FOOTWEAR INCLUDING WOVEN UPPER

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ABSTRACT

A shoe component, wherein the shoe component is formed by 3-dimensional weaving such that the shoe component has one or more woven layers, each having a warp direction and a fill direction, wherein the shoe component has one direction of stretch; a shoe containing at least one of the shoe components in an upper; and a shoe in which the entire upper, and optionally the midsole and/or outsole, are entirely formed by 3-dimensional weaving.
FOOTWEAR INCLUDING WOVEN UPPER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is an application filed under 35 U.S.C. §111(a) claiming the benefit pursuant to 35 U.S.C. §119(e) (1) of the filing date of U.S. Provisional Application No. 61/616,235 filed on Mar. 27, 2012 pursuant to 35 U.S.C. §111(b), which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to footwear. In particular, the invention relates to footwear formed with the use of 3 dimensional weaving methods to form at least a portion of the footwear, and potentially forming the entire footwear as a unitary structure.

[0004] 2. Description of the Background

[0005] Shoes are conventionally prepared by a multistep process. Shoes are typically assembled as they travel through a series of rooms or departments, each doing a particular segment of the assembly process. Even with the use of modern machines it can still take a large number of separate operations to make a pair of shoes.

[0006] From the material to be used in a shoe, leather, man made, etc. all the pieces for the upper of the shoe are cut out in the cutting room. The cutting is done by machines fitted with cutting dies. This part of the process can generate significant amounts of waste.

[0007] In the stitching room, the upper parts coming from the cutting room are sewn together. Most of the refinements to the upper are finished in the stitching room, finishing edges, applying perforations, fancy stitching and inserting eyelets to name a few. The upper must be a finished unit before going to the stock fitting room.

[0008] In the stock fitting room, the other parts are assembled, including outsoles, insoles, counters, toe boxes, shanks, heels, etc. These pieces are attached to the last to form a semi-completed unit. In the bottoming room, the outsole is attached to the semi-finished shoe. The shoe is also given finishing touches here, such as sole edging, trimming, etc. Depending on the type of construction being used the bottoms are attached by stitching, cementing or heat-molding.

[0009] In the lasting room, the upper and lining are drawn tightly over the last and attached to the insole. This is done in separate operations such as toe lasting, heel seat lasting, etc. This is done by machines that grip the upper and stretch it over the last. Proper lasting is critical to proper fit and appearance of the shoe.

[0010] In the finishing room, the last is pulled from the shoe.

[0011] The outsole is the most basic part of a shoe. The outsole is a protective layer of material between the foot and the ground. Outsoles have a wide variety of functional properties such as wear, flexibility, traction, insulation to mention a few. These properties vary in accord with the type of footwear. Most shoes use a "unit sole" which means the sole and heel are combined into one unit. The unit sole is applied in one operation and reduces the cost of production. There is no one type of outsole that is regarded "best" for all footwear.

[0012] A typical bottom unit contains a cushioning element, a midsole, often made of ethylene-vinyl alcohol (EVA) or polyurethane (PU) forms, along with structural elements from thermoplastic polyurethane (TPU), and traction elements most often made from rubber, PU or TPU. Thermoplastic Rubber (TPR) is the most dominant type of sole material used today. TPR soles are light-weight, durable, flexible and slip resistant. TPR soles have very good aesthetics and can be made to look like leather, if desired. TPR soles are used on casual shoes for men and women, kid's shoes and light-weight work oxfords. PVC (polyvinylchloride) was, at one time, a popular sole material, but it has limited esthetics. Because it is very durable, it is used mainly today in work boot construction. Rubber compounds, such as neoprene, nitrile and hypalon are all rubber compounds are used mainly in the construction of athletic footwear or "sneakers". Again, because of their durability, these materials can also sometimes be found on work boots. Crepe is a member of the rubber family and can be either natural or man made. It is heavy, loses color and can be hot in warm weather. Its use is limited to some sport and casual shoes. Composite materials are also used for shoe soles. Composite materials can be any mix of materials used to create slab soles that are inexpensive but long wearing. They are used mainly on inexpensive footwear. Sometimes they can be made to resemble leather in appearance.

[0013] There are many ways to attach the sole to the upper but only a few methods are typically used in mass production. Remarkable as it may seem the manufacture of shoes remains fairly labor intensive. No matter the type of construction the first stage in construction is to attach the insole to the under surface of the last. Two main operations follow: Lasting describes when the upper sections are shaped to the last and insole. Followed by Bottoming, where the sole is attached to the upper. The process of bottoming will determine price, quality and performance of the shoe.

[0014] In molded methods, the lasted upper is placed in a mold and the sole is directly molded to the bottom of a lasted upper instead of being glued.

