

Reducing Injuries by Engineering Natural Surfaces

Creating a Better Environment for Exercise: Reducing Injuries,  
Promoting Health, and Enhancing Enjoyment by Engineering Natural Surfaces

Kenneth Golden Harper

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### Abstract

With increasing development, there are less natural areas for runners and walkers to use than ever. After observing the possibility that flat, hard, unnatural surfaces could be a major cause of a seeming increase in common overuse injuries, research was done to investigate. After a few surveys confirmed the possibility and likelihood that this is the case, scientific and scholarly evidence was researched and put together as evidence. The research is interesting and indicates that it is very likely that flat, hard, unnatural surfaces are a major cause of common overuse injuries, often due to muscle imbalances. With this knowledge, it has been suggested that communities take an initiative to preserve, protect, and develop more natural places to exercise on, including bark chip trails, dirt trails, or gravel paths. It is also suggested that community members are educated on why they should use these areas and the benefits of doing so. More research is suggested on drawing an exact parallel between flat surfaces and injuries due to muscle imbalances.

### Creating a Better Environment for Exercise

There seems to be a contradiction with two things booming in our communities: development and exercise. With every passing day, once natural areas are transformed into modern developments. Many exercise enthusiasts are becoming increasingly dismayed by the vastly reduced amount of natural surface to exercise on. During this time period, there has been a spike in the injury rates of runners, particularly with surface related injuries. It seems that many paths and areas that used to have dirt or some other natural surface have now been paved. Some have given way to commercial or home developments, others have been paved in an effort to make them more visible or accessible. While the development and dedication of areas for people to exercise is to be lauded, it is sad that nearly all of these areas have become exclusively paved trails.

Paving exercise trails is not an advantageous choice because unnatural surfaces cause problems for many of the very people they are created for. First, paved areas are damaging to runners and walkers because the flatness of the surface causes muscular discrepancies. Also, the impact forces created by landing on the hard pavement also cause a problem. Injuries related to hard, flat, unnatural surfaces include Patellar Tendonitis, IT Band Syndrome, Shin Splints, back problems and many other foot and leg maladies. Some may say that paving is widely accepted, easy to maintain, and generally keeps most people happy. However, there are options that are easy to maintain, acceptable to the public, and possibly less expensive. Very serious exercisers are knowledgeable and work hard to find alternate, natural surfaces. However, the general public should be educated more. Communities need to create, protect, and promote natural surfaces for community members to exercise on so people can exercise more enjoyably and injury free.

### Where's the Dirt?

Many places with natural surfaces are becoming extinct. In recent years, grassy areas and dirt roads have been done away with in favor of development. Many orchards with dirt paths have also met their demise. The Provo River Trail has now been paved in its entirety, from Vivian Park in Provo Canyon to Utah Lake. Recently, a section of trail along University Avenue in Provo was set aside for bikers and another section for those on foot. Many people got their hopes up for a slag (gravel), bark chip, or dirt trail, but were saddened when the area for walkers and runners was paved. Many exercise trails near local businesses and nature trails have been introduced, but sadly - to the best of my knowledge, all have been paved. Many once unfenced areas that were open for people to use have now been fenced in, or had "No Trespassing" signs put up. All of this has led to the loss of natural surfaces to run on which have given way to hard, flat, unnatural surfaces.

An increasing number of people are taking to the mountain trails, made by both deer and man. Trail and Ultra running are growing at a substantial rate. Trail running gear is the fastest growing category in the outdoor market (Outdoor Retailer, 2005). These trails are wonderful and they have their place. While a great option for the very dedicated, these trails are not much of a daily option for anyone living far from the hills, on a tight schedule, or not up to the intense task of climbing the mountains. A mom on a tight schedule or a businessman on lunch break shouldn't have to drive 15 minutes to find a suitable place for their 30 minute jog in order to get a good workout and still avoid injury.

The Injured Runner Survey

Injured Runner Survey

What is your injury? Left knee

How many miles a week do you run? 7.5

What percentage of your running is done on the following surfaces?

Trail, Road, River Trail, Sidewalk, Track, Paved Trail 98 %

Dirt, Grass, Bark Chip, Canal Road, Mountain Trail 2 %

Injured Runner Survey

What is your injury? Left knee right foot

How many miles a week do you run? 12-15

What percentage of your running is done on the following surfaces?

