods of cross-training. Although the stationary elliptical has training and potential rehabilitation benefits, many runners find it unbearably boring to spend hours cross-training on an indoor elliptical machine while injured.

### ELLIPTIGO

One of the latest cross-training options is the ElliptiGO, a combination of a bicycle and an elliptical machine that allows users to train outdoors just as they would on a bicycle. Similar to a bicycle, the ElliptiGO has handlebars, gears and brakes and a step length of 25 inches. Although this is over 10 inches shorter than a typical step length during slower running (Peterson et al., 2015), it is 7 to 9 inches longer than most stationary elliptical trainers. In addition to a longer step length compared to stationary elliptical trainers, the ElliptiGO motion allows the foot to recover through the stepping motion in a downward angled position, similar to running.

U.S. Olympian Meb Keflezighi, who since beginning to incorporate the ElliptiGO into his training has remained injury free and recently competed in his fourth Olympic Games. The efficacy of ElliptiGO training is also beginning to be supported by scientific research. Earlier this year, a research study conducted at Ohio University showed no physiological or 5,000m time trial performance changes between ElliptiGO-only and running-only

training over a four-week period (Klein et al., 2016). Training was matched for total training time, frequency, intensity and terrain. The study also showed that a subjective rating of enjoyment was not different between ElliptiGO and run training but, subjective ratings of lower body muscle soreness were lower during ElliptiGO training. The study's conclusions were that ElliptiGO training yields similar fitness and performance benefits as running training but with lower associated ratings of muscle soreness during training. Although the study was done on trained collegiate runners, results are promising for all types of runners. For example, during periods of planned rest from running (e.g., following a competitive season), athletes and coaches could take advantage of such cross-training benefits to maintain fitness without the high impacts and muscle damage caused by eccentric muscle actions during running. However, it is important to remember that many athletes need time off not only to allow physical but also, mental recovery following long competitive seasons. Taking a full break without any planned training is often necessary.

New research aimed to answer the question of which cross-training modality was most optimal for "fuel economy," time trial performance and, mobility, in high school cross-country runners (Paquette et al., 2016). This study was novel in that it included four weeks of cycling, stationary elliptical trainer and ElliptiGO cross-training to replace two easy runs per week instead of completely replacing running training. The study, for which the results were presented at the annual meeting of the American College of Sports Medicine, showed improvements in 3,000m time trial performance for all cross-training groups that were similar to running-only training. This finding suggests that replacing two easy runs per week with cross-training does not affect running performance. Coaches can take advantage of this result with athletes who are more injury prone than others. The most interesting findings from this study, however, were that only the ElliptiGO group of runners improved their "fuel economy" and lower limb joint mobility after the four-week training period. These benefits of ElliptiGO usage to replace easy runs may be related to the stability requirements of the ElliptiGO. When riding the device, users must use certain muscles to stabilize their core (i.e., shoulders, torso, hips) to balance their whole body while pedaling. This stability requirement may have a training effect on muscles that are under-utilized during running, cycling and, stationary elliptical training. Future work on muscle activation requirements between modalities will shed more light on the mechanisms responsible for training benefits. Since stationary elliptical trainers and the ElliptiGO are forms of non-impact cross-training they both may be helpful to runners whose injury symptoms are intensified by the impact associated with running. For runners whose injury symptoms are unbearable while weight-bearing (e.g. elliptical), the impact-less reduced gravity (i.e., body weight) environment provided by water running is often the only option.

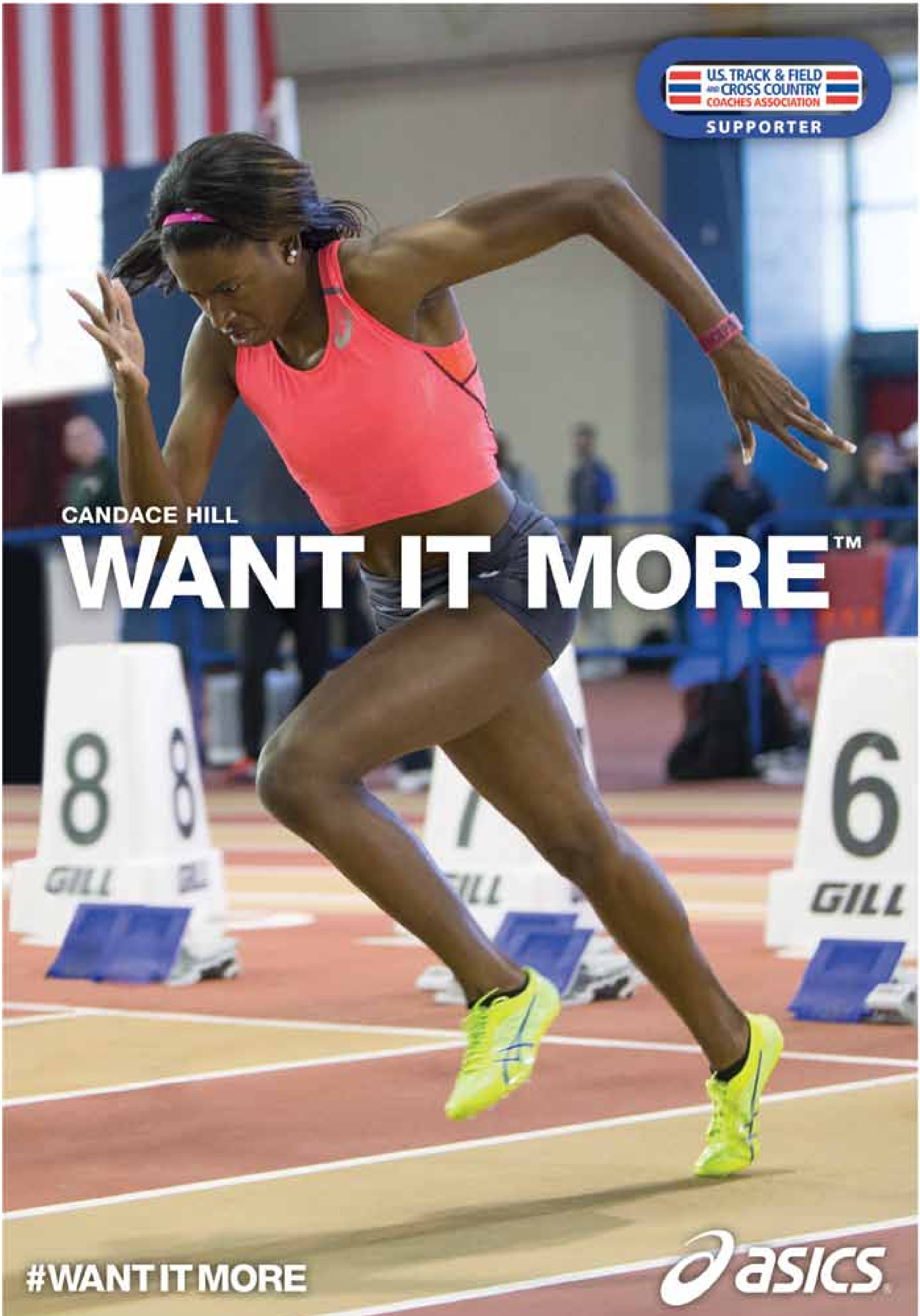
## WATER RUNNING

Water running has been a popular mode of cross-training among runners for many decades since it allows runners to very closely replicate the running motion without the high impacts and weight-bearing aspects of running. Water running can be performed in shallow water where a runner can still use the ground to propel themselves forward against the water's resistance. Deepwater running – sometimes while wearing a flotation belt – is performed in water depths that do not allow ground contact while runners attempt to move their arms and legs in motions similar to land running to stay afloat and moving forward. Just like swimming, deep water running does not provide the normal tissue loading conditions of weight-bearing exercise and coaches should incorporate supplementary weight-bearing exercises to avoid overuse injuries when they return to running.

There has been extensive research conducted on the effects of water running on running fitness and biomechanics. Research suggests that water running is an effective mode of cross-training to maintain aerobic fitness after up to six weeks of training in trained endurance athletes (e.g., competitive and cross-country runners) (Wilber et al., 1996; Bushman et al., 1997; DeMaere and Ruby, 1997). Similar to elliptical training, water running does not produce the same maximal physiological demands observed during running (Dowzer et al., 1999) suggesting limited maximal aerobic stimuli from these cross-training modalities. From a biomechanical perspective, different muscle activations and lower limb joint motions have been observed between deepwater and overground running (Killgore et al., 2006; Kilding et al., 2007; Masumoto et al., 2013). These biomechanical differences have the same implications as elliptical training with regards to returning to running training following extended periods of cross-training (i.e., different primary muscle actions). Similar to stationary elliptical trainers, water running can be quite mind-numbing in the confines of a 25 or 50m pool. That being said, many runners enjoy water running and the enjoyment aspect of cross-training on an individual basis should not be overlooked.

## CONCLUSIONS

Whether you can't run or are seeking ways to enhance your training regimen with some cross-training, remember not all forms of cross-training are created equal. Assess your needs and choose what works best. Adding cross-training to a runner's training has clear benefits and research suggest that modalities that produce running-specific movements may be more optimal. That being said, incorporating cross-training that produce non-running-specific movements can increase the variability of the training regimen and could have injury prevention implications. Some modalities may produce greater training benefits, or more "bang for your buck," than others and coaches should without a doubt consider scientific evidence to support their choices. Finally, although the physical training benefits of cross-training should not be ignored, we urge coaches to not forget about the mental or psychological aspect of cross-training for your athletes. If you notice that certain types of modalities provide a much greater enjoyment during train-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ing which allows athletes to "regroup" or "recharge" from the constant hard work that comes with running training, then by all means, take advantage of that.

