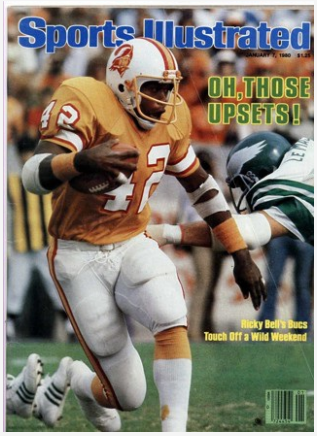
Really Making Tracks

Engineers have given indoor runners faster tracks

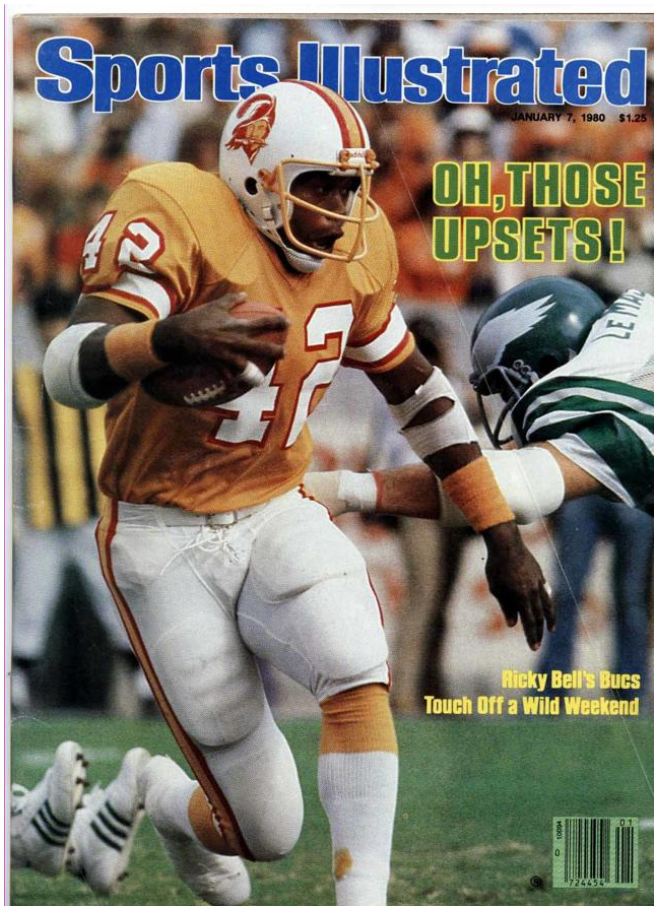


Code	**adi-pub-01129**
Title	Really Making Tracks
Subtitle	Engineers have given indoor runners faster tracks
Name	Sports Illustrated
Author	Really Making Tracks
Published on	Monday, January 7, 1980
Subject	ACES; Exercise Machine; Favorite; Force Plate; Help; KB; Media; Performance Analysis; Science; Shoes; Sports
URL	https://arielweb.com/articles/show/adi-pub-01129
Date	2013-01-16 15:40:46
Label	Approved
Privacy	Public

In the article "Making Tracks" by Dan Levin, the author explores the debate over which indoor running track is the fastest in the world. The article discusses the various factors that contribute to a track's speed, including its design, the quality of competitors, crowd reaction, and even the track's reputation. The author also highlights the work of engineers like Floyd Highfill and Thomas McMahon, who have designed some of the world's fastest tracks. Highfill's designs focus on the banking of turns, while McMahon's Harvard track emphasizes resilience and shock absorption. The article concludes by noting that while many factors can influence a track's speed, advancements in design and technology are continually pushing the boundaries of what is possible.