Trail, Road, River Trail, Sidewalk, Track, Paved Trail 99 %

Dirt, Grass, Bark Chip, Canal Road, Mountain Trail 1 %

Recent surveys taken at Runner s Corner in Orem, Utah have given us some very interesting information. An injured runner survey was taken as well as a trail runner survey. The idea for the surveys took shape when managers of the store (including myself, an employee of the store for 13 years and member of the BYU Cross Country team) started to notice some possible trends among those who were injured. Hawk Harper, the local running guru and owner of the store, says he has noticed a dramatic increase in reported injuries over the last ten years, despite better technology and better shoes. (Harper, 2005). Store managers also recently started to notice that it seemed that the people who ran natural surface trails regularly didn't ever seem to

have any serious injuries. We'll start by discussing the injured runner survey which revealed the following: Every person who filled out the injured runner survey had some sort of muscle imbalance, impact, or what the medical community would call an overuse injury. Nearly every person who took the survey did at least 80% of their running on unnatural surfaces such as the river trail, track, treadmill, road, etc. Most of them did all of their running on these surfaces. During the course of the survey, employees of the store were quick to pick up the trends among those surveyed.

The survey seems to indicate a strong correlation between hard, unnatural surfaces and common maladies of runners and walkers. Obviously, unnatural surfaces are not the only cause of injury, but they certainly are a big cause and possibly the biggest. It has long been held that our bodies don't particularly do well when subjected to the pounding of the pavement, as shown by the increasing quest for better cushioning in running and walking shoes along with the results from the scientific community.

In 1984, Dr. W.L. Lehman published his findings in *American Family Physician*: Common overuse injuries in running include iliotibial tract tendonitis, chondromalacia, patellar tendonitis, shin splints, stress fractures and various heel and foot syndromes. Most causes are due to training errors, anatomy factors, inadequate footwear, or poor running surfaces. Lehman goes on to specify how fixing these things helps to greatly reduce the risk of these injuries. The amazing thing is that in 20 years, not much has changed. Running shoes have come a very long way in those 20 years, but even with the great advances in shoe technology, running surfaces are still a major cause of injury.

## Even Muscle Distribution

Trail Runner Survey

Name Phillip Lowry

What percentage of your running is done off of pavement 90.3%

Have you had a serious ankle sprain (kept you from running for a week or more) in the last year? No

What is harder on your body, a marathon on the road or a <sup>100</sup>50 miler on the trail? A marathon

Do you recover faster after a long run on the road or on the trail? Trail

The trail runner survey is equally enlightening. The people who took this survey were asked how much of their running was done on natural surfaces, and if they had experienced any overuse injuries in the last year. They were asked if they had experienced any acute injuries (such as an ankle sprain) that had kept them from exercising for more than a few days. They were also asked if they felt they recovered faster from an Ultramarathon (50 miles or more) on natural surfaces or a Marathon (26.2 miles) on the road, and which one they felt was harder on their body. The results were overwhelming. This group did more than 30 percent of their exercise off road, and most of them did 80-100 percent on natural surfaces. The presence of overuse injuries was nearly non-existent. Surprisingly, so was the presence of any serious acute injuries such as ankle sprains. All respondents (who had run an Ultramarathon) said that they felt that a 50 miler on natural surface was easier on their body than a Marathon, and also that they felt that their body recovered slower from the Marathon on the road. It is possible that the results from these surveys may be somewhat skewed by factors that were not controlled for, such as athlete status,

stretching, etc. That said, trail runners are not generally better athletes than those who run on the road. Many of them turn to the trails for solace or after repeated injuries running on the road. As a population, trail runners are known for being quite loose with their lifestyle and injury prevention techniques, such as stretching. So despite the factors that were not controlled for, the unanimity among the responses still makes this very compelling evidence.

### Scholarly Evidence

In the *Ergonomics Journal* (Creagh, U., 1998), the researchers noted that running on off road terrain (dirt, short grass, and long grass) would result in changes to the characteristics of the normal running stride. Changes in the characteristics of the normal running stride are going to equate to a more various use of musculature, thus strengthening muscle areas more evenly. Likewise, the researchers of *Medicine and Science in Sports and Exercise* (Dixon, S.J., 2000.) found that different runners make different adjustments when changing surfaces. Their bodies adapt to the surface and use different stride angles and different muscle groups to accomplish these adaptations. Because there is better muscle strength distribution, there should be less chance of injury from improper muscle balance.

