Since the beginning of time man has wanted to fly. Now, with the influence of NASA and Nike's determination to introduce space-age materials into running footwear, runners are spending more time in the air and less on the ground.

It has been 30 years since *Runner's World* magazine started to publicise the laboratory testing of running shoes in the USA, thus heralding the start of the biomechanical era in footwear. All four of the major components that made up a running shoe in the 1970s - leather trim material, nylon uppers, EVA midsoles and carbon rubber outsoles - are still in place today. However, the technical and cosmetic advancements in materials between yesteryear and today can be compared with Kitty Hawk and the space shuttle Atlantis.

Leather has been replaced largely by poromeric or other polyurethane exoskeletal support components. EVA has won the midsole battle over PU and has evolved from a simple 'cookie-cutter' sheet to a sophisticated, highly compressed, injected form. Nylon uppers have developed from a basic 110-denier weave to dynamic stretch nylons and elasticised meshes. Sheet carbon rubber has evolved into compression molded plugs and strips for flexibility and weight saving.

Nike has been the dominant innovator in running shoes over the past quarter century. The other innovators include Adidas, New Balance, Asics (Tiger), Brooks, Reebok, Puma, Saucony, Etonic and L.A.Gear (the first to integrate flashing lights into the heels of running shoes). This survey takes a look at these companies today and the innovations they offer 21st century runners.

Nike's heritage is running. It was one of the first innovators to introduce soft foam midsoles and nylon uppers into running shoes. But it was the "waffle" outsole that brought most publicity to Nike in the 70s. Simple but effective, it gave better traction to the outsole with less weight, a dual feature still much sought after in today's latest running shoe models. In the late 70s, Nike acquired the Air Bag patent from NASA engineer Frank Rudi. This single cushioning device has remained the centre of Nike's success taking it to the pinnacle of the sport and shoe business during the latter part of the last century. So, what has Nike done for us runners lately?

The N-ergy S.C. System from New Balance features its patented responsive cushioning systems which is being introduced in its M2000 running shoe.

Having perfected air cushioning with varying PSI (pounds per square inch) and making encapsulated Air totally visual around the sole, Nike has further cosmeticised the Air Bag by making it visible through the inside. This is accomplished by adding a transparent insole board treatment along with a semi-opaque molded sock liner. Another continuous Nike evolution has been the quest to perfect a lightweight, breathable stretch nylon sock upper for runners. First introduced in the mid-1980s only to be withdrawn two years later, Nike's advanced concept team has been driven into futuristic technology by continuously experimenting with combinations of soft elasticised power mesh materials. These dynamic nylons are reinforced in the heel and forepart by molded PU exoskeletal overlays and EVA extended protrusions from the midsole. Continuous material advancements have not only kept Nike ahead of the competition with futuristic cosmetics, but have also created a new method of making shoes. Strong flexible polypropylene strips are literally welded onto various forms of nylon upper materials to create an endless variety of supports or cosmetics. This new form of dynamic upper has successfully reduced the average weight of a shoe from around 11ozs. (262gms) in the 70s to 8ozs. (227 gms) today. A shoe is worn at the most distal end of the body and is the heaviest piece of equipment worn by runners. A runner lifts his or her foot several thousand times in a marathon! That's why lightness is so important in a running shoe. Latest models from Nike include the Air Pegasus, Air Tiago, Air Dual, Air Agate, Air Terra Sebec, a constantly updated Air Max and the futuristic tech Air Presto Chanjo.

Options for customisation

Nike iD is the name for its make-your-own shoe programme. Offered on Nike's website, this long sought-after market approach is not as easy or functional as it sounds. Customising a running shoe by cosmetically choosing your own colour and perhaps having your initials stamped on the shoe is far from building in real features. Nike is one of several companies using computer technology to offer runners a hands-on approach to footwear. With its factories in the Orient and shoes produced in minimum production runs of tens of thousands at the least, customising a running shoe for an individual may be more of a marketing feat than an optimal feature for the feet.

On the other hand, adidas believes it has found the way to offer genuine customisation with its recently launched project - mi adidas - which will move swiftly from football boots to running shoes. It will give consumers the opportunity to create their own unique footwear to their exact personal specifications in terms of fit, function and design, thus providing a service that was so far only available to soccer stars such as David Beckham and Zinedine Zidane, or athletes like Haile Gebrselassie. The customised shoes will be delivered within two weeks and the price will be up to 50% above the price of an in-line product. Scanned information, combined with personal fit preferences, is entered into a computer to determine the best-fitting shoe. Once the customer has chosen his personalised function and fit, he has the opportunity to test the shoes before heading into the final design phase. He then gets the opportunity to design the colour elements and select his material preferences. As a final sign of individuality, he can create a uniquely embroidered monogram on his shoes.

With its Air Bag patent having expired a few years ago, Nike has introduced Shox R4, a quad spring cushioning/propulsion system. Several companies have tried a spring form of heel cushioning without success, including L.A.Gear and Activ from Korea. Nike's version is better engineered and market effective, meaning "if you can see and feel it - it must be doing something". Shox system is a quadrant of spring columns sandwiched between a top and bottom plate. The top plate distributes impact forces from the heel to the individual columns, deflecting like a trampoline. The bottom plate supports the columns, producing a secure base to guide the foot through the heel-to-toe transition. Combined with an air sole unit in the forefoot, Shox, because of Nike's sheer size represents the most futuristic approach to running footwear to date.