The article discusses the science and engineering behind building the fastest running tracks. McMahon and Greene have developed a track with a specific level of compliance, using a load-deflecting device to ensure accuracy. Davies and Highfill, on the other hand, focus on structural strength, using 2 by 4s to support their plywood surfaces. The choice of surface material is also discussed, with options ranging from plain plywood to various synthetics. McMahon asserts that the choice of surface material has zero impact on running speed, but synthetic surfaces wear better and are easier to clean. The article also mentions a new track at Madison Square Garden, a collaboration between McMahon, Greene, and Highfill, which will feature a blend of scientific know-how and practical experience. The track will have a painted wooden surface and its underpinnings will be made of fiberglass and other exotic materials. The article concludes by noting that despite advances in track-building research, opinions remain divided on which track is the fastest.

Below find a reprint of the 7 relevant pages of the article "Really Making Tracks" in "Sports Illustrated":



REALLY MAKING TRACKS

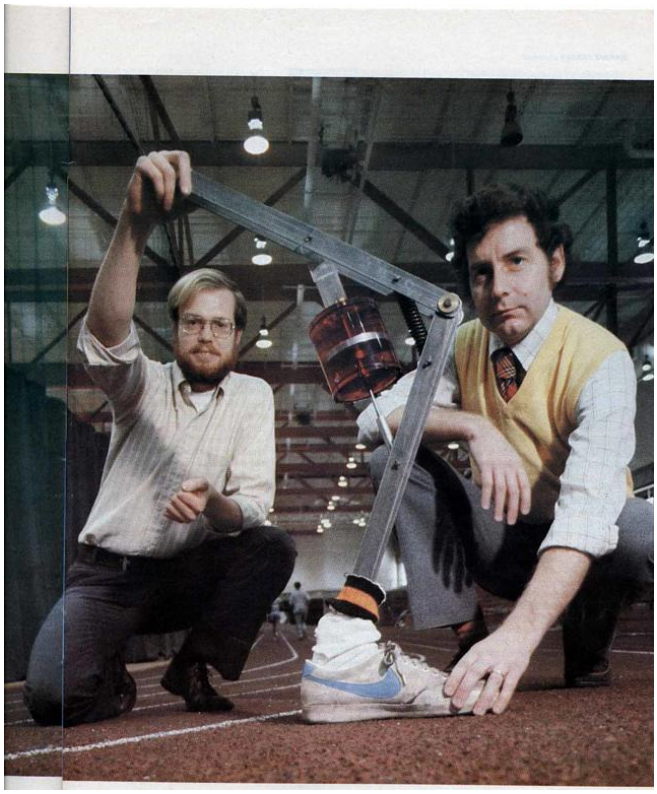
Engineers have given indoor runners faster tracks, but opinions differ widely as to which one is "fastest"

by DAN LEVIN

The fastest indoor running track in the world is in San Diego, Long Beach, Los Angeles, Albuquerque, Pocatello, Houston, College Park, Philadelphia, New York, Cambridge, Boston, Milan, Genoa and Turin. Let those who would single out one sift through a nightmare of statistical comparisons, evaluate the conflicting opinions of engineers and of great runners, weigh the importance of a dozen or so variables and define the word "fast." If, as one popular dictionary puts it, the definition is: "Adapted to or suitable for rapid movement: *a fast turnpike*," then probably the track that was used for the past 12 years in New York's Madison Square Garden did not qualify. A new Garden

continued

Peter Greene and Thomas McMahon (right) devised a mechanical "leg" to test the resilience of their Harvard track. Floyd Highfill, a specialist in the design of banking, collaborated with Greene and McMahon on Madison Square Garden's new track.



Bald Dick Buerkle moves up on the banking at Long Beach to pass like a stock car driver.

track will be inaugurated on the 19th of this month for the Olympic Invitational and it may join the swollen list of contenders for the title of "fastest indoor track in the world."

The old Garden track was a mess, which is not to say it was "slow." Its cork-and-rubber surface was pitted and torn by years of spiked-shoe pounding, the plywood base underneath the running surface sagged, the height of its banked turns had been messed around with at least twice. Among 11-lap-to-a-mile tracks the Garden's turns were relatively tight, which figures to limit speed. But as miler Paul Cummings said before last February's Millrose Games, "This meet has a definite aura about it—the level of excitement, the great competition, the crowd; there's something about it all that's conducive to great performances." Then he went out and played the rabbit in the mile as Eamonn Coghlan, with a 3:55, missed the indoor record by a mere one-tenth of a second. Not bad for an antique track with too tight turns.