[0015] Force Lasting (also known as Strobel-stitched method or sew in sock) has evolved from sport shoes but is increasingly used in other footwear. The Strobel-stitched method (or sew in sock) describes one of many force lasting techniques. The upper is sewn directly to a sock by means of an overlooking machine (Strobel stitcher). The upper is then pulled (force lasted) onto a last or molding foot. Unit soles with raised walls or molded soles are attached to completely cover the seam. This technique is sometimes known as the Californian process or slip lasting.

[0016] With regard to athletic footwear in particular, state-of-the-art in athletic footwear making currently consists of an upper that is cemented to a midsole and outsole to create a finished product. Uppers are typically cut from multiple flat goods (such as leather, mesh and synthetic materials) which are then stitched or otherwise bonded together. There can be anywhere from 5 to 30 different materials used in a single upper, all of which are required to somehow be attached to one another using multi-step processes. Once the completed upper is assembled, it is somehow formed into a 3-D shape, typically by a board or strobel lasting process which pulls the material around a foot-form. After lasting, the uppers then have a midsole cushioning element(s) cemented to the bottom. Midsoles sometimes have structural elements molded or cemented to them, including injection molded plastic or com-
posite structures. Rubber is the typical material bonded to the bottom of a midsole to give the product abrasion and traction properties.

[0017] The main problem with this state of the art process is there are still 50 to 70 pairs of hands that touch each shoe on its way down the assembly line. Many of these are handling the processes of stitching the upper, since each individual piece (even hidden pieces like foams, linings and reinforcements) requires one person to cut it out, another to treat it (skiving the edges, for instance), and another to stitch it. So this requires huge coordination with supply chain to have all materials in correct quantities and colors at the factory at the correct time. It also means that through all those hand-processes, there is opportunity for error and inconsistencies. There is also a large amount of waste when it comes to die-cutting out so many different materials. And finally, the process of forming multiple layers of flat materials into a 3-D shape is not always effective. The resulting uppers can be stiff, not breathable and not stretchy or otherwise conforming to the foot.

[0018] Accordingly, a shoe construction is needed in which the components of the shoe, and ideally the entire upper or even a unitary structure containing the upper and a midsole/outsole, can be produced in a single process step, thus reducing costs of production. Additionally, with athletic shoes in particular, it is desirable to have a shoe that will stretch and recover, while maintaining light weight and flexibility. Finally, a shoe design in which the function of the shoe can be adjusted by the changing of yarns, creating layers, and adjusting weave techniques in a single process is desired.

SUMMARY OF THE INVENTION

[0019] Accordingly, one object of the present invention is to provide a shoe component having built in stretch and recovery properties.

[0020] A further object of the present invention is to provide a shoe construction in which at least the upper is prepared in a single process, and has one direction stretch and recovery properties, while maintaining support and integrity of the upper.

[0021] Another object of the present invention is to provide a shoe in which the upper and at least the midsole form a unitary structure which is made in a single process, and has stretch and recovery properties while maintaining support and integrity of the upper.

[0022] These and other objects of the present invention, either individually or in combinations, have been satisfied by the discovery of a shoe comprising:

[0023] an upper; and

[0024] a sole,

[0025] wherein at least one portion of the upper is formed by 3-dimensional weaving, wherein said at least one portion has one or more woven layers, each having a warp direction and a fill direction, such that said at least one portion has one direction of stretch.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0027] FIG. 1 is a side view of one embodiment of a lace-up configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a mediolateral direction.

[0028] FIG. 2 is a side view of one embodiment of a lace-up configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a heel to toe direction.

[0029] FIG. 3 is a further view of an embodiment of the lace-up configuration shoe of FIG. 1 from a different perspective.

[0030] FIG. 4 is an exploded view of a lace-up shoe construction of the present invention showing the upper 20, midsole 30, joining with the outsole 40, and having inserted therein a cushioning or support insert 50.

[0031] FIG. 5 is an exploded view of a lace-up shoe construction of the present invention showing the upper 20, midsole 30, and outsole 40, wherein the midsole 30 is a separate structure from the upper 20.

[0032] FIG. 6 is a side view of one embodiment of a slip-on configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in the mediolateral direction.

[0033] FIG. 7 is a side view of one embodiment of a slip-on configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a heel to toe direction.

[0034] FIG. 8 is a further view of an embodiment of the slip-on configuration shoe of FIG. 6 from a different perspective.

[0035] FIG. 9 is a side view of another embodiment of a slip-on configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a third direction.

[0036] FIG. 10 is an exploded view of a slip-on shoe construction of the present invention showing the upper 20, midsole 30, joining with the outsole 40, and having inserted therein a cushioning or support insert 50.

[0037] FIG. 11 is an exploded view of a slip-on shoe construction of the present invention showing the upper 20, midsole 30, and outsole 40, wherein the midsole 30 is a separate structure from the upper 20.