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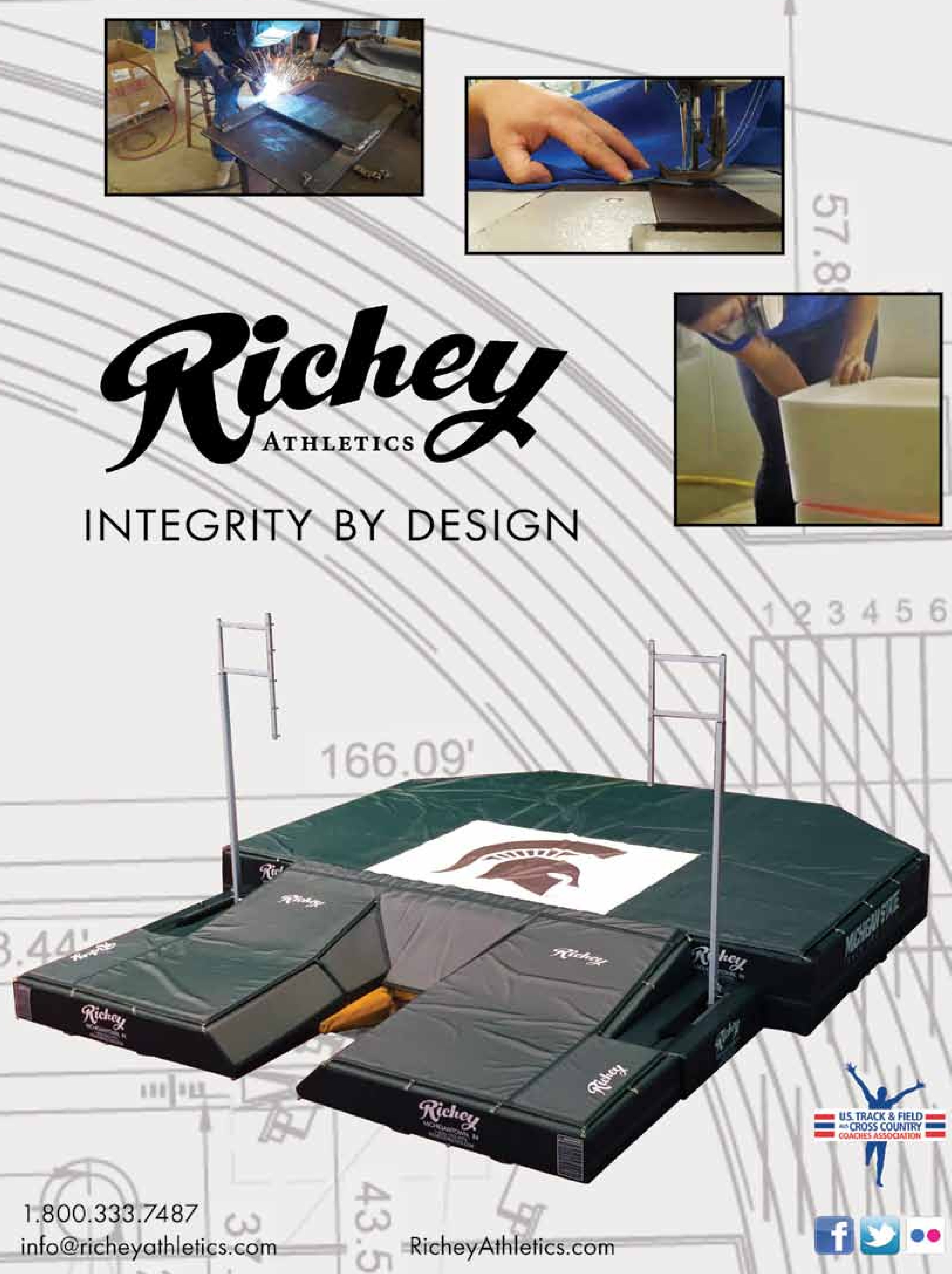
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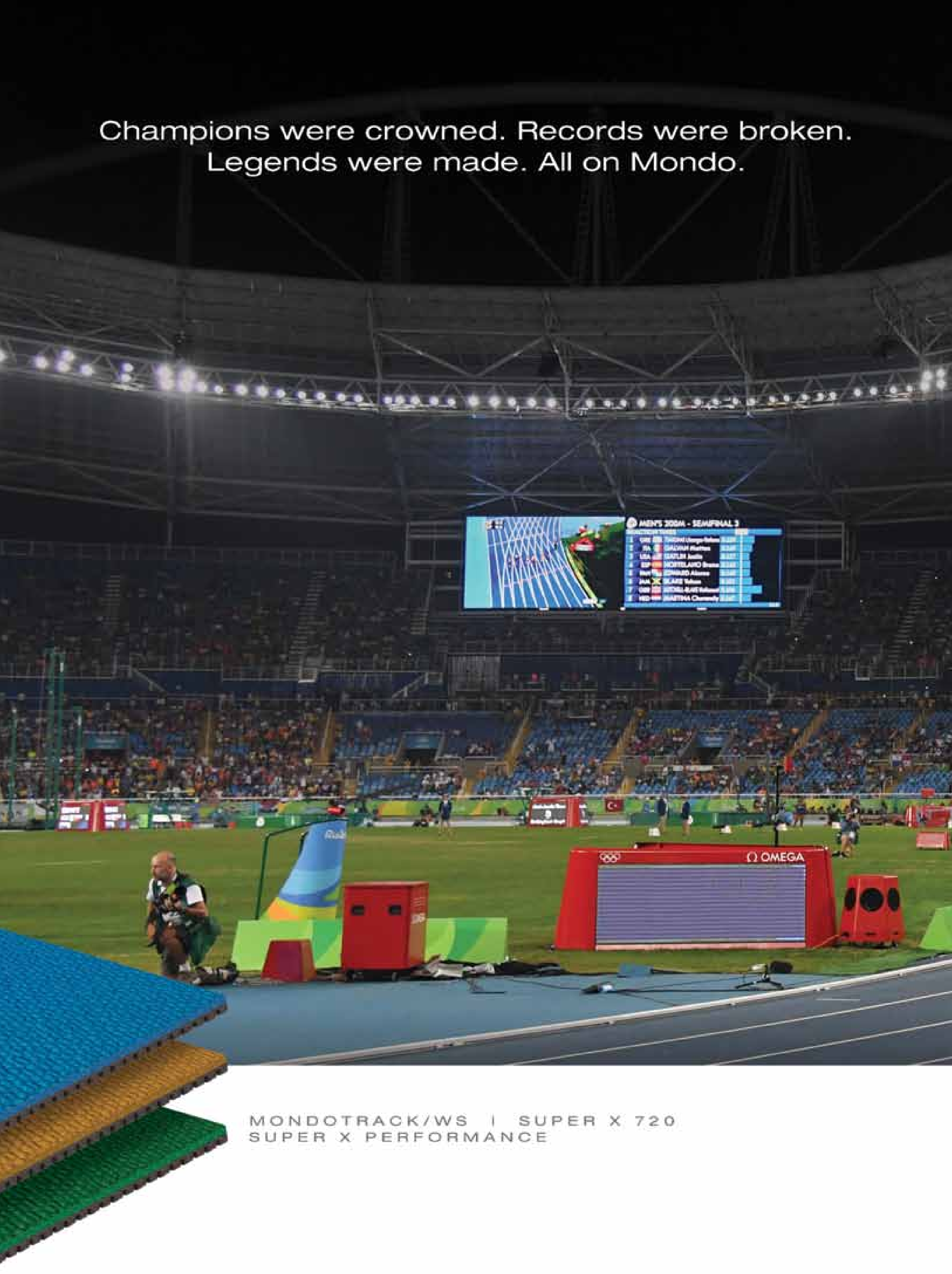
Champions were crowned. Records were broken.
Legends were made. All on Mondo.
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SUPER X PERFORMANCE


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# DEVELOPMENT RATES

## A COMPARISON FOR ELITE PERFORMERS IN THE THROWING EVENTS

**DON BABBITT, UNIVERSITY OF GEORGIA**

The throwing events in the sport of track and field are some of the most powerful activities in the world of athletics. Execution of these events at the highest level requires a combination of speed, power, coordination and flexibility, which can take many years to develop and refine. For this reason, the throwing events have been defined as sports of repetition. The focus of this article will be concentrated on a statistical data analysis to identify the developmental rates and age based performance patterns for elite performers in the four throwing disciplines within the sport of athletics (shot put, discus, hammer and javelin). While all of these disciplines are grouped as throwing events, they are each very distinct in their own way, with the implement weight ranging between 600g to 4kg for the women and 800g to 7.26kg for the men and elite level release speeds spanning from 13 m/s for shot put up to 30 m/s for the javelin.

This study is an extension of a previously published article by Babbitt and Saatara (1), which concentrated solely on the development rates of male throwers. These analyses were performed in an effort to determine how long it will take to reach the highest level of performance in each of the four throwing events, which in turn should help coaches and athletes set realistic goals and timetables for future athletic development. Development rates between the four throwing disciplines will also be examined for female throwers and a comparison between both genders in all four throwing disciplines will be carried out to determine any developmental differentiation among elite level performers.

### METHODS

Performance data for the top 24 throwers of all-time for each gender (there were only 23 for the men's javelin) in the four throwing disciplines (hammer, shot put, discus and javelin) was analyzed to determine the following values:

**1. Average age at when the top performance was achieved for each gender in each event group.**

**2. Average birth year of the top performers for each gender of each event group.**

**3. Average distance of the top performance for each gender of each event group.**

**4. Average distance for each group for each year between the ages of 18 to 30 years of age.**

**5. The percentage of the group's performance relative to their best performance year for each year between the ages of 18 to 30.**

It should be noted that the percentage of the group's best performance as a whole, in a given year, can be different from the average age in which the personal best was achieved for the group. To determine the percentage of a group's overall performance, the average distance for all twenty-four throwers was averaged for each year at each age between the ages of 18 to 30. The age with the highest average performance of the group was assigned the value of 100 percent. The averages for the remaining ages were then divided by the average for the best year to yield a percentage that less than 100 percent.

### RESULTS

Tables 1 & 2 lists the average birth year, age, age of personal best (PB) and the high and low PB for each for each gender of each throwing event group. Large differences in birth year were observed between the genders for both shot put and discus groups. The men's shot put group had an average birth year of 1969 compared with an average birth year of 1959 women's shot group. The gap in birth year between the discus groups was smaller, in that it was just under a six-year difference (1964.7 for men versus 1959 for women). There were moderate differences between the genders of both the hammer and javelin groups, with a difference of six years(1973.4 to 1979.3) observed between the genders in the javelin and an eleven-year difference (1971.1 to 1982.5) between the genders in the hammer. These differences were most likely due to the addition of the women's hammer as an official event at the Championship level in 1999, and the IAAF rule change in the women's javelin in 1999. These circumstances tend to skew the women's top performance group toward a much younger age.

The average age for personal best (PB) performance was found to be very similar for the shot put groups. Conversely, there were larger differences in the other three throwing groups. Both the discus (29.1 to 26 years of age) and hammer (29.2 to 27 years of age) groups revealed an older average age for personal best achievement for the men's group. The javelin groups showed the opposite finding, in which the women's group had an average age of PB that was three years older than that of the men's group (28 to 25 years of age).

Data from Charts 1 and 2 compare the developmental rate for each gender in terms of their progression toward their all-time best performance in the four given throwing disciplines. The shot put

appears to be the fastest developing event for both genders and also appears to have the closest developmental rate between men and women. The data shows there is only a one-year difference in the average age of top performance (25 for women and 26 for men).

Conversely, the development progression for the discus is one of the quickest for the women, whereas it shows the slowest rate of development for the men. A quick comparison of Charts 1 and 2 reveal that at young ages (18-21), the women's discus performance level is much better than all the other throwing disciplines. The developmental progressions for both the javelin and hammer appear to be similar for both genders; however, the average age of best performance is older for the women's top performers by two to three years.

See Chart 1 & 2

Comparison by gender for specific throwing events displayed a similar



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**Table 1**

| WOMEN | Shot Put | Javelin | Discus | Hammer |
|---|---|---|---|---|
| Average Birth Year | 1959 | 1979.3 | 1959 | 1982.5 |
| Average Age for PB | 28 | 28 | 26 | 27 |
| Average Personal Best | 21.68m | 67.78m | 72.30m | 76.95m |
| Highest PB in Sample | 22.63m | 72.28m | 76.80m | 79.58m |
| Lowest PB in Sample | 21.22m | 65.30m | 70.02m | 75.09m |
| Number in Sample | 24 | 24 | 24 | 24 |

**Table 2**

| MEN | Shot Put | Javelin | Discus | Hammer |
|---|---|---|---|---|
| Average Birth Year | 1969.7 | 1973.4 | 1964.7 | 1971.1 |
| Average Age for PB | 27.3 | 25.0 | 29.1 | 29.2 |
| Average Personal Best | 22.33m | 90.50m | 71.39m | 83.39m |
| Highest PB in Sample | 23.12m | 98.48m | 74.08m | 86.73m |
| Lowest PB in Sample | 21.92m | 88.22m | 69.91m | 82.28m |
| Number in Sample | 24 | 23 | 24 | 24 |

performance curve for the shot put (see Chart 3). The percentage of best performance was virtually identical all the way up to the age of peak performance for this event. Conversely, the discus performance curves differed greatly between the men and women (see Chart 4). Men's discus throwers who would ultimately go on to be the world's best lagged well behind the top women in their performance levels relative to their ultimate best until age 23. After this age, the performance percentage levels remained very close, through age 27. At this point, the top female discus thrower's performance dropped off as they approached 30 years of age while the men's discus throwers held steady at peak performance level through age 30.