Many factors contribute to making a track fast, and not all of them have to do with its design. Great competitors make slow tracks fast, poor ones make fast tracks slow. Crowd reaction is important, too. For example, a four-minute mile has never been run in the Cow Palace despite attempts by Jim Ryun and Kip Keino. A contributing factor: San Francisco's undemonstrative fans.

Even the reputation of a track comes into the equation. As Dick Buerkle, Coghlan's predecessor as indoor record holder in the mile, says, "If a track gets to be known as a fast one then you're likely to think, 'Well, I'll run fast there.' It's almost like a teacher and a kid. Expect the kid to be bad and he is. Expect a track to be fast and it's fast."

But in some cases there is no easy e
planation for superior performances. I
door records for men and women ha
been set at the Dartmouth Relays—
Villanova's four-mile relay team (16:1
in 1976, by Lorna Forde in the 500 m
ters (1:10.5) in 1978. The Dartmou
track is a nice one, eight laps to the mi
with an Astrotrack surface, but the co
petition is rarely world-class and the
lays are held in mid-January, supposed
before anyone is in top shape.

Because most major indoor tracks
portable, the men who put them toge
er also can have a significant impact
the results. Marty Liquori says, "T
track at The Spectrum in Philadelphia
fast one year, and the next the crew mi
have to rush to put it together. Then
spring will be different and times will
poor." At Toronto, where the track
usually set up over hockey ice, "One y
it's fine and the next it's like the bri
over the River Kwai," says Liquori.

Or a dry and crusty river bed. The s
face of many fast indoor tracks is p
wood. It is easily chipped to splinters
spiked shoes, and it will become trea
erous and slow if not replaced regula
Moreover, tracks can lose their resilien
fast ones going slow in a season of he
use. Polyurethane, plastic or rubber
faces over plywood are longer-wear
but do they slow a runner down?
and no. It depends on which runners
engineers you talk to.

Floyd Highfill of Las Cruces, N. M
a 40-year-old chemical engineer and
most influential designer of runn
tracks to date, is much less concer
with surfaces (although all the tracks

Ron Davies ranks with Highfill as a fast-track des

has designed, save one, utilize plywood) than with turns. Highfill has developed a unique banking design that he and many runners claim helps get a competitor from straightaway to straightaway faster than any other. Tracks designed by Highfill are being used in Los Angeles, Albuquerque, Pocatello, Idaho, College Park, Md. and Philadelphia, but, thanks to Coghlan, the most renowned is in San Diego.

The week after Coghlan ran his 3:55 in New York he was in San Diego for the Jack in the Box Indoor Games, saying, "San Diego has the fastest track." The 26-year-old Irishman was not just speculating. A year earlier he had run a mile there in 3:57.9—and had finished third. Wilson Waigwa won in 3:55.7, and a record five runners broke four minutes. Little wonder Coghlan thought the track was fast.

This time he ran a 3:52.6 mile, breaking Buerkle's world record by an astounding 2.3 seconds. The second- and third-place finishers, Steve Scott and Steve Lacy, broke it, too, with times of 3:54.1 and 3:54.7. When Coghlan was asked, "Is this the fastest track you've ever been on?" he replied, "It must be. It's the fastest mile I've ever run. But most of the credit must go to the competition. Without them I might have slowed down, as I did in New York."

The Jack in the Box meet, run toward the end of the season, generally attracts the top runners. How would Coghlan have fared without such strong rivals, or on the same track six weeks earlier, or if the 18 men who labored all night to assemble the track had been less conscientious? As meet director Al Franken said, "They took more time to set it up this year—they had to be more careful—because last year when they took it apart they stacked the sections out of order." When they got it together, it was certainly springy. A workman had to be assigned to patrol the track, pounding in nails that were being worked loose by the vibrations set up by the runners.