[0038] FIG. 12 is a top view of one embodiment of a slip-on configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in the mediolateral direction.

[0039] FIG. 13 is a top view of one embodiment of a slip-on configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a heel to toe direction.

[0040] FIG. 14 shows one embodiment of a slip-on configuration shoe of the present invention in which the midsole portion 30 of the unitary structure 10 has a pocket built therein, having an opening 32 into which a support element 50 or other element can be placed.

[0041] FIG. 15 is a top view of one embodiment of a lace-up configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in the mediolateral direction.

[0042] FIG. 16 is a top view of one embodiment of a lace-up configuration shoe of the present invention formed with the warp yarns in the 3-dimensional weaving running in a heel to toe direction.
[0043] FIG. 17 shows one embodiment of a lace-up configuration shoe of the present invention in which the midsole portion 30 of the unitary structure 10 has a pocket built therein, having an opening 32 into which a support element 50 or other element can be placed.

[0044] FIG. 18 shows various shoe components of the present invention formed by 3-dimensional weaving having the warp yarns running in the direction shown.

[0045] FIG. 19 is a top view of one embodiment of the present invention formed with the warp yarns in the 3-dimensional weaving running in the medial lateral direction, and showing a functional flange member 22 extending from one side.

[0046] FIG. 20 shows an embodiment of a shoe of the present invention wherein a functional flange 22 having lace holes 24 extends from the side of the shoe construction, and can be moved into place as indicated by the arrow to provide a lace-up configuration in conjunction with a similarly placed flange (not shown) on the other side of the shoe.

[0047] FIG. 21 shows an embodiment of a lace-up configuration shoe of the present invention having a functional (or decorative) flange 22 that can be moved into place as indicated by the arrow, and affixed to either the upper of the shoe or to a second functional (or decorative) flange (not shown) on the other side of the shoe.

[0048] FIG. 22 is an exploded view of a tongue-less lace-up shoe construction of the present invention showing the upper 20, midsole 30, and outsole 40, wherein the midsole 30 is a separate structure from the upper 20.

[0049] FIG. 23 shows another view of a tongue-less lace-up shoe construction of the present invention.

[0050] FIG. 24 shows a further embodiment of a slip-on shoe construction of the present invention.

[0051] FIG. 25 is a cross-section view of a shoe construction of the present invention wherein the unitary structure 10 has an upper portion 20 and a midsole portion 30, and has a pair of functional flanges 22 on the sides which can be moved into place over the upper as indicated by the arrows.

[0052] FIG. 26 is a cross-section view of a shoe construction of the invention shown in FIG. 25 wherein the functional flanges 22 are rotated towards an upper portion of the shoe; and

[0053] FIG. 27 is a cross-section view of a shoe construction of the present invention including functional flanges 22 rotated towards an upper portion of the shoe and additional flanges 26 located between functional flanges 22 and the midsole portion 30.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0054] The present invention relates to a shoe component formed by 3-dimensional weaving, a shoe incorporating at least one 3-dimensionally woven shoe component, a shoe upper formed entirely from 3-dimensional weaving, a unitary structure comprising an upper and a midsole where the entire unitary structure is formed by 3-dimensional weaving, and a shoe comprising the unitary structure, as well as a shoe formed entirely by 3-dimensional weaving, including upper and entire sole.

[0055] Central to the present invention is the technique of 3-dimensional weaving. 3-dimensional weaving is a technique for creating a textile product by utilizing a three dimensional Cartesian coordinate system as the infrastructure for weaving simultaneous independent fabric layers in conjunction with weaving connectors between and among the layers. The 3-dimensional weaving technique is described in detail in U.S. Pat. Nos. 7,836,917 and 7,836,918, the entire contents of each of which are hereby incorporated by reference. This technique is used to form fabrics having a plurality of woven layers, into which can be directly woven various openings, pockets, and textures. The 3-dimensional weaving technique also provides a process for imparting a variety of properties to the resulting fabric, including different modulus, stretch and recovery characteristics.

[0056] The term “fiber” as used herein refers to a fundamental component used in the assembly of yarns and fabrics. Generally, a fiber is a component which has a length dimension which is much greater than its diameter or width. This term includes ribbon, strip, staple, and other forms of chopped, cut or discontinuous fiber and the like having a regular or irregular cross section. “Fiber” also includes a plurality of any one of the above or a combination of the above.

[0057] As used herein, the term “high tenacity fiber” means that class of synthetic or natural non-glass fibers having high values of tenacity greater than 10 g/denier, such that they lend themselves for applications where high abrasion resistance is important. Typically, high performance fibers have a very high degree of molecular orientation and crystallinity in the final fiber structure.