The rate of ascension toward top performance for the javelin was greater for the top male throwers when compared to top female throwers (see Chart 5). The javelin also revealed the largest age difference between the genders in terms of age of top performance. The men's group reaching their top performance at age 27 while the women did not reach their top performance until age 30. The rates of development for the hammer the was similar in nature to that of the javelin in that the men showed a faster rate of performance development than the women up to age 26 (see Chart 6). The men also reached their peak performance a little earlier than the women (28 years of age to 30 years of age)

See Charts 3, 4, 5 & 6

## DISCUSSION

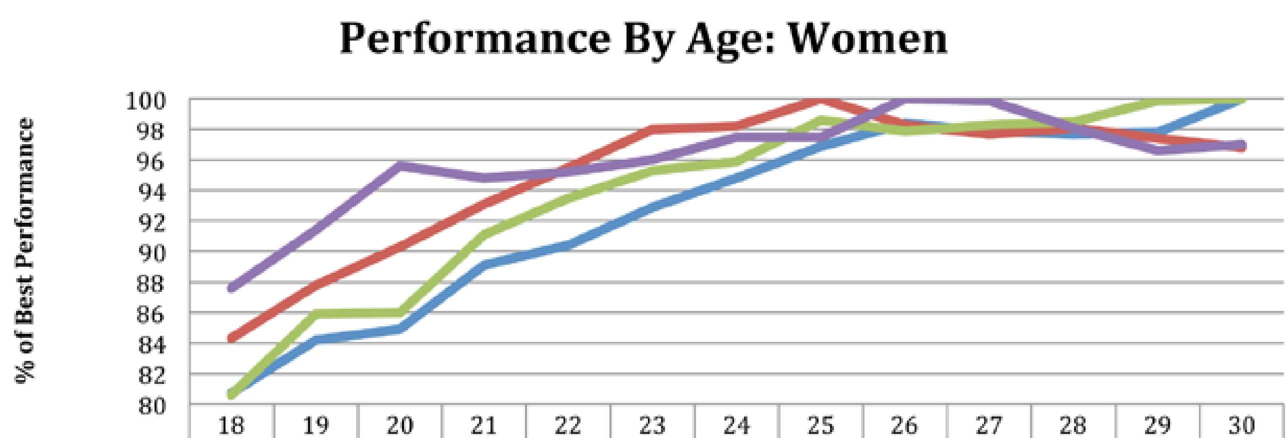
In comparing gender differences between the rate and age to top performance of the world's elite throwers, the shot put was seen to be the most similar. Of the four throwing disciplines, this event requires the most power development and has the highest percentage of release velocity generated in the final delivery phase (2,6). This suggests that throwers with superior power generating capabilities will have a greater advantage in shot putting when compared with the other throwing events. With this being said, the rate of strength development, rather than technical development, could be the primary determinant to improving performance up to peak levels.

Training methods for power development, such as Olympic and Power lifting, plyometrics and sprinting, are employed by both genders (4). These programs are often very similar and could explain the parallel slopes of performance development for this particular discipline. In addition, it appears that the development of power could be even more influential in the women's shot put, given the 4kg shot is lighter in comparison to strength levels of top level female shot putters, when compared with those of men to the 7.26kg shot. This may explain why the age of peak shot put performance for the elite women's group was younger (25 years of age), when compared with the men (26 years of age).

The developmental rates between genders for the discus throw were in stark contrast to that of the shot put. The women were roughly five percentage points ahead of the men between ages 18 to 23 as they trended toward their collective age of top performance. After age 23, the level of performance was very similar for both genders up through the age of 30. Reasons as to why women tended to increase performance at a faster rate for the "developmental years" could be due to differences in power development, and the fact that the women's competition implement is only half the weight of the men's implement (1kg to 2kg), while the strength and power levels of elite women are at least 60-70 percent of that of elite men. Women's discus throwers in this elite group appeared to rely on power development for performance compared with the men's elite discus group.

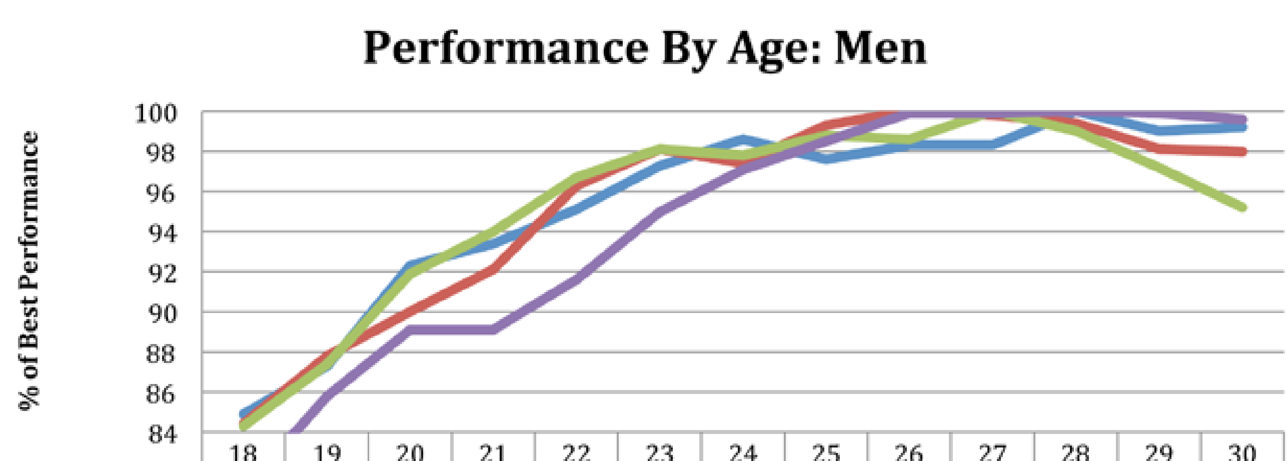
Because power development can also be enhanced at a much faster rate than speed and skill development, this hints to the notion on performances that rely of power will develop more rapidly than performance in sports that require slower developing skills such as rhythm and timing for success. In addition, it should

## Chart 1




| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hammer | 80.7 | 84.2 | 84.9 | 89.1 | 90.4 | 92.9 | 94.8 | 96.9 | 98.4 | 97.9 | 97.7 | 97.8 | 100 |
| Shot Put | 84.3 | 87.8 | 90.3 | 93.1 | 95.5 | 98 | 98.2 | 100 | 98.3 | 97.7 | 98.1 | 97.4 | 96.8 |
| Javelin | 80.6 | 85.9 | 86 | 91.1 | 93.5 | 95.3 | 95.9 | 98.6 | 97.9 | 98.3 | 98.5 | 99.9 | 100 |
| Discus | 87.6 | 91.4 | 95.6 | 94.8 | 95.2 | 96 | 97.5 | 97.5 | 100 | 99.9 | 98.1 | 96.6 | 97 |

## Chart 2

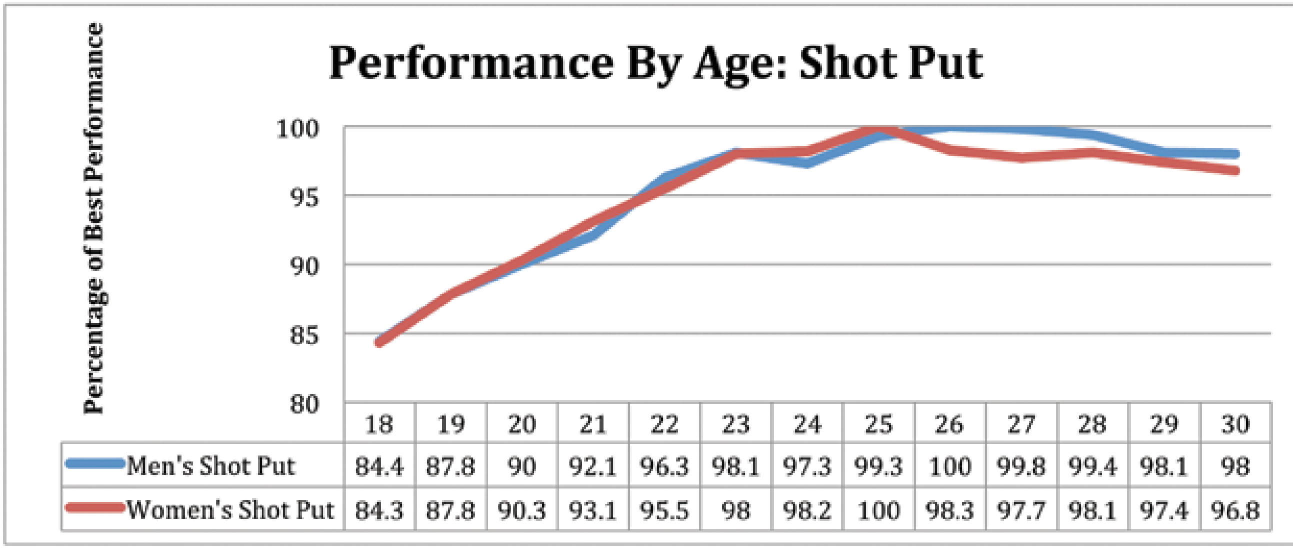



| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hammer | 84.9 | 87.3 | 92.3 | 93.4 | 95.1 | 97.3 | 98.6 | 97.6 | 98.3 | 98.3 | 100 | 99 | 99.2 |
| Shot Put | 84.4 | 87.8 | 90 | 92.1 | 96.3 | 98.1 | 97.4 | 99.3 | 100 | 99.8 | 99.4 | 98.1 | 98 |
| Javelin | 84.3 | 87.4 | 91.9 | 94 | 96.7 | 98.1 | 97.8 | 98.8 | 98.6 | 100 | 99 | 97.2 | 95.2 |
| Discus | 81.1 | 85.8 | 89.1 | 89.1 | 91.6 | 95 | 97.1 | 98.5 | 99.9 | 99.9 | 100 | 99.9 | 99.6 |

be noted that all 24 of the top women's discus throwers of all-time came from the USSR, East Germany, Cuba, China and other Eastern European countries. All of which were heavily influenced by Soviet and East German systems of training, which selected for and emphasized powerful women's discus throwers. This also explains why the average birth year for this group was 1959 which saw these athletes reach their peak in the mid-1970's when the Soviet Union and Eastern European countries were the dominant forces in the women's shot put and discus. It should also be noted that the systems that produced these results are not able to be replicated in today's world of throwing. Because of this, the data for the women's shot put and discus may not provide the exact template of what one would expect from throwers today.

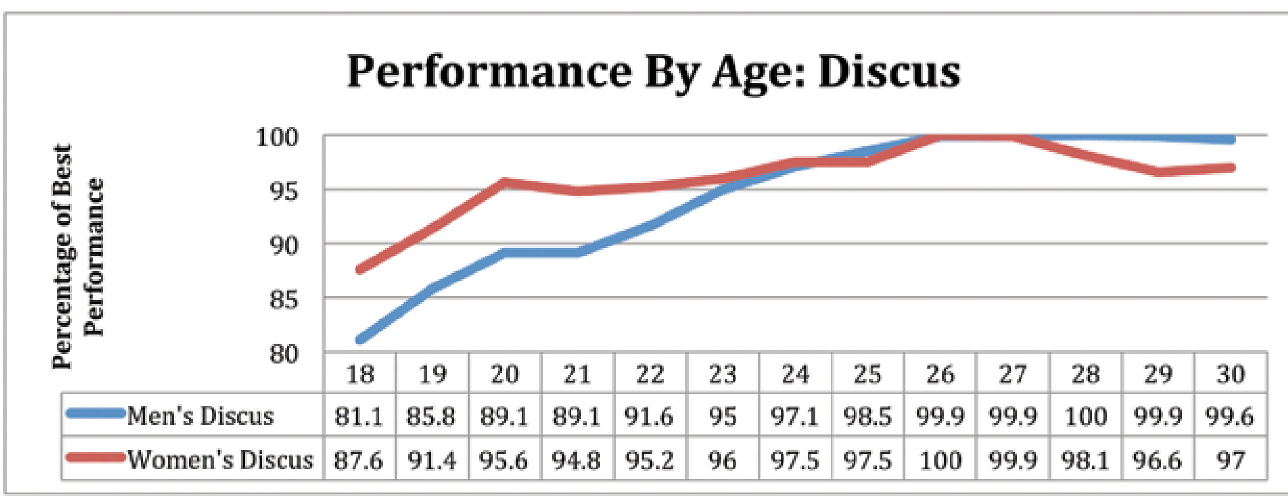
In contrast to what we have seen in the developmental rates for the shot put and discus, the javelin and hammer

## Chart 3




| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Men's Shot Put | 84.4 | 87.8 | 90 | 92.1 | 96.3 | 98.1 | 97.3 | 99.3 | 100 | 99.8 | 99.4 | 98.1 | 98 |
| Women's Shot Put | 84.3 | 87.8 | 90.3 | 93.1 | 95.5 | 98 | 98.2 | 100 | 98.3 | 97.7 | 98.1 | 97.4 | 96.8 |