Authorities suggest that there is a strong connection between injuries and the different uses of musculature. It seems that when people go off road and run on a surface that makes them adjust their stride and use a more varying amount of muscles, that injuries are almost non-existent. It is the combination of less impact, along with more even muscle balance in the athlete that reduces the chance of injury. Importance of keeping the muscles of the leg balanced should be stressed. Over-working one muscle group while under-working another muscle group (such as running on a flat surface like a road or track that encourages little use of varied musculature) is a

major contributor to the problem. It seems that when one group of muscles become inherently stronger than another, that bad things tend to happen. Man was meant to live and has adapted to live with his naturally created environment. He was not created to use a perfectly smooth, flat surface like a track or paved trail. Our muscles don't seem to be meant to take a repeated, sustained beating on a flat surface. When a person travels on a more natural surface, as it seems man was intended to do, then the impact is distributed more equally among the muscle groups and that person has less chance of injury.

Not much research has been done on surfaces (probably due to a lack of hype). However, we can examine the research done on the reaction of muscles to shoes and draw likely parallels. Insight can be gained from the recent August 2005 Issue of Running Research News (which is the gold standard for scientific studies in the running community), in the article "Run Free, Or Try." Owen Anderson, Ph.D., one of the most respected people in the distance running community, states "Human muscles and tendons need to receive mechanical stimuli in order to adapt and grow stronger. If these mechanical stimuli are large, adaptation can be extensive; if they are small (or non-existent), muscles and tendons may actually decrease in strength and functional capacities." The case was being made here that even overly supportive running shoes will weaken certain muscle groups. (Dr. Anderson was evaluating a new "barefoot shoe" by Nike. Upon finding that he was doing the study, and likely knowing the repercussions of a negative article by Running Research, Nike sent him a pair to use for himself.) After making the case that overly supportive shoes could possibly weaken muscles, he went on to write "The tibialis-anterior muscle, which helps to stabilize the foot during stance, becomes active during a later phase of stance during shod running, compared with the barefoot condition. It has been established that the kinetics of

barefoot running are different than the kinetics of shod dashing. Train in the shoes in which you are going to compete, because such shoes will mimic the kinetics and kinematics of race day and thus foster the best improvement in performance-specific strength." In other words, even the difference in shoes uses different muscles in various ways. If this is true, think of the possible difference from hard, flat ground to the varying terrain of a grassy field or dirt trail!

G.P. Bruggeman, a very respected German researcher adds this on how using a more flexible shoe can change musculature: "The cross-sectional areas of these (hallicus longus or big toe) muscles increased by 4 percent over the five-month period when the (special shoes) were employed during warm-up activities, and their strength was upgraded by around 20 percent." (2005) This was the result of using a shoe that allowed more flexibility in the forefoot and provided very little stability. Since the shoe attempted to mimic a barefoot condition, the foot was allowed a greater range of motion. This resulted in not only an enlarging of a muscle that is under-worked in traditional (stiffer) running shoes but also a 20 percent gain in strength. Using such shoes would be similar to changing on to a natural surface which would require muscles that would otherwise not be used as much to be recruited and strengthened.

The following summarizes the above research with the article "Worship the Ground You Run On" from Muscle and Fitness, July 2003. (Claps, F.) "Mixing up the surfaces you run on ensures the best overall fitness" is how Claps opens this article. He then goes on to rate different surfaces and their propensity for injury. Dirt is rated the best overall surface, with other surfaces like wooded paths and gravel also rated high. Pavement and concrete are rated the lowest. He describes the pros and cons of every surface in detail, but I think what has been written is sufficient for our needs. Running on natural surfaces recruits a more various group of muscles

and ensures a more even balance of musculature. Impact is reduced and injuries are held to a minimum when people choose to mix up their terrain and use natural surfaces when possible.