[0058] The term “filament” as used herein refers to a fiber of indefinite or extreme length such as found naturally in silk. This term also refers to manufactured fibers produced by, among other things, extrusion processes. Individual filaments making up a fiber may have any one of a variety of cross sections to include round, serrated or crenular, bean-shaped or others.

[0059] The term “yarn” as used herein refers to a continuous strand of textile fibers, filaments or material in a form suitable for weaving, or otherwise intertwining to form a textile fabric. Yarn can occur in a variety of forms to include a spun yarn containing staple fibers usually bound together by twist; a multifilament yarn containing many continuous filaments or strands; or a mono filament yarn which consists of a single strand.

[0060] The term “composite yarn” refers to a yarn prepared from two or more yarns (or “ends”), which can be the same or different. Composite yarn can occur in a variety of forms wherein the two or more ends are in differing orientations relative to one another, so long as the final composite yarn containing the two or more ends is stably assembled (i.e. will remain intact unless forcibly separated or disassembled). The two or more ends can, for example, be parallel, wrapped one around the other(s), twisted together, or combinations of any or all of these, as well as other orientations, depending on the properties of the composite yarn desired.

[0061] In using the 3-dimensional weaving technique in the present invention, the warp yarns can be any desired yarn having low levels of stretch, preferably less than 5% stretch, more preferably less than 3% stretch. The yarn can be a natural or synthetic yarn, and can be of any desired denier based upon the desired overall weight of the shoe component being made. Preferred deniers are from 10 to 400 denier, more preferably from 50 to 200 denier. The warp yarn can also be a composite yarn if desired, such as a core-sheath construction wherein a sheath yarn is wrapped around a core yarn. Again, the core and sheath of such constructions can be any
natural or synthetic yarn, so long as the composite has the overall low levels of stretch desired.

[0062] The warp yarns are preferably a high tenacity fiber. Preferably the high tenacity fiber comprises a high molecular weight polyolefin, preferably high molecular weight polyethylene or high molecular weight polypropylene, an aramid, a high molecular weight polyvinyl alcohol, a high molecular weight polyacrylonitrile, liquid crystal polyster or mixtures or copolymers thereof.

[0063] The fill yarns can likewise be made from any natural or synthetic yarns, and similarly have any desired denier based upon the desired overall weight of the shoe component being made. Such natural or synthetic fibers include, but are not limited to, cotton, wool, nylon, polyester, rayon, cellulose acetate, etc. The fill yarns preferably have deniers in the 10 to 400 denier range, more preferably from 50 to 200 denier. The fill yarn preferably has a higher level of stretch than the warp yarns, and more preferably is an elastomer yarn having high stretch and recovery properties.

[0064] As the elastomeric yarn component, any elastomeric fiber may be used, as monofilament or multifilament yarn. Additionally, two or more elastomeric fibers can be combined in the core of a composite yarn, or used as a blend, twisted, in parallel, or air-tacked, etc. An elastomer is a natural or synthetic polymer that, at room temperature, can be stretched and expanded to typically twice its original length. After removal of the tensile load it will immediately return to its original length. Along with spandex, rubber and anidex (no longer produced in the United States) are considered elastomeric fibers. Spun from a block copolymer, spandex fibers exploit the high crystallinity and hardness of polycrystalline segments, yet remain "rubbery" due to alternating segments of polyethylene glycol. Suitable elastomeric fibers include, but are not limited to, fibers made from copolymers having both rigid and flexible segments in the polymer chains, such as, for example, block copolymers of polyester and polyethylene glycol. Particularly suitable elastomeric fibers include, but are not limited to, Spandex, such as LYCRA (produced by United Yarn Products), ELASSPAN (produced by Invista), DORLASTAN (produced by Bayer), CLEARSPAN (produced by Radici) and LINEL (produced by Fillatex).

[0065] Elastomeric yarns typically have one or more of the following materials properties: can be stretched over 500% without breaking; able to be stretched repetitively and still recover original length; lightweight; abrasion resistant; poor stretch, but stronger and more durable than rubber; soft, smooth, and supple; resistant to body oils, perspiration, lotions, and detergents; no static or pilling problem; very comfortable; and easily dyed.

[0066] The elastomeric yarn can be any desired denier, preferably from 10 to 400, more preferably from 15 to 350, most preferably from 50 to 200. The elastomeric yarn can be used alone or combined with one or more other yarns of any desired type, natural or synthetic, so long as the combination retains its elastomeric properties. If combined with one or more other yarns, the elastomeric yarn and other yarns are preferably blended, or the one or more other yarns are wrapped around the elastomeric yarn to provide an elastomeric core composite yarn, thus retaining the stretch property.