## Chart 4



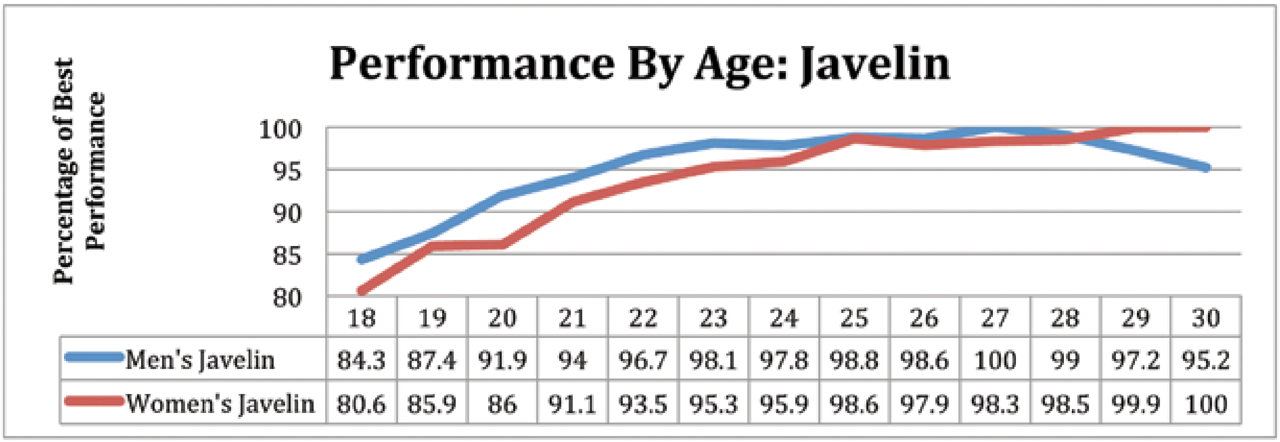

| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Men's Discus | 81.1 | 85.8 | 89.1 | 89.1 | 91.6 | 95 | 97.1 | 98.5 | 99.9 | 99.9 | 100 | 99.9 | 99.6 |
| Women's Discus | 87.6 | 91.4 | 95.6 | 94.8 | 95.2 | 96 | 97.5 | 97.5 | 100 | 99.9 | 98.1 | 96.6 | 97 |

throw developmental rates revealed both a slower and steadier rate of progression for the women compared to what was seen for the men. For both of these events, the peak age of performance for the elite female throwers was thirty years of age, compared with the peak ages for the men's javelin group of 27 years, and 28 years for the hammer. What made this result even more interesting was the relatively young female athlete sample (average birth year 1979 for javelin) due to an IAAF rule change in the javelin, and the introduction of the women's hammer as an official event in 1999 (average birth year of 1982). One would think that the newness of the events would cause the top throwers to be young, rather than older, but this was not the case.

To explain the age of peak performance gap between men and women in the javelin, it can be theorized that it takes longer for women to develop the special strength required for peak performance when compared with men. It may take longer for women to "catch up" in terms of the upper body development needed for the specific demands of the javelin which causes us to see the continued improvement of performances up to and through 30 years of age for this elite group of women's throwers (3, 7, 8).

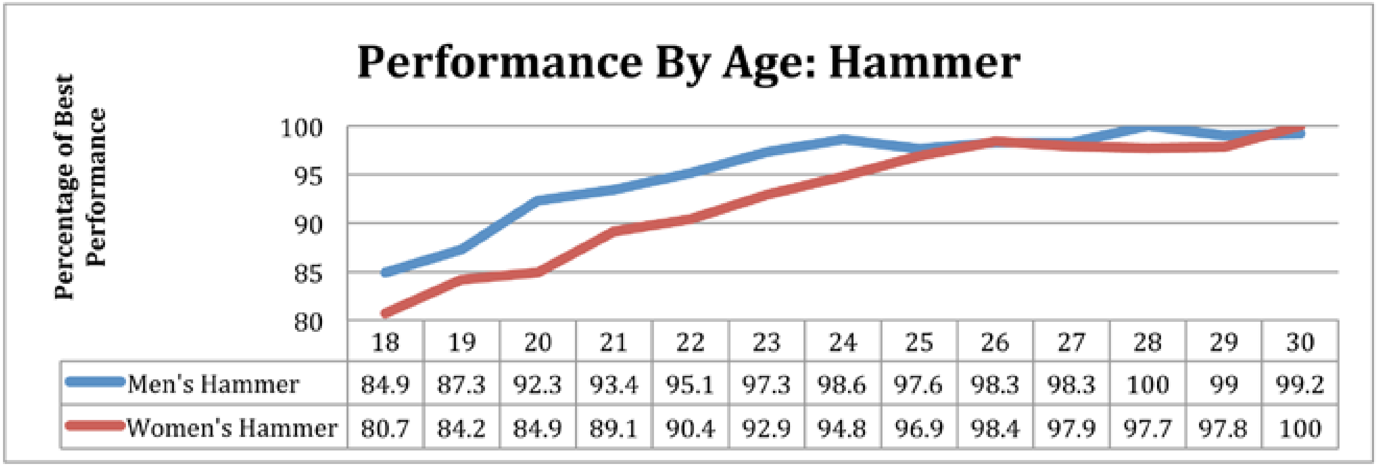
The opposite may be true for explaining the development of women's hammer throwing, relative to the men. This theory is similar to the one proposed to explain the slower development of the men's discus relative to women's discus. In this case, more time may be needed for the women's hammer throwers to develop the ideal rhythm and timing to produce peak performances. The weight of the women's hammer is only 4kg, compared to 7.26kg for the men, and the ball path from the start of the throw to delivery can be in excess of 60 meters (5), therefore, refinement of rhythm and timing may become a more important factor for long throws than that of sheer power application and development.

## Chart 5




| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Men's Javelin | 84.3 | 87.4 | 91.9 | 94 | 96.7 | 98.1 | 97.8 | 98.8 | 98.6 | 100 | 99 | 97.2 | 95.2 |
| Women's Javelin | 80.6 | 85.9 | 86 | 91.1 | 93.5 | 95.3 | 95.9 | 98.6 | 97.9 | 98.3 | 98.5 | 99.9 | 100 |

## Chart 6




| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Men's Hammer | 84.9 | 87.3 | 92.3 | 93.4 | 95.1 | 97.3 | 98.6 | 97.6 | 98.3 | 98.3 | 100 | 99 | 99.2 |
| Women's Hammer | 80.7 | 84.2 | 84.9 | 89.1 | 90.4 | 92.9 | 94.8 | 96.9 | 98.4 | 97.9 | 97.7 | 97.8 | 100 |

### CONCLUSION

This study is the first of its kind to inspect the differences in developmental rates between genders for the throwing events in track and field. It is hoped that the discussion of the data will give coaches an idea of the differences they may expect to see in training athletes of each gender and help them adjust and set their expectations if needed while developing their throwers. Because of the ever-changing nature of the sports of track and field, it would seem that further study using only subject groups made up of the top throwers who have finished their careers within the past 10 years would be the next area scrutinize.

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# A Recruiting Blueprint

## THE ART AND SCIENCE BEHIND SUCCESSFUL COLLEGIATE RECRUITING

**DENNIS NEWELL**


GARY TOWNE PHOTO

Eleven years ago I accepted the position of Associate Head Cross Country/Assistant Track & Field Coach at the University of Mary in Bismarck, North Dakota. The University of Mary is an NCAA Division II university. The University of Mary is a small, private, Catholic, liberal arts school in the Upper Plains of North Dakota. When I first started in this position, I was excited and eager to be a collegiate coach in the NCAA. However, I was quickly overwhelmed with the task of recruiting quality student-athletes to a university which seemed to have many challenges in recruiting and training middle distance and distance runners to compete at the conference, regional and national level of cross country and track & field.

I decided to gather information from coaches around me that I trusted and respected. I needed to find out what successful recruiting actually was before I could try to accomplish it. Once I found general themes I made a list of steps that were important and necessary, in the collegiate recruiting process. These steps can be followed in a sequential order to help keep me on track, organized and accountable with my recruiting.

The first step is to identify the recruits that I want to join my university and program. I start by identifying their athletic abilities in cross country and track & field events that are important to my program and in competitions that show accurate data of their athletic abilities. I look through conference, district, regional and state meet results and highlight those I want to contact in the future. Once I have identified the recruits I want to contact, I look up the address of the school they compete for and enter that information into a spreadsheet. I now have a comprehensive list and means of connection with the majority of the high school recruits I want to contact.

The next step for me is to make contact with these recruits. This can sometimes be the most difficult task of the recruiting process. I send out a recruiting questionnaire to each high school with the recruit's name on it. I call the high school and ask them to hand deliver the recruiting questionnaire to the recruit. The recruiting questionnaire is a simple form with pre-paid postage on the back and is the size of a postcard. It requests information from the recruit including mailing address, email, cell phone, GPA, ACT/ SAT score, etc. Once I have the recruit's questionnaire, I enter the information into the spreadsheet. Once a month, I submit this spreadsheet to our admission's department to add these recruits to our university's global database. The university sends out a vast amount of information on a scheduled basis; helping get information into the recruit's hands. If I do not receive the recruiting questionnaire back in a timely manner I contact their coach, send a private message to them on Facebook, or reach out by some other means. There are many creative ways to get a cell phone number or email for a recruit. I use multiple methods of getting in touch: text, email, recruiting software, social media (private messages only), hand-written letters and notes, phone calls and face-to-face meetings through home, school and competition visits. Each contact method needs to be used in an appropriate manner based on the specific information I am trying to deliver and get back from the recruit. The method of contact also should be appropriate for the relationship that I have at that point in the recruiting process. I typically follow this order of contact for the first two to four weeks of communication:

**1. Introduction: Mail a recruiting brochure, hand-written note and business card**

**2. Follow-Up: Text message asking for a specific date and time to call to talk**

**3. Contact: Phone call to discuss university and program**

**4. Information: Recruiting software email with university and program Information**

**5. Information: Recruiting software email with NCAA eligibility information**

**6. Follow-Up: Text message asking for a specific date and time to call to talk**

**7. Contact: Phone call to discuss recruiting software emails**

I continue to communicate using email or mail to deliver information, texts to set up phone calls and phone calls to follow up on email or mail information and answer questions and concerns until I build a high comfort level with the recruit. Once a comfortable level of communication is established and developed, I progress the communication into a home and/ or campus visit. I strive to make contact early and often in the recruiting season and to establish which methods of contact work best for each recruit.

The next step is to inform the recruits. I want to get the right information to my contact. That information can be delivered in several different ways (as shown above). Much like using appropriate contact methods, using appropriate delivery methods of the information is vital, as is delivering the 'right' information. If I am proactive in my recruiting efforts and informing the recruits, then I have more control in delivering the information I want them to have in their possession. I always have a reason for communication; to inform them or give them information about our university and program in a positive way. I keep my communication short, simple, to the point and meaningful everytime. I deliver the information as efficiently as I can.

From the first contact to either a commitment or walking away from my university and program, I am continually trying to create the best possible experience I can, from beginning to end. I follow the above sequential steps for the most part, but I am always adding the human touch to make sure the entire process is as genuine as possible for the recruit and their support group. I truly believe that if I can create the best possible experience for them I will have a better chance of convincing them to join my university and program; even if other variables are not exactly what they are looking for.

I am constantly trying to find the best package for each and every recruit. A package can oftentimes be financial. But, a package can also have nothing to do with finances. As a coach who is constantly recruiting, I must first listen to the needs before I present the resources that I have available. The most important variables and resources are the ones that they see as being important. I look for every academic, athletic, loan and need-based aid that is available. I have a responsibility to make the best financial package available. I am recruiting to my university and program, and part of that process is creating the most affordable option possible. Recruits are often looking for several different variables in their collegiate experience including academic, athletic, social, religious, proximity to and from their parent's home, the conference or division or association the university belongs to (NAIA/ NJCAA/ NCAA/ etc.), etc. I try to find out what 'package' they are looking

The Full Names and Complete Mailing Addresses of the Publisher, Editor and Managing Editor are: Sam Seemes, Mike Corn, 1100 Poydras St., Suite 1750 New Orleans, LA 70163.

Techniques is owned by USTFCCCA, 1100 Poydras St., Suite 1750 New Orleans, LA 70163.

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for, and then attempt to develop a package that suits their needs.

The decision is something that needs to be handled carefully and sometimes delicately. I want to make sure I have done everything appropriately up to this point. I have made contact with the recruit I wish to join my program. I have communicated with the recruit early and often. I have given adequate information I want them to have regarding my university and program, collectively created the best package that I have the resources to create for that specific person, and I have created a positive experience in the recruiting process that will give them the clearest picture of my program.