Futuristic, however, does not necessarily mean a better function for the runner. Two companies which have been hugely successful following a more conservative product development course are adidas and New Balance. Adidas is now concentrating on its new moisture transporting lining system called Climalite, which draws perspiration away from the skin. [You will note we call everything a "system" in running shoes, even if it's a lining.] Adidas has tried using different technologies in the past, such as its Torsion System for flexible torsional rigidity and PU midsoles, but the success and marketing power of major competitors have forced adidas to follow more popular trends. Many companies, with adidas being one of them, offer a series of running models to accommodate different weights and running styles - Ultra light for racing, Buzz for trail running, Exigence for stability, Ride for cushioning and Tyranny for over-pronation control. Adidas also makes a water-resistant model (Buzz) and has added a graphite plate in its updated Gazelle model for shock deflection.

If Nike has advanced running footwear with its cutting edge approach, New Balance has reached its major niche in the marketplace in more traditional fashion. NB's major contribution to running footwear has been the least innovative of all - width fittings.

Long recognised as a basic necessity of a well fitting shoe, NB has persisted in investing its future and considerable extra expense in this one important feature. And it has paid off. For its size (around $1 billion), NB enjoys the largest percentage volume in running shoes than any other brand, with approximately half its sales in

Nikes updated Air Max

width fittings other than medium. Of course NB has kept up with other material and cushioning evolutions but usually only after they have been introduced and well tested by other makers. Recently NB has started to become more adventurous with modern cosmetic looks and the introduction of its improved version of a shock absorbing heel component. Its N-ergy system consists of a DuPont Hytrel thermoplastic elliptical centre chamber with two outside channels for stability. NB continues with the Abzorb cushioning technology, which is a more traditionally established PU elastomer encapsulated into EVA. In a sort of tortoise-and-hare technology race with Nike, New Balance today is an awfully big tortoise capable of covering large areas of ground with a single bound.

Reebok also has its roots in running technology. Having played catch up to the early running shoe leaders, Reebok made a gigantic technological leap forward with its introduction of the Pump technology in the 1990s. First, and most successfully, launched as a basketball feature, Reebok's major contribution to running shoe technology has been to add an inflatable bladder to a running shoe upper, offering the wearer an air molded custom fit. Recently Reebok has had a second wind with this innovative (if somewhat limited feature in running shoes) technology with the Pump Run model for men and women. Reebok also continues with its much publicised DMX cushioning technology but in today's search for the ultimate marketing weapon adding a piece of honeycomb shock absorbing material is somewhat passé and has been long ago imitated. After trying both cosmetic extremes from simplistic-monochromatic to fluorescent cosmic, Reebok has currently settled somewhere between being more conservative than Nike and more radical than New Balance and adidas in its running shoe look.

Asics, originally from Japan, follows global trends with some distinctly Japanese traits. Excellent quality control and attention to innovative detail, along with a persistent belief that Gel cushioning is better than Air, marks Asics as a major contributor to running footwear technology. With a history to rival adidas and Puma, Asics, with input from Blue Ribbon Sports (Nike's original company name), was the first to make shoes with nylon uppers and blown rubber midsoles. Taking a more conservative approach, Asics, like New Balance, has been content to allow others to do the early experimentation preferring to come in later with perhaps a slightly different and possibly improved version of its own.

Like Nike's Air, Asics features Gel cushioning in its entire running shoe line and continues to enjoy steady growth in the two major markets of USA and Japan.

What of the other innovators in the running shoe marketplace today? They have all made their contribution. Puma with its Dial lacing system still ranks as a major innovator in running shoes. Originally from Germany, Puma was the first to use a hook and loop closure system on running shoes. More recently it has been the advocate for a foamless midsole using only a cellular PU molded unit to replace the established EVA white molded look. If the feature catches on commercially the company becomes a major innovator in the industry. However, if the innovation does not enjoy great selling success it will tend to be viewed more as a gimmick and less as a true contribution to a runner's comfort and performance. L.A. Gear fell into the gimmick-over-function category with its introduction of flashing lights on running shoes in the early 1990s. Obviously a great safety feature for night runners, it was quickly rejected by serious runners in favour of 3M's reflective material mainly because L.A.Gear pushed the lighted feature in children's shoes to greater success.

Brooks has made some major contributions to today's running footwear, most notably in the area of motion control. It was the first to offer runners an over-pronation control device with its Varus wedge, Diagonal Roll Bar and Kinetic Wedge. It has changed owners several times but still enjoys a pure reputation as a serious running shoe for serious runners. Every year, Brooks, like the other smaller brands, introduces minor 'running' improvements to its models that mainly go unnoticed. Two of the early American contributors to modern running innovation are still in the marketplace, albeit quietly. Saucony, in addition to making the first shoes to actually walk on the moon (true), was the first to use slip lasting for running shoes - offering the runner a lighter construction and an insoleless softer ride. Saucony was also the first to introduce deflection plates into softer midsole materials, giving a more stable landing platform to the heel area. It continues to offer these features in its 2001 running shoe line but, with larger companies offering similar or more advanced features, success is measured more by marketing muscle and shelf space. Last and, I'm afraid, least of the great running shoe innovators is Etonic. This Boston-based original golf shoe company was quick to jump on the new running shoe boom of the 1970s. With help from podiatrist Rob Roy MacGregor, Etonic was the first to popularise the removable molded sock liner into running shoes, now a current staple even in the cheapest brands.

So what's next?

NASA has already lent its name to a new shoe brand - Modellista, which enters the market using a new space age anti bacterial lining. Nike is working on a new interlocking phylon/PU midsole. We have seen toe-less, heel-less and Japanese split-toe running shoes, we even have running clogs. For all that is new today, however, the strange thing about yesterday's innovations is that they keep showing up on the best seller list under the Retro heading such as adidas Gazelle and Nike Cortez. Running shoe companies have always thrived on new innovation but I guess that the "if the shoe stays popular we'll make yesterday's models today" line of thought still survives.

Mel Cheskin