[0067] Elastomeric yarn containing composite yarns are further described in U.S. Pat. Nos. 5,568,657 and 5,442,815, the contents of which are incorporated herein by reference. Elastomeric yarn containing composite yarns having wicking properties are described in U.S. Provisional Application Ser. No. 61/020,790, filed Jan. 14, 2008, the contents of which are hereby incorporated by reference.

[0068] The present invention uses this 3-dimensional weaving process to generate shoe components, and in a preferred embodiment to generate an entire shoe upper/midsole unitary structure, which can be affixed to an outsole for providing a traction element or cushioning element, or can have a plurality of traction elements and/or cushioning elements affixed thereto on the exterior layer of the midsole portion. In a particularly preferred embodiment, the traction elements and/or cushioning elements are directly formed during the 3-dimensional weaving process by the use of yarns that provide traction properties to form at least a portion of the exterior layer of the midsole portion of the unitary structure. Such yarns for providing traction or cushioning properties include fusible yarns, abrasion yarns, cushioning yarns, and high tenacity yarns.

[0069] In providing a cushioning effect to the lower midsole portion of the unitary structure of a preferred embodiment of the present invention, it is also preferred to weave in during the 3-dimensional weaving process various types of yarns and structures, such as pile yarns, air mesh constructions, hollow fibers, etc.

[0070] In the products of the present invention, the 3-dimensional weaving process is preferably performed using a rigid warp yarn with an elastomeric fill yarn. By using a plurality of successive fabric forming operations, resulting in incremental stretch capacity from each successive operation, the resulting multilayer 3-dimensionally woven fabric is provided with unidirectional stretch. The multilayer 3-dimensionally woven fabric exhibits high stretch/recovery properties in the fill direction (due to the elastomeric yarns used therein) and rigid or extremely low stretch properties in the warp direction.

[0071] This unidirectional stretch property can be used quite effectively in the construction of shoes. Various components of the shoe can be individually formed using the 3-dimensional weaving technique in order to provide varied levels and directions of stretch as needed. The unidirectional nature of the stretch in each component can provide a unique combination of stretch and rigidity that is highly beneficial in providing comfort and support in a shoe construction. The components of the shoe can be any portion of the shoe construction as desired, and are preferably selected from the group consisting of the tongue, quarters, vamp, heel seat, and toe box.

[0072] In a preferred embodiment of the present invention, a unitary structure in the general shape of a foot covering is formed by 3-dimensional weaving, such that the unitary structure contains a top portion that is a shoe upper, and a bottom portion corresponding to a shoe midsole (or even a full sole in some alternative embodiments). In the preparation of such a unitary structure, a flange can be preferably formed at the intersection of the upper and midsole portions. This flange is typically formed on an exterior surface of the unitary structure. The unitary structure can be turned inside-out to result in the flange being present on an interior surface if desired. Alternatively, the flange can be formed in such a manner as to externally protrude laterally and can be formed as a pair of flanges, one on each side of the unitary structure in a shape and size sufficient to externally wrap over the vamp portion of the shoe and connect one to another. In a preferred
embodiment, the pair of flanges can be configured to have lacing holes and thus provide the capability to lace up the shoe on the foot, or can be configured to have another form of attachment, such as hook-and-loop (or “VELCRO”) type closures.

[0073] The unitary structure of a preferred embodiment of the present invention can be formed by weaving from top down or laterally. Additionally, in either top down or lateral weaving of the unitary structure, the warp direction can run in a heel to toe direction or in a medial-lateral direction. When the warp direction runsable in a heel to toe direction, the resulting 3-dimensionally woven fabric has stretch in a medial-lateral direction. When the warp direction runs in a medial-lateral direction, the resulting 3-dimensionally woven fabric has stretch in a heel-to-toe direction.

[0074] The above noted cushioning elements can also be provided by insertion of a cushioning insert into a pocket formed in the midsole portion of the structure of the present invention. The pocket can have an opening to either the interior of the structure or to the exterior of the structure. In a further embodiment, this pocket can be used to house a support element which provides arch support for the wearer.

[0075] The shoe construction of the present can take on any typical shoe form, and is preferably a slip-on construction or lace-up construction. For a slip-on construction, it is preferred to have at least a portion around the opening into which the wearer’s foot enters the shoe to be made of the 3-dimensionally woven fabric in order to provide a more form fitting shoe. For the lace-up construction, the upper preferably comprises a tongue portion. In the face-up construction the tongue can be separately formed, or can be formed as a portion of the upper during the 3-dimensional weaving process.

[0076] One feature provided by the 3-dimensional weaving process is the ability to form pockets or compartments within and between the plurality of layers of the 3-dimensionally woven fabric. These pockets or compartments can be used as locations for inserts to provide various functions, such as antimicrobial inserts, charcoal or other odor reducing inserts, structural inserts, or as noted above support inserts.