Once I feel the recruit has received all the information they need to make an informed decision, and they have no more questions or concerns about our university and program, I bring up a timeline on making a decision to either join my university and program or walk away. If the first five steps are followed to the best of my ability; then I have done my best to lead the recruit to join my program. However, keep in mind, creating the best opportunity at your university and within your program is not always enough to get a commitment. Some will be looking for something else in their collegiate experience. I understand that I do not have everything to accommodate every single recruit out there. But, if they are looking for a place with the resources I have, then I want to make sure I do my best to get their commitment.

Identify, Contact, Inform, Experience, Package and Decision. These six steps have helped me stay on task in a sequential order in my recruiting duties. I use these guidelines while allowing for my own personal touch to be integrated into the process. I have a set of tools to use from my university and program, and it is my job to use those tools in an appropriate manner.

Most universities and programs are different. We do not all have the same number of scholarships, the same number of coaches on staff, the same facilities, etc. I understand that I recruit against other coaches and programs with different assets and different challenges. I decided long ago that I cannot focus on what I do not have and what others do have. I need to use the resources available to me to get recruits to my university and program.

### HERE ARE SOME KEY POINTS TO THINK ABOUT IN THE RECRUITING PROCESS:

#### I AM "SELLING A PRODUCT," SO I BETTER KNOW MY PRODUCT

The better I know my university and program, the less likely I will be to get caught off-guard with a question or concern that I cannot respond too. I make sure I know my strengths and weaknesses as a community, as a university, as a program, and as a coach. I sell my strengths and I defend my weaknesses. I meet with our admissions department once a month to go over our academic programs, scholarships, grants, loans and other aid opportunities available to each and every recruit. What do I have to enhance my university e.g. scholarships, facilities, coaches on staff, graduate assistants on staff, location, altitude, cost of school, degrees, culture, history, etc.? I may have to defend some of these variables as well.



GARY TOWNE PHOTO

### MY UNIVERSITY AND PROGRAM HAS A NICHE, KNOW IT AND OWN IT

I work at a university that has a niche (I believe all schools have a specific niche). Thus, I need to identify those recruits that fit the niche of my university. My recruiting class, roster retention and overall team success is directly tied to getting the 'right' recruits into my program. I work at a NCAA Division II, Catholic/ Benedictine, private university in south central North Dakota that has limited resources from academics, budget and facilities to scholarships, staff, etc. I identify the recruits that most closely fit the niche of my university. I own what we are, I never try to sell the recruit something that we are not.

### I DESIGN A "RECRUITING SCHEDULE" JUST LIKE I WOULD DESIGN A TRAINING PLAN FOR MY CURRENT STUDENT-ATHLETES

Every day of the week I have a schedule of states I will call. Every week I go through and highlight the recruits I speak with in blue, and the recruits I can't get in touch with in orange, helping me track interest levels. Every four weeks I sit down with my coaching staff to communicate where we are as a program. I continually evaluate each staff member to make sure everyone is accountable to the overall recruiting goal of the program. At this time I also reevaluate my goals and strategies to enhance my recruiting; do I need to make more calls, less calls, longer conversations? Should I use different methods of contact for different recruits, develop better recruiting resources like brochures/ videos/ etc.?

### I MAKE IT MY JOB TO GET THE RECRUIT THROUGH THE UNIVERSITY ADMISSIONS AND NCAA ELIGIBILITY PROCESS

There are several steps to getting a recruit into a university and eligible to participate in athletics at the NCAA level. I walk the recruit and their support group (high school coach, parents, high school counselor, etc.), through the process step by step until the recruit has been accepted to my university and evaluated by the NCAA through the NCAA Online Eligibility Center. The NCAA and the university will likely need an official high school transcript, an official SAT/ ACT score, a completed application and payment of the application fee. A list of tasks will need to be completed by the recruit through this online account; both the university and the NCAA will make evaluations and determinations on the given information to make a decision on acceptance and eligibility status.

### RECRUITING INTERNATIONAL STUDENT-ATHLETES

Recruiting international student-athletes can sometimes add an extra element of work in the University Admissions and NCAA Eligibility Process. Each university is different and I suggest you contact your admissions department and your international admissions representative in these regards. My university requires many steps to get international student-athletes in a position to attend our university and to be eligible to participate in athletics. The international student-athlete needs to register with the NCAA Online Eligibility Center and submit official transcripts and test scores like any other student-athlete looking to become NCAA eligible. The extra work comes into play when getting accepted into my university. The international student-athlete needs to take the above stated steps to get accepted into the university. However, they also need to get an official transcript evaluation by World Education Services, an official TOEFEL score, an official passport, an official proof of finances and an official I-20 form completed and submitted to the university in a timely fashion. These steps can be very time consuming and need to be addressed early in the recruiting process. Also keep in mind that some international student-athletes will have special circumstance that could differ from your local student-athletes such as finances, travel, communication, etc.

### I USE SOCIAL MEDIA TO SHOWCASE MY UNIVERSITY AND PROGRAM

Social Media is a very useful tool if used properly and professionally. Our program uses Facebook, Twitter and Instagram to show potential teammates our day to day life so they have a sneak peak of what it will be like to be a part of our program. We use these types of social outlets to show pictures, events, awards, team activities, new recruits, coaches, etc. that help to show a positive reflection of our community, university, program, student-athletes and coaches.

### I SET RECRUITING GOALS THAT CHALLENGE MYSELF

*'Diligence is the mother of good luck.'*
*- Benjamin Franklin*

I make contact with recruits that I might think would never go to my university, for whatever reason, as my first challenge. I try to make contacts with as many recruits as I can in hope to find the next "diamond in the rough." I put in the time because I believe hard work pays off with BIG returns. Recruits very rarely just randomly show up on the doorstep of my office in Bismarck, North Dakota, so I have to go out and find them and get them interested in my university and program.

### VISITS: COMPETITION/ HOME / CAMPUS

It is important to get to competitions to evaluate recruits to determine more than what is on a piece of paper. Biomechanics, build, attitude, social interaction, team cohesion, relationship with coach, etc. Home visits are a great way to personalize the recruiting experience and show that I am willing to make the effort to accommodate the recruit. I take the opportunity to find out what the recruit's background is in their home with their family. A campus visit is a must for any recruit that is seriously considering my university and program as an option. I walk them through the halls and classrooms, show them all the facilities, have them eat lunch and stay in the dorms with current student-athletes.

### I MAKE IT GENUINE BY ADDING THE HUMAN TOUCH

I want to do as many things to make the recruiting process genuine. Hand written notes and face to face interaction are the best two methods of creating a lasting impression on the recruit and their support group. An email can be easily deleted, a phone call easily forgotten; but a hand written note from the Head Cross Country/ Track & Field coach is something that can make a lasting impression on a recruit and their support group. A home visit is an interaction that will also make a lasting and genuine impact on recruits and their support group.

### I DON'T TAKE IT TOO PERSONAL

I can assure you that you will be told "no" more than you are told "yes" by the recruits. The first few times I had a recruit tell me he (and she) was going to another university… well, I was really upset. I could not accept that the recruit did not want to be a part of my university and program.

I understand that I am recruiting into my niche. I need to be open to the idea that my strengths are not the right fit for every recruit. Again, I don't want every recruit, I want the 'right' recruits.

### I HANDLE MYSELF LIKE A PROFESSIONAL IN ALL SITUATIONS

I look and sound the part. First impressions and perceptions can make or break my relationship with the recruit. I establish myself as a professional in every sense of the word from the start of the coach/ athlete relationship. My professionalism will earn respect from the start of the recruiting process.

### I NEVER TALK ABOUT OTHER PROGRAMS POORLY

I made a rule from day one that I would never recruit by speaking poorly of any other program, university, or coach. No matter what, I only can attest to my university and program. I refuse to 'negative' recruit another program. If the recruit hears you talking in a negative manner about another program or coach it only reflects on your character and can ultimately tarnish your reputation, as well as your university and program.

### BE CREATIVE, BE PATIENT, BUILD RELATIONSHIPS; RECRUITING TAKES EFFORT, CONSISTENCY AND TIME

"Recruiting is like a shower; you have to do it every day or you will start to stink!"
- Gary Wilson

I am building relationships with the recruit, with the recruit's parents and with the recruit's coach. I know this process will take time, and I know I need to earn the recruits trust over time and by my efforts. Thus, I am constantly trying to separate myself from other programs with my personal touch and genuine approach to the recruiting process. I talk to the recruit about their goals and where they want to take their running, career and life. I make the recruiting process about their needs, wants and desires. If I am like every other coach and every other program, I don't trust I will win that battle.

### MISTAKES

The majority of this article is built around two learning experiences; gaining knowledge from those around me and making mistakes with or without that knowledge being used properly. I understand that mistakes are going to be made, and recruits will be won and lost. However, this information is designed to minimize those mistakes and losses and increases those successes.

My recruiting philosophy is fairly simple. I focus on becoming better at the process of my daily tasks, instead of the outcomes. I follow sequential steps in the recruiting process and work hard to showcase the resources I have available to me with a genuine delivery.

Dennis Newell is the Head Cross Country/ Associate Head Track & Field Coach at the University of Mary in Bismarck, North Dakota. Newell holds a B.S. in Exercise Science and a M.S. in Kinesiology. Newell is also a USTFCCCA Specialist in Endurance and is currently completing his USTFCCCA Master Endorsement in Cross Country.

KIRBY LEE PHOTO

# ON THE PHYSICS

## AND TECHNIQUE OF HAMMER THROWING

YURI SEDYKH AND VLADIMIR STRELNITSKI

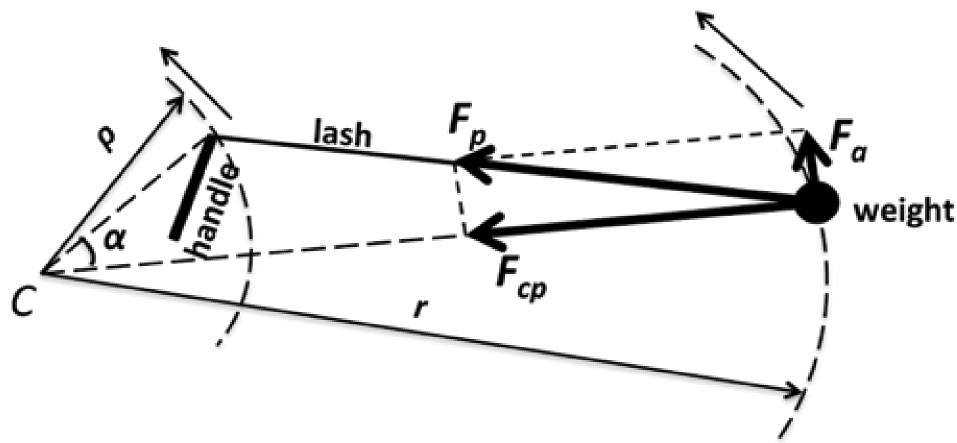


Fig. 1. The model "Nagaika." $C$ is the center of rotation; $\rho$ is the radius of drive at which the point of the attachment of the lash to the handle is being moved; $r$ is the radius of the weight's orbit; $\alpha$ is the lead angle; $F_p$ is the force of the pull exerted on the lash by the handle. When the handle is turned with a non-zero lead angle ($0° < \alpha < 180°$), the pull $F_p$ is resolved into two components – the centripetal force $F_{cp}$ keeping the weight on its orbit and the force $F_a$ accelerating the weight along the orbit.

It is universally recognized that of all contemporary throwing events the hammer is the most challenging technically. The physical theory of the complex and extremely fast motion of the hammer-thrower system has not been developed sufficiently which leaves many debatable technical questions without well-grounded answers. What follows is the summary of a collaborative investigation of the problem by the Olympic and World champion and World Record holder Yuri Sedykh and a physicist and coach Vladimir Strelnitski.

In the following discussion it is supposed that the thrower is right-handed (turning counterclockwise when observed from above).

### 1. THE "NEUTRAL" POSITION AND THE "TRIANGLE" OF THE CHEST AND ARMS

An important breakthrough in the hammer throwing technique occurred in the 1960s-70s when the leading throwers, first in the Soviet Union and then in other countries, abandoned the "dragging," discus-like technique and replaced it with a more "frontal" style.