But still there were problems. Steve Scott was asked, "Was it the track or the competition?"

"Well, it sure wasn't the track," he said. "Did you see that soft spot in Lane 1 right after the starting line? A few times I thought my knees were going to buckle. I still think the fastest track is at the Sunkist meet in Los Angeles. It's newer and it has more support beams."

The Sunkist track is also a Floyd Highfill design, and it is nine years newer. But Highfill says it has no more support beams than San Diego's, though he admits that you can order one grade of plywood and get another, and possibly the Sunkist track has a different resiliency for that reason. But it still has 11 laps to the mile, as do San Diego's and Madison Square Garden's, though it is relatively wide for a track of that size. The radius of its turns, 40' 3", is only two inches shorter than those at San Diego, a vital measurement when it comes to speed. But the L.A. Sunkist meet is usually held in January, and the crowd is not as demonstrative as San Diego's. What if. . . ? Analyzing indoor tracks consists of a series of what if's. But there are fewer mysteries now that men like Floyd Highfill are designing them.

Highfill built the San Diego track in 1967. It was his third. He had been a distance runner at the University of New Mexico ("Though not the kind you would have heard of," he says) and after graduating in 1960 he became involved in amateur track with the Albuquerque Jaycees. Their annual outdoor meet was in financial trouble, and when it was suggested they sponsor one indoors he offered to help them build a track. He had taken courses in physics as well as in mechanical and civil engineering, but he had seen only one indoor track in his life, in Lubbock, Texas. It was so old they had to repair it between races. Highfill says, "It was obvious from the moment I saw it that the turns were designed all wrong. They lifted the straightaway in a gradual rise to the high point, right in the middle of the turn, and then they tapered it out the same way. It looked nice, but a runner was on a constantly changing surface, and at every step he was forced to readjust his stride and speed.

"My idea was to raise the straightaway as rapidly as possible at the entry to the turn, and once the track reached its maximum height I would keep it at that level through about 75% of the turn. The runner should be able to go through that portion of the track at a constant speed—I didn't make any actual tests, and I still haven't, but it seems reasonable—and finally I would bring the turn around and down to the straightaway again. I wasn't trying to build the fastest track. I was just trying to design one that would give a runner maximum running efficiency."

Highfill no longer designs tracks full time; he works for the New Mexico Department of Agriculture as an associate state chemist, but his theories haven't changed. He has used them in all of his tracks. The larger the building the larger the track Highfill designs for it. His track in Albuquerque, for example, is 10 laps to the mile, and in Pocatello it is eight to the mile. The larger the track and the more gentle the turns, the faster it is—theoretically, at least—and there are facts to back those who regard Pocatello and Albuquerque as rapid, although neither gets runners of the quality that go to San Diego or the Millrose Games, and Albuquerque is situated at an altitude of 5,300 feet, a handicap at distances of more than a half a mile or so. Nevertheless, the unofficial indoor world record for 880 yards (1:47.9) was set at Albuquerque by Ralph Doubell in 1969. Ten years is a long time for a record to stand.

At San Diego, Paul Cummings was asked, "What's the fastest indoor track you've ever run on?" "Pocatello," he said, "but *the* fastest indoor track of all is in the Houston Astrodome—five laps to the mile, banked, plywood, good bounce." The Astrodome track, which has not been used since early 1974, will be laid down for a meet on Feb. 16, providing an opportunity to judge who has early foot in this Olympic year.