[0077] In a particularly preferred embodiment of the present invention, the shoe of the present invention comprises an upper and midsole unitary structure formed by 3-dimensionally woven fabric. The midsole is made of both warp and fill of suitably low denier to provide a total shoe weight of from 5-to-10 ounces, most preferably from 6-8 ounces, including the weight of the lightweight outsole.

[0078] In a further preferred embodiment, the exterior layer of the midsole portion of the unitary structure of the present invention is formed from low melting (fuseable) yarns which permit the midsole portion to be affixed to the outsole upon application of sufficient heat to melt/fuse the low melting yarns, thus adhering the unitary structure to the outsole.

[0079] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views.

[0080] FIG. 1 depicts a side view of an embodiment of the present invention. In the embodiment shown in FIG. 1, the warp direction of the weaving of footwear structure 10 is shown by lines 12. In this regard, footwear structure 10 is formed with the warp yarns in the 3-dimensional weaving running in the medial-lateral direction. Footwear structure 10 includes upper 20, midsole 30, and outsole 40. Upper 20 includes tongue 28 woven integrally with upper 20. Upper 20 also includes apertures 27 for receiving shoelaces for securing the footwear structure to the foot of a person.

[0081] FIG. 2 depicts a side view of another embodiment of the present invention. Footwear structure 10 of FIG. 2 includes the same components as footwear structure of FIG. 1, however the warp direction 12 in FIG. 2 is orthogonal to the warp direction 12 in FIG. 1. In particular, footwear structure 10 in FIG. 2 is formed with the warp yarns in the 3-dimensional weaving running in the heel-to-toe direction.

[0082] FIG. 3 shows a perspective view of footwear structure 10. This footwear structure could have a warp direction as shown in either of FIG. 1 or 2. FIG. 3 also shows the flexibility of tongue 28. As indicated by the arrow in FIG. 3, tongue 28 can be moved in a medial-lateral direction with respect to footwear structure 10.

[0083] FIG. 4 shows a cushioning or support insert 50 being inserted into footwear structure 10. In addition, FIG. 4 also shows outsole 40 being connected to midsole 30 of footwear structure 10. In this embodiment, outsole 40 is separately formed from the integrally woven upper 20 and midsole 30. The separately formed outsole 40 is then attached to midsole 30.

[0084] FIG. 5 shows an additional embodiment in which both midsole 30 and outsole 40 are separately formed from integrally woven upper 20. Both midsole 30 and outsole 40 are then later attached to upper 20.

[0085] FIG. 6 illustrates a side view of one embodiment of a slip-on configuration shoe of the present invention. This embodiment is similar to that shown in FIG. 1, but does not include the apertures 27 and tongue 28 shown in FIG. 1. In a similar manner as FIG. 1, footwear structure 10 is formed with the warp yarns in the 3-dimensional weaving running in the medial-lateral direction.

[0086] FIG. 7 illustrates a side view of one embodiment of a slip-on configuration shoe of the present invention. This embodiment is similar to that shown in FIG. 2, but does not include the apertures 27 and tongue 28 shown in FIG. 2. In a similar manner as FIG. 2, footwear structure 10 is formed with the warp yarns in the 3-dimensional weaving running in the heel-to-toe direction.

[0087] FIG. 8 illustrates a side view of another embodiment of a slip-on configuration shoe of the present invention. This embodiment is similar to that shown in FIG. 1, but this footwear structure 10 is formed with the warp yarns in the 3-dimensional weaving running in a direction oblique to both the medial-lateral direction and the heel-to-toe direction. In this regard, the present invention includes footwear structures with the orientation of the upper in any possible angle relative to the warp.

[0088] FIG. 9 shows a perspective view of a slip-on footwear structure 10. This footwear structure could have a warp direction as shown in either of FIG. 6 or 7.

[0089] FIG. 10 shows a cushioning or support insert 50 being inserted into the slip-on footwear structure 10. In addition, FIG. 9 also shows outsole 40 being connected to midsole 30 of slip on footwear structure 10. In this embodiment, outsole 40 is separately formed from the integrally woven upper 20 and midsole 30. The separately formed outsole 40 is then attached to midsole 30.

[0090] FIG. 11 shows an additional embodiment in which both midsole 30 and outsole 40 are separately formed from integrally woven upper 20. Both midsole 30 and outsole 40 are then later attached to upper 20.
FIG. 12 illustrates a top view of one embodiment of a slip-on footwear structure 10 formed with the warp yarns in the 3-dimensional weaving running in the medial-lateral direction.

FIG. 13 illustrates a top view of one embodiment of a slip-on footwear structure 10 formed with the warp yarns in the 3-dimensional weaving running in the heel-to-toe direction.

FIG. 14 illustrates an embodiment of a slip-on footwear structure 10 which includes an opening 32 in midsole 30. Opening 32 allows support insert 50 to be inserted inside of footwear structure 10. Outsole 40 can then be attached to midsole 30, which seals opening 32.