In the modern technique, the hammer is efficiently accelerated only from the moment of the right foot landing (hammer azimuth 270) to the moment of the hammer's lowest point, which is supposed to be directly in front of the thrower (azimuth 0). When the hammer arrives at its lowest point, the thrower arrives at a highly symmetric, "neutral" position: the axes of the feet, pelvis and shoulders are parallel, the weight of the body is equally distributed on both legs, the shoulders and the arms make a symmetric, isosceles triangle, with the wire of the hammer being symmetric relative to the sides of the triangle. In this position, the thrower cannot accelerate the hammer. S/he starts the rotation on the left heel and right ball together with the hammer (i.e. with the same angular speed) without breaking the symmetry of the wire of the hammer relative to the triangle of the chest and arms.

Actually, this symmetric configuration of the upper body and the hammer (the "triangle") is kept unchanged through all the turns, up to the release. In contrast with the "still" upper body, the lower body is more active: the axis of the feet and, to a lesser extent, the axis of the pelvis, overtakes the axis of the shoulders during the single support phase to create a torque accelerating the hammer after the right foot landing. In order to keep the "triangle" configuration of the upper body, which is crucially important for an efficient acceleration of the hammer, the face of the thrower should always be directed toward the hammer (but the sight should not follow the up and down movements of the hammer, it remains at the level of the horizon, or slightly higher).

The major advantage of the new technique is a larger radius of the hammer rotation. Although everyone knows the advantage of a large hammer radius (a longer hammer has a potential to fly farther!), the reasons for that are not immediately obvious. The two main reasons are: (1) at a given angular speed of rotation, the linear speed of the hammer is proportional to its radius, therefore in order to reach a high linear speed with a shorter hammer one has to rotate faster, which runs across physiological limits; and (2) at a given linear speed of the hammer, the centrifugal force acting on it is inversely proportional to the radius of rotation, so a greater radius of rotation corresponds to a lesser physical load on the thrower.

Another advantage of the new technique is the usage of stronger muscles (mostly legs) for the acceleration of the hammer. In the “dragging” technique, considerable load in creating the accelerating torques falls on the slanting muscles of the twisted body, which is less efficient and potentially conducive to back problems.

### 2. ROTATION, TRANSLATION, PENDULUM

The inclined, screw-shaped orbit of the hammer is the sum of three motions: rotation in a horizontal plane, translation in the direction of the throw, and pendulum-like oscillation in a vertical plane. The ultimate source of all these motions is the interaction of the thrower’s legs with support. Tangential efforts (as if the thrower tried to turn the ground with the feet, in the direction opposite to the direction of the hammer rotation) provide the hammer with the horizontal acceleration (see section 4 of this article). Transferring the body weight from leg to leg gives energy to the pendulum motion. The heel-toe rolling on the external edge of the left foot in the direction of the throw draws the hammer into a translational motion in the same direction.

The thrower should take care of all the three components, in a measured, proportional way. Ignoring the rotational or translational component (sitting back insufficiently in the double support phase; outrunning the hammer insufficiently in the single support phase) makes the hammer’s orbit too steep and doesn’t allow the thrower to impart a high linear speed to the hammer. Ignoring the pendulum component (insufficient transfer of the body weight from leg to leg) makes the orbit too flat, which shortens the range of the throw even if the thrower succeeds in accelerating the hammer to a high linear speed at the release.

An important property of the pendulum component is the vertical deceleration, “soaring” of the hammer when it rises towards its highest point on the left from the thrower. The thrower should use this property: give the hammer more freedom (relax the upper body) and smoothly, fast but without haste, overtake the hammer by pivoting on the toe of the strongly bent left leg, with an active motion of the right thigh up and forward, carried close to the left thigh. If, while doing so, the thrower manages to keep most of the body weight on the left leg, the landing on (the toe [!] of) the right foot will be swift but soft and the transfer of the weight to the right leg gradual enough. The “falling” on the right foot is a major technical mistake, unfortunately quite frequent. It hinders the efficient execution of the three important technical elements following the foot landing: (1) the acceleration of the hammer in its way to the lowest point, (2) the passage through a correct “neutral” position and (3) the active rotation on the left heel and right tow in the transition to the single support phase.

### 3. THE AXES OF ROTATION

Contrary to a widespread belief, the system hammer-thrower doesn’t have a single axis of rotation. The hammer (and the arms of the thrower) rotate around an axis deflected from the vertical backward (relative to the direction of throwing), the angle of deflection increasing from 20-30 in the first turn to 35-45 before the release.


In contrast to this, the thrower's center of gravity rotates around an almost vertical axis, only slightly inclined backward. The difference of the two axes becomes apparent in the characteristic up-and-down "waving" of the arm "triangle" relative to the trunk during the turns.

The rotation of the torso around the almost vertical axis in a full heel-toe turn is in itself composed of four partial rotations, each 90° in hammer's azimuth: (1) a double-support turn around the axis passing through the left heel and the head of the thrower, (2) a single-support turn around this axis, (3) a single-support turn around the axis passing through the toe of the left foot and the head and (4) a double-support turn around this axis. The higher the technical skills of the thrower are, the fuller each of these partial rotations is and the smoother the transition between them.

### 4. THE NATURE OF THE ACCELERATING FORCE

How does the thrower create the force that accelerates the ball along its orbit, which means – perpendicular to the wire? The answer can be obtained by considering a simple, easily manufactured model, "Nagaika": a cord ("lash") with a weight at one end, the other one being attached to a wooden "handle" (Fig. 1). Nagaika whips were used by Russian Cossacks to exert control over horses. Taking the free end of the handle in your hand and trying to make the weight turn in a horizontal plane, you will see that you can only do that by rotating the end of the lash attached to the handle around a vertical axis which also becomes the axis of the rotation of the weight, at a larger radius.

Another important conclusion from this experiment is that if we want to accelerate the weight (i.e. to make its rotational speed rise), the point of the lash attachment to the handle must lead the weight in the "phase angle" (the angle between an immovable reference radius and the radius of the moving point). The lead angle of the attachment point relative to the weight is designated in Fig. 1. The caption to Fig. 1 briefly explains how the pulling of the lash with a lead angle 0°< <180° creates an acceleration force tangential to the orbit of the weight. This force is a small part of the force of the pull and it is maximum when the lead angle is 90°. (See Figure 1)

How does the "Nagaika" model work in the application to the hammer?

Obviously, the role of the "lash" is played by the wire of the hammer augmented with the arms of the thrower. In the old, "dragging" technique, the left arm dominated in the pull from the beginning to the end of the throw. In the modern technique it dominates only during the preliminary winds and the entry into the first turn; in other turns and in the release both arms participate in the pull equally. The point of the attachment of the "lash" to the "handle" (the role of the "handle" is played by the torso of the thrower) is now the midpoint of the chest. During the phase of the hammer acceleration (from the azimuth of 270 to 0) this point is moved, mostly by an effort of the legs, around an axis close to the axis of the hammer rotation, along a "curve of drive" with a smaller radius than the radius of the hammer rotation but with a phase

KIRBY LEE PHOTO

lead, which creates an acceleration force. The primary generator of this "driving" rotational motion of the torso is the interaction of the legs with support.

## 5. THE BALANCE OF FORCES AND TORQUES

In the reference frame rotating together with the thrower, s/he is a subject of two opposite centrifugal forces, one acting on the hammer and the other – on the thrower's center of gravity. Besides, there is the weight of the thrower, the horizontal and vertical forces of the support reaction and the torques (relative to axes passing through the feet) produced by all these forces. The optimum balance of the forces and torques at each stage of the rotation is crucial for keeping the balance of the body without which an efficient acceleration of the hammer is impossible.

We developed a quantitative mechanical model that demonstrates that the optimum equilibrium requires a sufficiently deep sitting back in the double support phase and a sufficiently deep squatting (left knee collapse) in the single support phase. The model provides the optimum angles between the hip and the horizontal, the shank and the vertical and the trunk and the vertical for each stage of the turn, depending on the weight of the hammer and the weight, height and other anthropometrical characteristics of the thrower. In practice, each thrower should find the optimum angles by trial and error, remembering that the typical error of a beginner is an insufficient sitting back in the double support phase and an insufficient knee collapse in the single support phase.

The practical criterion of sufficiency is a "nicer feeling" of the motion. For example, on the entry into the first turn, the thrower should "fall" back (with a rotational motion of the pelvis around the left foot) so far that by the moment of the "neutral" position the thrower feels that the feet became "light," freed of any stress of their interaction with the support. This feeling corresponds to the balance of the horizontal component of the centrifugal force acting on the hammer and the (practically horizontal) centrifugal force acting on the body's center of gravity. The sufficiently deep squatting on the left leg in the single support phase helps the thrower to remain (rotate) longer on the left toe, passing to the right leg smoothly and softly, without "falling" on it.

The horizontal pull from the hammer trying to drag the thrower out of the circle is maximum when it is in the middle between the hammer's lowest and highest points, i.e. when the hammer's azimuth is around 90 or 270. Around these moments, the pull from the hammer cannot be fully balanced by the centrifugal force acting on the thrower's body but it can (and should) be countered by setting, respectively, the left or the right foot firmly against the ground. This "blocking" leg effort also serves to raise the vertical ("pendulum") component of the hammer speed.

Besides other things, our mechanical model gives a quantitative explanation of the advantages of the controversial "leaning forward" used by some throwers on the entry into the first turn. Although keeping the force balance requires from a leaning forward thrower a deeper sitting back with the lower body (which tends to decrease the radius of the hammer rotation), the net result of leaning forward with an additional sitting back turns out to be an increase of the hammer radius, up to 5-10 percent. As mentioned before, the greater radius of the hammer rotation allows the thrower to give the hammer a higher linear speed for the same angular speed of the system rotation, which makes the entry more comfortable and efficient. In the subsequent turns, the centrifugal force acting on the hammer increases and the balance of forces requires a more upright, and even slightly leaning backward position of the upper body.

## 6. THE RATE OF THE HAMMER SPEED RISE

It is well known that the length of a throw is determined primarily by the linear speed of the hammer at the moment of release. The speed increases gradually in the winds and turns, according to the equation

$$V_f = V_0 \cdot \prod_i (1 + \delta V_i)\ ,$$

where $V_f$ is the final speed, $V_0$ is the speed developed upon the entry into the first turn, $\delta V_i = (V_i - V_{i-1})/V_{i-1}$ is the fractional speed increase in the turn i, and the symbol $\prod_i$ means a product of several multipliers, marked by the running index i. We determine a turn as a period between two consecutive "neutral" positions of the thrower (consecutive lowest positions of the hammer) and, besides the turns, we include in the list of the multipliers the speed increase in the final effort, i.e. the effort of the thrower to "lift" the hammer from the moment of its last lowest point to the moment of release.

It can be shown that the relative speed increase in any turn has a theoretical upper limit: $\delta V_i \lesssim 0.3$. In reality, the best throwers are close to this limit, but only in their first turn. In subsequent turns, $\delta V_i$ steeply drops and may only increase again in the final effort. For example, in the 86m 74cm record throw by Yuri Sedykh the value of $\delta V_i$ in the three turns and the final effort were, respectively, 0.25, 0.08, 0.04, and 0.10. The drop of $\delta V_i$ is explained by the worsening of the conditions for the hammer acceleration from turn to turn, because of the steeply increasing centrifugal force acting on the hammer.

The above equation demonstrates the importance of developing the maximum possible hammer speed on the entry into the first turn, because $V_0$ is not simply added to the speeds developed in the subsequent turns but it is the basis, the seed factor, for the speed growth. Thus, the rule is: the initial speed $V_0$ should be as high as the thrower can develop without compromising the technique of the subsequent phases of the throw. The best throwers reach about 2/3 of the final hammer speed on the entry into the first turn.

The discussion throughout this article helps to solve the dilemma of the three versus four turns. If the thrower is ready to work hard on mastering an impeccable, fast and broad entry into the first turn, excellent rotations, and a powerful, explosive final effort, the three turns may be an optimum solution. After all, the current world record in the men's hammer throw was established 30 years ago with the three-turn technique. However, if there are doubts in any of these three capabilities, it's probably better to follow the majority of contemporary throwers and focus on the less technically demanding four-turn option.