Coghlan says, "I always compete on 11- or 12-lap tracks, never on eight. I think it's sort of cheating to run on an eight-lap track." Be that as it may, because of the variety of indoor track sizes, the International Amateur Athletic Federation does not recognize any world indoor records. Coghlan's mile and other indoor "world records" have only informal international sanction. The AAU does recognize American indoor records, with two provisos: they can only be set on tracks that are at least eight laps to the mile with a 2- to 2½-inch curb. So no national records will be set in the Astrodome, or at Long Beach next week in the Muhammad Ali games. The eight-lap track in the Long Beach Arena does not have a curb. It is considered a hazard, something to trip over. The fastest 1,500 meters ever run by an American, Cummings' 3:37.6, is not recognized as an American record. Cummings ran it last Jan. 6 at the Muhammad Ali meet, finishing second to John Walker's 3:37.4 (the fastest 1,500 ever run indoors). That

continued

same night Herman Frazier ran a best-ever 1:01.2 in the 500 meters.

The Ali meet is the first important one of the indoor season. Runners are still working the kinks out of their legs, yet it was the second straight Ali meet in which Frazier and Walker had run world's best times in the 500 and 1,500.

The designer of the Long Beach track and others of the same size in Boston, Milan, Genoa and Turin and of six smaller ones is England's Ron Davies, a 51-year-old mechanical engineer and former middle-distance runner. He is president of Amalgamated Recreational Engineers and Network Associates, Ltd. (ARENA). Davies calls it "the first company to study sports facilities from an athlete's point of view." The unique aspect of his tracks, like Highfill's, is the banking of the turns. Davies and Highfill agree that turns must be as wide as possible, but Davies is more concerned with transitions in elevation. As he says, "A runner's legs are in the air much of the time, and changes up or down can affect his performance adversely, even cause him to stumble." Thus, Davies raises the straightaways of his tracks 14 inches off the ground; as the innermost lane begins to curve into a turn, the track actually dips a bit. In mid-lane it remains level, so the runner's elevation never changes, only his tilt, and Lane 2, the main passing lane, rises only slightly. But this is less apparent than the angle of the banking, which is so steep at Long Beach (19½ degrees) that runners routinely tumble off.

The function of banking is to neutralize centrifugal force, which tends to drive a runner toward the outside of any unbanked track as he enters a turn. The larger the track the smaller the problem; on quarter-mile tracks it is negligible. Ideally, a runner in the turn of a banked track should be perpendicular to the track, but that can only happen at one running speed, and the track designer must decide what that speed will be. A runner doing a four-minute-mile pace (60 seconds per quarter) will remain perpendicular to the track throughout Highfill's curves, but to do that on Davies' he must do a 46 flat for a 440. "At Long Beach you have to pick up speed just to blow through a turn," says Mark Belger, who in 1978 set the American record for 880 yards (1:48.1) at a Highfill track in College Park. But the first time he ran at Long Beach he fell off. The conclusion is that you can't just say "fast." You have to say "fast for what?" The 440 or the mile?

Are Davies' tracks faster than Highfill's? Davies insists that the quarter-inch layer of synthetic surface that most of his clients seem to favor does not slow down runners, and that it is much more gentle on the legs than the plywood of Highfill's tracks. He adds, "Resiliency is important, but the fastest surface would be concrete."

There are those who would disagree, most notably a 37-year-old Harvard professor of applied mechanics and biology named Thomas A. McMahon, who is the designer of Harvard's indoor track. Once McMahon held the same views on concrete as Davies, but no more, and perhaps Davies and Highfill should begin feeling a bit uneasy. The two-year-old Harvard track, eight laps to a mile with a polyurethane surface over a plywood undersurface, is causing quite a stir around the Ivy League, where it is known as the Pink Carpet.

The Harvard track is a permanent structure in a bright new building all its own, unlike most of Highfill's and Davies' creations, which are set up for one or two meets a year. It is used for training as well as competition, and from the start Harvard was more concerned with safety than with speed. Runners on the university's old cinder track had suffered numerous leg injuries, and McMahon, who had done research on the locomotion of four-footed animals, was asked for advice on building a new one. Should it be banked? Yes, he said, though he added that safety would be more a function of the track's "compliance" (*i.e.*, resilience) than of its banking. But he expressed concern that an emphasis on safety would produce a very slow track. "Do the best you can," he was told.