FIG. 15 is a top view of embodiment of a least a configuration of footwear structure 10 in which the warp yarns in the 3-dimensional weaving running in the medial-lateral direction. One example of such an embodiment is shown in FIG. 1.

FIG. 16 is a top view of embodiment of a lace up configuration of footwear structure 10 in which the warp yarns in the 3-dimensional weaving running in the heel-to-toe direction. One example of such an embodiment is shown in FIG. 2.

FIG. 17 illustrates an embodiment of a lace up configuration of footwear structure 10 which includes an opening 32 in midsole 30. Opening 32 allows support insert 50 to be inserted inside of footwear structure 10. Outsole 40 can then be attached to midsole 30, which seals opening 32.

FIG. 18 shows various shoe components of the present invention formed by 3-dimensional weaving having the warp yarns running in direction 12.

FIG. 19 illustrates a top view of one embodiment of a slip-on configuration of footwear structure 10 formed with the warp yarns in the 3-dimensional weaving running in the medial-lateral direction and including a functional flange member 22 extending from one side.

FIG. 20 illustrates a perspective view of a lace up configuration of footwear structure 10 including a functional flange member 22 extending from one side. Functional flange member 22 includes apertures 27 for receiving shoe laces.

FIG. 21 depicts an embodiment of a lace-up configuration shoe of the present invention having a functional (or decorative) flange 22 that can be moved into place as indicated by the arrow. Functional flange 22 can then be affixed to either the upper 20 or to a second functional (or decorative) flange (not shown) on the other side of the shoe. As noted above, the flanges 22 of the present invention may be functional or decorative flanges. In particular, functional flanges may be part of the lacing system and/or may be used in securing the sole.

FIG. 22 is an exploded view of a tongue-less lace-up shoe construction of footwear structure 10 showing the upper 20, midsole 30, and outsole 40. The midsole 30 is a separate structure from the upper 20, as is the outsole 40. Midsole 30 and outsole 40 are affixed to upper 20 after integrally weaving upper 20.

FIG. 23 shows another view of a tongue-less lace-up shoe construction of the present invention.

FIG. 24 shows a further embodiment of a slip-on shoe construction of the present invention.

FIG. 25 is a cross-section view of footwear structure 10 having an upper portion 20 and a midsole portion 30. Footwear structure 10 also includes a pair of functional flanges 22 on the sides which can be moved into place over the upper as indicated by the arrows.

FIG. 26 shows the functional flanges 22 after they are rotated towards an upper portion of the shoe.

FIG. 27 is a cross-section view of footwear structure 10 including functional flanges 22 rotated towards an upper portion of the shoe and additional flanges 26 located between functional flanges 22 and the midsole portion 30. The present invention allows weaving of specific characteristics of the shoe (such as stretch, non-stretch, sweat-wicking, etc) where desired in a single unified upper. No (or very few) sewing or bonding processes are needed to create the upper. The programming of the type of weave, along with the choice of yarns, allows for simple changes to characteristics within the upper for different types of shoes, sizes and colors. Finally, there is no waste from cutting out dozens of materials, rather only the waste from cutting out the entire upper. Thus, the present invention provides both a process and performance enhancement.

The present invention also allows for a certain amount of shaping of the upper even before lacing, meaning the overall shape of a woven upper should be a 3-D shape rather than a flat one. This allows the upper to conform to the foot much better, and require less (perhaps none) forcing of 2-D materials around a 3-D last. This enhances the fit and performance of the end product, not only by shaping it in 3-D and minimizing layers, but also because the precision and consistency of the upper (with no human hands touching it as it goes down a stitching line) will be vastly improved.

Additional embodiments include weaving in the cushioning and traction elements that are currently cemented to the upper, thereby eliminating even more waste and processes.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

1. A shoe comprising:
   an upper;
   a sole,
   wherein at least one portion of the upper is formed by 3-dimensional weaving, wherein said at least one portion has one or more woven layers, each having a warp direction and a fill direction, such that said at least one portion has one direction of stretch.

2. The shoe of claim 1, wherein said at least one portion of the upper is at least one member selected from the group consisting of tongue, quarters, vamp, heel, and toe box.

3. The shoe of claim 1, wherein the at least one portion of the upper formed by 3-dimensional weaving is the entire upper.

4. The shoe of claim 1, wherein the sole comprises a midsole and an outsole, and the upper and the midsole form a unitary structure wherein the entire unitary structure is formed by 3-dimensional weaving.