Yuri Sedykh was the 1976 and 1980 Olympic Champion in the Hammer Throw. He set the current world record of 86.74m (284'7") in 1986.

Vladimir Strelnitski has PhD in astrophysics. Director Emeritus of the Maria Mitchell Observatory (retired in 2013). He taught the Physics of Movement at Springfield College in Massachusetts and currently coaches the hammer throw at Springfield.

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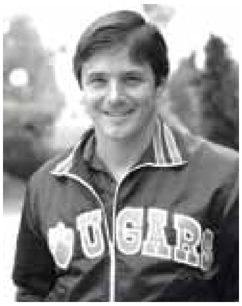
# USTFCCCA COACHES HALL



## TERRY FRANSON

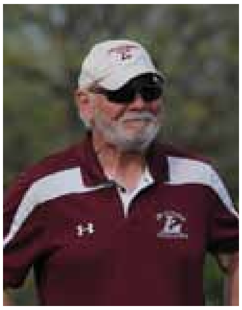
AZUSA PACIFIC

Terry Franson's rise from an All-American hammer thrower in Division II to one of the most successful coaches in NAIA history was nothing short of meteoric. Franson took over as head coach of the Azusa Pacific program in 1982, leading the program to a runner-up finish in the national championship meet. For their efforts, Franson was named the NAIA Coach of the Year for the first of 10 times in his career. Over the next 13 years, APU dominated the NAIA national title scene. Franson led the Cougars to 11 team titles, including seven in a row from 1983-1989. To this day, APU is one of only two programs in NAIA history that has won more than four in a row.

Two athletes in particular helped turn Azusa Pacific into the powerhouse that it was in the mid-1980s: Innocent Egbunike and Christian Okoye. Egbunike, a sprinter joined the program in 1981 and Okoye, a thrower, enrolled the following year. Egbunike and Okoye combined for 12 individual titles in the span of five years. The duo's success wasn't limited to the collegiate level. Egbunike won a bronze medal at the 1984 Los Angeles Olympics as part of Nigeria's 4×100 relay team and Okoye, affectionately nicknamed "The Nigerian Nightmare," played in the NFL with the Kansas City Chiefs from 1987 to 1992 and scored 40 touchdowns.

Another one of Franson's pupils, Dave Johnson, earned a bronze medal in the decathlon at the 1992 Barcelona Olympics. Other Olympians that Franson coached include two-time Olympian Davidson Ezinwa, Osmond Ezinwa and Fatima Yusuf, the first African woman to go sub-50 at 400 meters.

When Franson stepped down as head coach in 1995, he had mentored 125 All-Americans and 39 national champions. He was inducted into the NAIA Track & Field Hall of Fame in 1997 and the Mt. SAC Relays Hall of Fame one year later.



## PAT HEALY

UW-LA CROSSE / SOUTHERN OREGON STATE

Pat Healy's illustrious 40-year coaching career lasted through the end of the 2016 outdoor track & field season when he retired from UW-La Crosse.

Healy began coaching at Dallas High School in Oregon in 1976 and then in 1983 moved to the collegiate ranks as an assistant at his alma mater, Western Oregon State. Healy landed at UW- La Crosse in 1991 and remained there until his retirement. While Healy's cross country teams were successful in their own right with two top-4 finishes at NCAAs, it's what his teams did on the track and in the field that made UW-La Crosse a national mainstay on the Division III level.

From 1992 to 2014, the Eagles finished in the top four twenty-one times between the NCAA Division III Indoor and Outdoor Track & Field Championships, including five runner-up finishes indoors (1993, 1999, 2001, 2009, 2014) and two outdoors (1993, 1997).

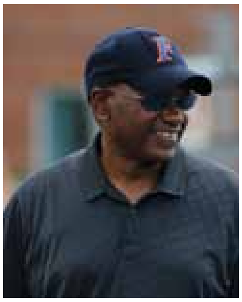
UW-La Crosse finally broke through in 2015 when the Eagles swept the indoor-outdoor titles and Healy became just the third coach in history to be named USTFCCCA Indoor Coach of the Year and USTFCCCA Outdoor Coach of the Year in the same academic year.

In his final year at UW-La Crosse, Healy's teams took sixth indoors and fourth outdoors, adding yet another top-4 finish to the already staggering total. All told, the Eagles were top-10 in 41 of a possible 50 NCAA championship meets.

His teams at UW-La Crosse featured a total of 467 All-Americans, which included 261 outdoors, 196 indoors and 10 in cross country.

At the conference level, the Eagles were head and shoulders above the rest. UW-La Crosse won 16 indoor titles and 16 of the last 19 outdoor crowns.

Healy was named USTFCCCA National Coach of the Year a total of six times and Midwest Region Coach of the Year four times.



## MIKE HOLLOWAY

FLORIDA

Throughout his career, Mike Holloway has stayed true to Gainesville, Florida. Whether he was the assistant coach at Gainesville High School (1983-84), a graduate assistant with the Florida women's team (1986-87), the head coach of Buchholz High School (1985-1995) or back with the Gators since then, Holloway never wavered in his desire to build local programs to national powerhouses.

The Gators have thrived ever since Holloway took over as the head coach of the men's track & field programs at the University of Florida in 2003 and added the title of women's head coach in 2008. In his first three years, the Florida men placed second at the NCAA Division I Indoor and Outdoor Track & Field Championships four times.

A breakthrough came in 2010 when he guided men's track & field program to the NCAA Indoor title. That same meet, the women placed fourth, their best finish since Holloway took over the program in 2008. Over the next three years, the Florida men continued their dominance as they won the 2011 indoor title, swept the 2012 indoor-outdoor slate and added the 2013 outdoor titles to the collection soon after.

The next championship for the men wouldn't come until 2016, but it served as sweet redemption for Holloway and the Gators. Florida had placed sixth at the SEC Outdoor Championships, leaving many to think they were well out of the title hunt.

Since Holloway took over in 2003, the Gator men have placed second or better in 17 of the 28 NCAA Championship meets.

All told, Holloway has coached 373 All-American men (169 indoor, 204 outdoor) and 230 All-American women (96 indoor, 134 outdoor). Of those, 39 men won individual and/or been part of a relay championship, compared to 13 women since 2008.

Holloway also served as the sprints and relays coach on the 2012 Olympic team and head coach for the 2013 IAAF World Championship team.

# OF FAME CLASS OF 2016

## BOB KITCHENS

UTEP / MISSISSIPPI STATE / WEST TEXAS A&M

Between tenures as the head coach at UTEP, Mississippi State and West Texas A&M, Kitchens accumulated a legacy that combined numerable successes at both the individual and team levels. His athletes earned a combined 26 NCAA national titles and 265 All-America honors, with his teams pooling for 18 conference titles and a half-dozen top-five finishes at NCAA Championship meets.

After an 11-year tenure at the helm of the West Texas A&M program – including the women's team he started in 1978 – Kitchens took over the job as the head men's track & field coach at Mississippi State in 1979 where he coached Lorenzo Daniel to a collegiate record in the 200. Kitchens made the move from Starkville to El Paso, Texas in 1988 where he would cement his legacy as one of the nation's premier sprint coaches at UTEP. Over the next 22 years, he would personally mentor 10 individual NCAA champion sprinters and 84 All-Americans – an average of nearly four per year.

But his success would spread far beyond just the sprints. Under his watch, the entirety of the Miner program produced 231 All-America honors and 23 NCAA event titles. His men and women combined for 16 conference titles and 15 top-10 finishes at either the NCAA Indoor or Outdoor Championships, highlighted by a streak in 1992-94 where his men were top-six at both NCAA meets. That run culminated in 1994 when his Miners were the national outdoor runners-up and third indoors.

His men's teams were strong throughout his tenure in El Paso, recording top-10 finishes as early as 1992 and as late as 2006, but the end of his run at UTEP belonged to the women's team. The Miner women turned in their first top-10 outdoor finish ever in 2008, a prelude for what was to come in Kitchens' final season in 2010. UTEP was seventh overall both indoors and outdoors for the best finishes in program history.

Leading the charge was sprint sensation Blessing Okagbare. She won a combined four NCAA titles that season, two each indoors and out, and would eventually become a finalist for The Bowerman Award.

## MARTY STERN

VILLANOVA

Villanova has a long and proud tradition of excellence in the mid-distance and distance events, and few coaches in the school's storied history have left as significant an impact as did Marty Stern. Leading the Wildcats' women's program from 1984 through 1994, Stern oversaw an era of Nova distance running in the late '80s and early '90s that no women's program has ever matched. Stern watched as his Wildcats reeled off an unprecedented five consecutive NCAA Division I Cross Country team titles from 1989 through 1983 in an era peppered with individual champs on the grass and on the track. No other team has won more than three consecutive national titles, and no other school has accounted for more than three consecutive individual national champions.

He coached 145 All-Americans, 21 individual NCAA champions, 12 collegiate record holders, 22 Big East titles, 21 Penn Relay Championship of America titles, 12 world Records, eight American records, 13 Olympians, and 4 world champions.

After his first five years, Stern's women broke through in the biggest way imaginable in 1989. Huber capped her magnificent career with the individual national title, leading Villanova to a 99-point team score and a 69-point win over defending champion Kentucky.

Their 69 point win was the Championships' widest margin between the winner and runner-up to that point, but the mark wouldn't last long. One year later, Nova tallied 82 points to beat Providence by 90 points. Stern kept the momentum going into the next season. The Wildcats tallied up to a final score of 85 points, 83 points clear of runner-up Arkansas for what remains the third-biggest margin of victory in meet history.

Sterns' final cross country season in 1993 ended in similar, dramatic fashion. The Wildcats tallied their lowest score of the Sterns era with 66 points to claim the team title once again.

## BUBBA THORNTON

TEXAS / TCU

Charles "Bubba" Thornton has worn many different hats – and at least a couple different helmets – throughout his adult life. Track & field athlete, college football player, professional football player, football coach, athletic director and track & field coach are all titles he's held at some point over the past half century.

The Texas native spent a combined 31 years at the helm of the track & field programs at his alma mater TCU – where he played football and lettered in track for two years – and then Texas. Between his days in Fort Worth and Austin, he coached athletes to a combined 35 NCAA event titles, more than 300 All-America honors, and 161 conference championships.

Many of those athletes went on to compete at the Olympics. Thornton-coached athletes won national event titles in 20 of his 31 seasons as a head coach, and his teams finished top-15 at the NCAA Outdoor Championships 13 times, including four top-five finishes. Those teams won 16 conference titles in the Southwest Conference and the Big 12.

He took the reins at TCU in 1982, and over the course of the next 13 years would turn his Horned Frogs into national contenders in the sprints. In 1989, Thornton guided the quartet of Horatio Porter, Andrew Smith, Greg Sholars and Raymond Stewart to a collegiate record time of 38.23(A) in the 4x100 relay, a mark that still stands today.

In 1996, Thornton made the move three hours south to the University of Texas to head up the Longhorn men's program. In 1997, his men posted Texas' all-time best finish at the NCAA Championships with a runner-up effort, weeks after winning their first of five Big 12 titles under Thornton's watch.

With titles in 1997 and 1999, 2003 and 2006, and in his final year coaching in 2013, his men claimed Big 12 outdoor crowns in three different decades. Thornton retired from coaching the Longhorns in 2013.

## DONAVAN BRAZIER
TEXAS A & M UNIVERSITY

Texas A&M freshman Donavan Brazier, a Grand Rapids, Michigan native burst on the scene during January's Aggie 11-Team Invitational in only his second collegiate meet. Brazier scorched the track over 800 meters on his way to the fifth fastest time in collegiate history indoors (1:45.93) and in the process broke a 34-year-old American junior record. This was the fastest time in collegiate history prior to the NCAA Indoor Championships.

In June at the NCAA Outdoor Track & Field Championships, Brazier shattered Jim Ryun's 50-year-old collegiate record on its anniversary, running 1:43.55 to edge Brandon McBride, who ran the third fastest time in collegiate history.

He ran 1:45.07 in the 800-meter semifinals at the NCAA Outdoor Championships for the fastest-ever qualifying time in meet history, and the 10th-fastest time in meet history overall. Brazier finished the indoor season ranked number 3 in the world at 800 meters and number 4 in the world at that distance outdoors.