McMahon, together with Peter R. Greene, a postdoctoral fellow in mechanical engineering at Harvard, began a type of research that had never been done before. In the basement of Harvard's high-energy physics laboratory they set up 80-foot track segments of every conceivable consistency, from pillows end to end to boards to concrete. They began to write computer programs. Twenty volunteer running subjects were hired, and they pounded back and forth on the little tracks. Both men had assumed that concrete would produce the fastest times, but certain board tracks, with surfaces far more compliant than concrete, proved to be faster. They had not at first taken into account the damping phenomenon—the effect of shock absorption, for want of a better term, in the muscles of the legs. They had thought it unimportant, but finally, as Greene puts it, "We decided to throw a shock absorber into the equation. Bingo!" The answer came out of the computer: the degree of compliance they should incorporate into their track should be 10 times greater than that of most modern tracks.

Such a track would certainly be kinder to legs—and there is no question that the new track worked wonders on the legs of Harvard runners. Chronic knee pains and shin splints disappeared as if transported to Lourdes. But more surprising, according to McMahon and Greene's predictions, this unheard-of level of compliance would actually allow runners to travel 2% to 3% faster than they had before.

In the track's first season, 1977-78, the best times for Harvard runners at home averaged 3.87% faster than their best times anywhere else, and 2.04% faster than their best for the previous season. In December of 1978 a Boston educational TV station, WGBH, was filming a series on sports technology, and it wanted to illustrate the unusual qualities of the new track. Buerkle, then holder of the indoor record for the mile, was brought to Harvard to see what he could do. It was very early in the season. He had entered only one timed race—and done a 9:15 for two miles at Cornell two weeks earlier—but now, spurred by nine top Boston-area competitors, he ran a mile in 4:00.45. At the same stage of the previous season, the season in which he had set his record, his best mile was 4:11. It was tempting to give the track all the credit for the marked improvement, but Buerkle said, "Running is so complex. Still, the track didn't hurt at all."

It is difficult to explain the damping phenomenon in non-technical language. Greene says a simple test with a basketball is illustrative. When he drops one on the Harvard track it bounces significantly higher than when he drops it from the same height on concrete. "And in one sense a man is similar to a basketball," says Greene. "Both have springiness and shock absorption."

McMahon compares the Harvard track to another innovation in sports equip-

ment, the fiber-glass vaulting pole. "It bends more than the old pole," he says, "but it stores energy and returns it to the vaulter, enabling him to vault higher than before."

Harvard Track Coach Bill McCurdy, in his 29th season at the university, is much less technologically oriented than either McMahon or Greene. When asked for advice about the height of the banking for the new track during its design stage he pointed to his hip and said, "Put 'er right about here." "He has good intuition," says McMahon, whose calculations produced the same conclusion.

McMahon also came up with a unique and complex banking design when he was working on the track, but Harvard decided the expenses were high enough without it, so it is probable, though unproven, that runners do not get around the Harvard turns "as efficiently as possible," as Highfill says.

The Harvard banking may be less sophisticated than some, but the track's underpinnings now make those of other fast tracks seem like junior high school woodworking projects. It is hard to tell. Although McMahon utilizes sheets of three-quarter-inch plywood, as do Davies and Highfill, that is all he will reveal about his design, except to say that underneath the plywood are "other wood and synthetic materials," in precise and intricate patterns.

McMahon told the contractors hired to build the track that the surface had to have exactly 10 times the compliance of Harvard's old cinder track (but he will not disclose exactly how springy it is). "I said," he recalls, " 'It must deflect this much at a given weight.' They said, 'We never built anything like that. We usually just slap the boards together.' " So McMahon and Greene built a load-deflecting device to guarantee the right range of compliance. It has a leglike structure and, says Greene, "It is accurate to one-thousandth of an inch."