5. The shoe of any one of claims 1-4, wherein the one direction of stretch is in a heel-toe direction.

6. The shoe of any one of claims 1-4, wherein the one direction of stretch is in a medial-lateral direction.

7. The shoe of claim 3, wherein the upper comprises a lace closure.

8. The shoe of claim 7, wherein the upper is woven from top down.
9. The shoe of claim 7, wherein the upper is woven laterally.
10. The shoe of claim 3, wherein the shoe is a slip-on construction.
11. The shoe of claim 10, wherein the upper is woven from top down.
12. The shoe of claim 10, wherein the upper is woven laterally.
13. The shoe of claim 4, wherein the unitary structure comprises a lace closure.
14. The shoe of claim 13, wherein the unitary structure is woven from top down.
15. The shoe of claim 13, wherein the unitary structure is woven laterally.
16. The shoe of claim 4, wherein the unitary structure is a slip-on construction.
17. The shoe of claim 16, wherein the unitary structure is woven from top down.
18. The shoe of claim 16, wherein the unitary structure is woven laterally.
19. The shoe of claim 4, wherein the unitary structure comprises at least one 3-dimensionally woven flange externally projecting laterally from a vicinity of the midsole portion.
20. The shoe of claim 19, wherein the at least one 3-dimensionally woven flange is a pair of 3-dimensionally woven flanges each externally projecting laterally from opposite sides of the midsole portion and wherein the pair of flanges contain a mechanism by which the flanges can be detachably connected to one another when externally wrapped over a vamp portion and form lacing structures.
21. The shoe of claim 19, wherein the at least one 3-dimensionally woven flange is a pair of 3-dimensionally woven flanges each externally projecting laterally from opposite sides of the midsole portion and wherein the pair of flanges contain a mechanism by which the flanges can be detachably connected to one another when externally wrapped over a vamp portion.
22. The shoe of claim 4, wherein the outsole is a solid piece formed of a member selected form the group consisting of thermoplastic rubbers, natural and synthetic rubbers, crepe rubber, and composite materials; and is affixed to an underside of the midsole portion of the unitary structure.
23. The shoe of claim 4, wherein the outsole comprises a plurality of woven portions on an underside of the midsole portion of the unitary structure, wherein the plurality of woven portions are formed from at least one member selected from the group consisting of fusible yarns, abrasion resistant yarns, cushioning yarns, and high tenacity yarns.
24. The shoe of claim 23, wherein the plurality of woven portions forming the outsole are woven into the underside of the midsole portion of the unitary structure during the 3-dimensional weaving process of forming the unitary structure.
25. The shoe of claim 4, wherein the midsole portion of the unitary structure comprises a plurality of 3-dimensionally woven layers forming a pocket having an opening proximal to one end thereof, wherein said pocket runs substantially an entire length from toe to heel and substantially across an entire width of the midsole portion.
26. The shoe of claim 25, wherein the opening for the pocket is in an external layer of the plurality of 3-dimensionally woven layers.
27. The shoe of claim 26, further comprising a support member inserted in the pocket, such that a wearer of the shoe is provided with arch support.
28. The shoe of claim 27, wherein the support member is formed so as to provide cushioning to a wearer’s foot.
29. The shoe of claim 25, wherein the opening for the pocket is in an internal layer of the plurality of 3-dimensionally woven layers.
30. The shoe of claim 29, further comprising a support member inserted in the pocket, such that a wearer of the shoe is provided with arch support.
31. The shoe of claim 29, further comprising an insert member inserted in the pocket, and providing odor and/or bacteria control to a wearer of the shoe.
32. The shoe of claim 4, wherein the unitary structure comprises a plurality of 3-dimensionally woven layers, wherein an internal layer of the unitary structure comprises one or more yarns selected from the group consisting of cushioning yarns, antimicrobial yarns, and wicking yarns.
33. In a conventional shoe construction formed of an upper portion and a sole portion, the improvement wherein the upper portion is a one piece upper formed by 3-dimensional weaving, wherein said one piece upper has one or more woven layers, each having a warp direction and a fill direction, such that said one piece upper has one direction of stretch.
34. In the conventional shoe construction of claim 33, wherein the one direction of stretch is in a heel to toe direction.
35. In the conventional shoe construction of claim 33, wherein the one direction of stretch is in a medial-lateral direction.
36. A shoe component, wherein the shoe component is formed by 3-dimensional weaving such that the shoe component has one or more woven layers, each having a warp direction and a fill direction, wherein the shoe component has one direction of stretch.
37. The shoe component of claim 36, wherein the shoe component is a member selected from the group consisting of tongue, quarters, vamps, heel seat, and toe box.
38. The shoe component of claim 36, wherein the shoe component is a midsole component.
39. The shoe component of claim 38, wherein the midsole component comprises a plurality of 3-dimensionally woven layers forming a pocket having an opening proximal to one end thereof, wherein said pocket runs substantially an entire length from toe to heel and substantially across an entire width of the midsole component.