A few more examples of different surfaces and their effects:

" "Concrete is very hard compared to almost any other running surface, and although it seems as if the marginal differences in hardness would be inconsequential, they aren't. Repetitive stress injuries occur due to the cumulative effect of impact forces." (Journal of Running and FitNews Staff, 2001)

" Mark Bloom in the March 1997 Runner's World Magazine rates 10 surfaces in the article "Judging a Path by it's Cover." A Dirt road is rated the best with Concrete and Asphalt rated at the bottom. \_\_\_\_\_

"\_\_\_\_\_ "The body is an all-terrain vehicle. We cannot run on concrete for long without consequences. But while most runners believe that the rigidigy of concrete is the main problem, the *continuity of the surface* is just as bad and maybe worse...on an unvarying surface, your body is subjected to exactly the same forces with every strike of the foot. Not only is stress of impact exxaggerated by the hard surface, but it is also repeated excessively because the mechanics of every step are exactly the same. Worse still, the body is given no chance to adapt to other stresses. At best, same surface and hard-surface runners become strong in one way, but weak in all the others --- and therefore vulnerable to injury" (Ingraham, P. 2005).

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### Practicality

With the knowledge that natural surfaces are a better choice, how do we take this knowledge and apply it? What are the arguments against it? What specific groups do we want to accommodate?

The main reason that this issue hasn't been taken up by more people is arguably ignorance. People are simply unaware of the benefits of going off-road. If many of the very people who are participating in the sport are unaware, how can we expect city planners, engineers, and government leaders to be sensitive to the subject? People need to be educated on this issue. If educated, many people can be saved from pain and injuries. Demand for better places to exercise will increase. Hopefully with the combination of these two things, people will enjoy their exercise more.

What kind of surface is practical? In the Northwest, bark chip trails are a popular and very acceptable surface. Hard packed dirt is probably the most popular surface among runners. Dirt canal roads are a very popular choice for many runners and walkers. In some public areas, slag gravel has been used with great success. Walkers, runners, and bikers all find it to be a good solid surface for a trail. Another option is to pave half of the trail for those who might want that, and to use one of the above mentioned surfaces for the other half. The question that needs to be asked is: Who are we trying to accommodate with this trail?

There are certainly some cost and maintenance issues involved. An attempt to explore these in depth will not be given as that would require a lot more research and take away from the focus at hand. That said, it seems that most of the surfaces mentioned above are relatively inexpensive and easy to maintain. Communities should explore the options and make what they

feel is the best choice for their community and the population they want to accommodate.

What about bikers? As mentioned above, those who bike for exercise find hard packed slag gravel to be an acceptable surface. Serious road bikers obviously do not, but shun paved exercise trails anyway as they are not built for the high speed activity that they participate in. Traffic from walkers, runners, and others also makes for dangerous situations and many paved trails impose speed limits in an attempt to reduce collisions and other accidents. For these reasons, road bikers stick to the roads. Mountain bikers would more than likely enjoy having a natural surface to bike to and from their favorite mountain trail on. For those recreational bikers that want pavement, there is a lot of it out there and there are currently a lot of options compared to what walkers and runners have.

People like to go places. They like to go on outings, to go somewhere. Very few people want to run or walk 10 miles on the track! (That's 40 laps). In fact, very few people like to go a mile in circles. There is something about covering ground and going somewhere that gives people a sense of accomplishment and freedom. If this was not the case, we could just tell all runners and walkers to go do laps around the closest park and everyone would be happy. Also, one reason many trails are popular is because they are marked and people know how far they have gone. It is recommended that areas are constructed and preserved that allow people to go somewhere and still reduce the incidence of injury.

### Recommendation

Natural surfaces are a better choice for runners and walkers than paved surfaces and allow them to exercise with less injury and more enjoyment. Exercise enthusiasts deserve more natural surfaces to exercise on. These natural surfaces should allow people to both enjoy their exercise and reduce their risk of injury. Those developing these trails should take into account the target population they are making the area for and what type of surface is going to be the most practical for their community. Factors such as who will be using the area, how much it will cost, and how easy it will be to maintain should be considered. Citizens should be made aware of both the trail and the benefits of using the more natural surface. This could most likely be accomplished by signs at trailheads and other spots.

If these things are done, we are likely to have a happier, healthier public that has a greater chance of sticking with exercise and being successful in taking care of their bodies. Hopefully community leaders everywhere will respond to this great opportunity to make their community a better, healthier, and more attractive place.

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