Davies and Highfill support their plywood surfaces with 2 by 4s. Highfill places them every four feet apart, and he says, "I space them that way mainly for ease in carrying the sections when they take them apart after a track meet. I did try some different arrangements of 2 by 4s, but I didn't use any instruments or anything like that." Davies also utilizes 2 by 4s, but his are only 16 inches apart and run longitudinally, instead of transversely, as Highfill's do. "It's for structural strength," he says. "It has nothing to do with springiness."

Whose tracks are intrinsically faster? Do Davies' and Highfill's complex bankings offset McMahon's and Greene's compliance formulas? Do surface materials matter? There is much talk about how fast 3M's Tartan is, and Rubaturf, made in Sweden from old tires, and Astrotrack, Elastoturf and Chevron. Highfill thinks plain plywood is the fastest. Davies gives his customers a list of available synthetics and lets them choose. The Harvard track is covered with a three-eighths-inch-thick carpet of polyurethane Chem-Turf. McMahon, who spent a lot of time researching such things, was asked, "How important was the choice of Chem-Turf when it comes to running speed?" "It is of zero importance," he said, "though synthetic surfaces do wear much better than wooden ones, and they are easier to clean."

The new Madison Square Garden track, the first of a promising collaboration among McMahon, Greene and Highfill, will have a painted wooden surface, but it will be used for only four meets annually. It will be a blend of Harvard scientific know-how and Highfill's experience in constructing portable wooden tracks. The compliance will be the same as that of the Harvard track, but the track's underpinnings will be of fiber glass and more exotic materials. Harvard's are of plywood. Its banked turns, designed by McMahon and Greene, will be, according to McMahon, "of a novel design never before used to our knowledge in a running track or, for that matter, in any kind of track."

For now, each of the extant tracks has its devotees. Belger, whose personal best for 800 meters is 1:45.8 outdoors, thinks he could run a 1:46 at Harvard, where he has trained but not competed. "I feel like a butterfly on the track," he says. "But I really don't care what track I run on. What really counts is the competition. Still, if I wanted to break a record I think Harvard would be the place to do it. You could move Albuquerque to sea level, and I still think I could run faster at Harvard."

A Boston-area track coach who shall go unnamed said last year, "Would I take the Harvard track? Are you kidding? I'd push my mother off a cliff for it."

Two weeks after that statement was made, a Ron Davies-designed track was opened at Boston University. It is eight laps to the mile, with a quarter inch of Rubaturf on top. The coach with the expendable mother brought some of his runners over for a workout and said later, "The BU track makes Harvard's look like the subway. There's no doubt it's a faster track."

And out at Amherst, Mass., Gideon Ariel, a computer scientist and consultant to a shoe manufacturer and the United States Olympic Committee, has been working at the offices of Computerized Biomechanical Analysis to calculate the properties of the ultimate track. "You must deal with an integrated system—the human body, the shoes, the top surface, the undersurface," he says. "If you deal with only one component, you cannot design anything. Sure, the hardest surface is not necessarily the fastest, but there is a difference in damping phenomena between blacks and whites. Blacks have better damping qualities. You can take five whites at random and ask them to jump on a force plate and then do the same with five blacks, and I can show you different characteristics."

Thus, the more science intervenes in these matters, the more complex they are shown to be. And it is no wonder that despite the recent acceleration of track-building research and the results recorded on the new ones, most track people remain divided on whether this track or that one is inherently the fastest. In a frustrating 1979 indoor season in which he contracted a mild but pesky virus, Buerkle entered five major meets and failed to improve on his surprising time at Harvard. Nevertheless, he says, "I think psychology has a lot to do with it. To say why a track is fast, that's pretty hard to do, although those scientists at Harvard, they . . . I don't know. I don't know what to say."

Highfill says, "It doesn't matter how fast a track is, you can't run a four-minute mile on it if you can't run a four-minute mile." Ah, but it does matter to a 4:01 miler who might break four minutes on a faster track, or to fans who might cheer a world record on one rather than another. And even if tests were developed that could give every track an accurate speed rating, the fun of figuring out the "fastest" would not be gone because there can be no one fastest track for everyone. **END**