## EDWARD CHESEREK
UNIVERSITY OF OREGON

Cheserek continued to prove there are very few men like him when it comes to racing on the big stage of NCAAs. Between indoors and outdoors, the Oregon junior captured four individual titles and anchored a championship distance medley relay team.

What he did at the NCAA Indoor Championship in mid-March was nothing short of remarkable. Less than 30 minutes after winning the 5000-meter title, he doubled back to notch a come-from-behind victory for the Ducks in the DMR against the fastest all-conditions miler in collegiate history (Washington's Izaic Yorks). Cheserek polished off the triple (3000-5000-DMR) the following afternoon.

In wrapping up the Outdoor season on his home track in Eugene, Cheserek became the first man since Galen Rupp to sweep the indoor and outdoor slate clean. He won the 5000 and 10000 meter crowns over the span of three days. These victories brought his career total to 15 NCAA championship titles over the span of three years.

## JARRION LAWSON
UNIVERSITY OF ARKANSAS

Lawson became the first man since Jesse Owens in 1936 to sweep the 100, 200 and long jump titles at the same NCAA championship meet. All told, Lawson tallied 31.5 points by himself, breaking the modern-day scoring record at the NCAA Outdoor Championship. Lawson began his 2016 season by racing to 6.60 mark in the 60m, setting the school record in the process. He led Arkansas to the program's 33rd conference indoor title with a win in the long jump and fourth-place finish in the 60-meter dash at the SEC Indoor Championships. Lawson picked up his third national title with a win in the long jump at the Indoor Championships. He earned a spot in NCAA history as the career all-time leading scorer in the long jump with 33 points. He ended the indoor season ranked 10th in the world in the long jump and went on to grab a 4th place finish at the Olympic Games in Rio in the event.

# FINALIST 2016



## COURTNEY OKOLO
UNIVERSITY OF TEXAS

Courtney Okolo, a native of Carrollton, Texas turned in a senior year to remember as she captured two individual 400 meter titles and anchored a pair of championship 4×400 teams. Indoors, Okolo went 3-0 in 400-meter finals against fellow collegians, including a near one-second victory at NCAA Championship meet. Okolo also contributed to Team USA's victory at the IAAF World Indoor Championships in Portland, Oregon the week after the NCAA meet.

Outdoors, Okolo reached a level never before touched by a female collegian. At the LSU Alumni Gold Invitational, Okolo lowered her collegiate record to 49.71 and became the first female collegian to go sub-50 seconds in the 400.

Less than two months later, she completed the sweep of the 400-meter titles with a strong run at Hayward Field with the 10th fastest time in collegiate history at 50.36 and authored an incredible come-from-behind victory in the 4×400.

## KETURAH ORJI
UNIVERSITY OF GEORGIA

During the indoor and outdoor seasons, Keturah Orji went 8-0 against fellow collegians in finals and swept the triple jump titles. She also added a fourth-place finish at the IAAF World Indoor Championships in the discipline.

Titles were one thing for Orji, but leaving her mark on the record book was another. Indoors, Orji landed at No. 6, No. 7 and No. 8 on the all-time performances list and is now the fifth best performer with her leap of 14.14m (46-4¾).

Outdoors, she broke the collegiate record at the NCAA East Prelims (14.29m or 46-10¾) and then one-upped herself at NCAAs in Eugene, Oregon when she flew 14.53m (47-8) to establish a new American record. She also posted the all-conditions outdoor collegiate best in the triple jump with a wind-aided leap of 14.60mw (47-11, +2.9m/s) to win the SEC Championships title. Orji has surpassed 14 meters in wind-legal conditions six times this season alone; no other woman had ever done it more than four times in an NCAA career.



## RAVEN SAUNDERS
UNIVERSITY OF MISSISSIPPI

During the indoor season, Saunders went 7-1 in finals during the indoor season and recorded the 12 best throws among all collegians in the Shot Put. Along the way, she broke the collegiate record by one centimeter (19.23m or 63-1¼) at the Iowa State Classic in mid-February. She also threw 19.01m (62-5) to become the only woman in collegiate history to surpass 19 meters twice in the same meet, indoors or outdoors. Saunders finished the indoor season ranked #5 in the world.

Saunders was also dominant outdoors as she went 8-0 in finals and saved her best for last at NCAAs when she smashed Meg Ritchie's 33-year-old collegiate Shot Put record with a heave of 19.33m (63-5) in Eugene, Oregon. She completed the outdoor campaign owning the top five throws of the year, two of which earned her a spot in the top ten marks in collegiate history.

ALL PHOTOS BY KIRBY LEE

# 2016 HIGH SCHOOL OUTDOOR TRACK

## GIRLS COACHES OF THE YEAR

**JEFF CARPENTER**
NATIONAL GIRLS COACH OF THE YEAR
BISHOP KELLY (ID)

Alabama
**Jim Tate**
St. Pauls Episcopal High School

Alaska
**Jason Hofacker**
Anchorage Christian Schools

Arizona
**Eric Richardson**
Chandler High School

Arkansas
**TJ Powell**
Magnolia High School

California
**Amrit Lal**
Carson High School

Colorado
**Conrad Crist**
Fort Collins High School

Connecticut
**Anne Burrows**
Bloomfield High School

Delaware
**Jim Fischer**
Ursuline Academy

District of Columbia
**Anthony Belber**
Goergetown Day School

Florida
**Mark Napier**
Lakewood Ranch High School

Georgia
**Jason Cage**
Westlake High School

Georgia
**Robert Wilson**
Westlake High School

Hawaii
**Kimo Higgins**
Hawaii Preparatory Academy

Idaho
**Jeff Carpenter**
Bishop Kelly High School

Illinois
**Brian Evans**
Lincoln-Way East High School

Indiana
**Le'gretta Smith**
Warren Central High School

Iowa
**Jesse Hunt**
Waukee High School

Kansas
**Tad Remsberg**
Newton High School

Kentucky
**Sheree Beaumont**
Louisville Male High School

Louisiana
**Tommy Badon**
Lafayette Christian Academy

Maine
**Danny Paul**
Falmouth High School

Maryland
**Henry Brady**
Charles Herbert Flowers High School

Massachusetts
**Thomas Shaw**
Milton High School

Michigan
**Eugene LeBron**
Ithaca High School

Minnesota
**Meghan Orgeman Crumb**
Alexandria Area High School

Mississippi
**Greg Warnick**
Tupelo Christian Preparatory School

Missouri
**Jesse Griffin**
Lee's Summit West

Montana
**Spencer Huls**
Corvallis High School

Nebraska
**Nancy Lockmon**
Giltner High School

Nevada
**Roy Session**
Centennial High School

New Hampshire
**Noah Pion**
Bedford High School

New Jersey
**Mike McCabe**
Union Catholic High School

New Mexico
**Tim Flores**
V. Sue Cleveland High School

New York
**Mike DeMay**
Rush-Henrietta Senior High School

North Carolina
**Elizabeth Gary**
Southeast Raleigh Magnet High School

North Dakota
**Rory Biel**
Fargo Davies High School

Ohio
**Jared Krout**
Findlay Liberty-Benton High School

Oklahoma
**Tim Grantham**
Edmond Memorial High School

Oregon
**Dave Turnbull**
Summit High School

Pennsylvania
**Kelly Jensen**
Cheltenham High School

Rhode Island
**John Marchand**
Smithfield High School

South Carolina
**Kevin Shiver**
Wando High School

South Dakota
**Jim Jarovski**
Lincoln High School

Tennessee
**Yusuf Sharif**
Whitehaven High School

Texas
**June Villers**
DeSoto High School

Utah
**Larry Jones**
North Summit High School

Vermont
**Chip Langmaid**
St. Johnsbury Academy

Virginia
**Justin Byron**
Nansemond River High School

Washington
**Duane Lewis**
Lynnwood High School

West Virginia
**David Bailey**
Winfield High School

Wisconsin
**Calvin Matthew**
Rufus King High School

Wyoming
**Brent Jurgensen**
Natrona County High School

# & FIELD COACHES OF THE YEAR

## BOYS COACHES OF THE YEAR

**PETE BOUDREAUX**
NATIONAL BOYS COACH OF THE YEAR
CATHOLIC HIGH (LA)

Alabama
**Pat Galle**
UMS-Wright Preparatory School

Alaska
**Jason Hofacker**
Anchorage Christian Schools

Arizona
**Eric Richardson**
Chandler High School

Arkansas
**Andrew Yoakum**
Fayetteville High School

California
**Coley Candaele**
Vista Murrieta High School

Colorado
**Jeff Donnel**
Pomona High School

Connecticut
**Jeff Weber**
Wethersfield High School

Delaware
**Joseph Gioffre**
Salesianum School

District of Columbia
**Anthony Belber**
Georgetown Day School

Florida
**Fred Finke**
Lyman High School

Georgia
**Napoleon Cobb**
Southwest DeKalb High School

Hawaii
**Gary Sanchez**
H.P. Baldwin High School

Idaho
**Brad Abbott**
Rocky Mountain High School

Illinois
**Barry Malloyd**
East St. Louis Senior High School

Indiana
**Kenneth Browner**
Carmel High School

Iowa
**Bill Schwarz**
Prairie High School

Kansas
**Ryan Foster**
Shawnee Mission North

Kentucky
**Terry Yeast**
Mercer County Senior High School

Louisiana
**Pete Boudreaux**
Catholic High School

Maine
**Derek Veilleux**
Scarborough High School

Maryland
**Beth Shook**
Westlake High School

Massachusetts
**Jim Blackburn**
Newton North High School

Michigan
**Rick Bauer**
Saugatuck High School

Minnesota
**Aaron Berndt**
Wayzata High School

Mississippi
**Shane Baltz**
Senatobia High School

Missouri
**Matt Warren**
Lafayette High School

Montana
**Rob Stanton**
Billings West High School

Nebraska
**Colin Johnston**
Millard West High School

Nevada
**Pat Wulfekuhle**
Yerington High School

New Hampshire
**Hayden Daly**
Concord High School

New Jersey
**Karl Torchia**
Christian Brothers Academy

New Mexico
**Kenny Henry**
V. Sue Cleveland High School

New York
**Ron Wilson**
Huntington High School

North Carolina
**Gary Bishop**
North Brunswick High School

North Dakota
**Tim Jacobsen**
Century High School

Ohio
**Chuck Kyle**
Saint Ignatius High School

Oklahoma
**Chris Lowrey**
Edmond Memorial High School

Oregon
**Erin Regali**
Henry D. Sheldon High School

Pennsylvania
**Steve Shisler**
State College Area High School

Rhode Island
**Jim Doyle**
Bishop Hendricken High School

South Carolina
**Blake Bishop**
Hilton Head Island High School

South Dakota
**Scott Benson**
St Thomas More High School

Tennessee
**Brad Perry**
Brentwood Academy

Texas
**Kyle Carver**
New Deal High School

Utah
**Andy Jacobs**
Orem High School

Vermont
**Mark Chaplin**
Union 32 High School

Virginia
**Claude Toukene**
Western Branch High School

Washington
**Duane Lee**
Lincoln High School

West Virginia
**Doak Markley**
Williamstown High School

Wisconsin
**Mike Steiner**
Brookfield East High School

Wyoming
**Mark Hileman**
Kelly Walsh High School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| **201: TRACK & FIELD TECHNICAL CERTIFICATION**<br>*DECEMBER 17-18* | **202: PROGRAM MANAGEMENT CERTIFICATION**<br>*DECEMBER 13* | **310: STRENGTH & CONDITIONING COACH CERTIFICATION**<br>*DECEMBER 12-13* |
| **408: SPORTS SCIENCE FOR SPEED/POWER EVENTS**<br>*DECEMBER 12-13* | **409: SPORTS SCIENCE FOR DISTANCE EVENTS**<br>*DECEMBER 12-13* | **503: MASTER'S ENDORSEMENT IN THE HURDLES**<br>*DECEMBER 12-13* |
| **505: MASTER'S ENDORSEMENT IN THE HIGH JUMP**<br>*DECEMBER 12-13* | **507: MASTER'S ENDORSEMENT IN THE HAMMER**<br>*DECEMBER 12-13* | **511: MASTER'S ENDORSEMENT IN DISTANCE EVENTS**<br>*DECEMBER 17-18* |

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