

BODY ARMOR SYSTEM**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims priority to United States Provisional Patent Application No. 63525119 filed on 5 July 2023 and United States Provisional Patent Application No. 63525121 filed on 5 July 2023. The entire disclosures of which are hereby incorporated by reference in their entirety and for all purposes.

FIELD

[0001] This invention relates to body armor, body protection and a system for such as typically used by the military, law enforcement, (personal) security, as well as sport.

BACKGROUND

[0002] Typically, ballistic and stab protection is covered by vests and helmets. These products only cover about 30% of the body, leaving the rest exposed to harm. Further, there are significant concerns about competing aspects of body armor – typically thought of as 1. Protection levels (resistance to threats), 2. Mobility and comfort, and 3. Cost. What is generally overlooked when selecting a body armor system is the coverage area of the body, with little meaningful improvement since the adoption of vests/helmets decades ago.

[0003] There is a need to address armor more holistically, with the parameters of 1. Protection Levels, 2. Mobility and comfort. And 3. Body surface area coverage. The 4th element can be cost which is generally in flux with new materials and manufacturing methods being developed all the time.

[0004] There are numerous body armor systems currently on the market, typically taking the form of protective vests and helmets such as “bullet resistant vests”. These provide significant protection for specific, limited areas of the body. However, these same systems provide little to no protection to critical mobility areas, leaving large areas of the body unprotected due to challenges of covering body parts which bend, flex, and curve in complex and sometimes opposite directions. Joints-like knees and elbows are generally not covered, as robust armor doesn’t resist bending in one direction, and is significantly resistant to bending in two opposite directions concurrently.

[0005] There are some protection systems segmented at joints, such as an upper thigh pad and a shin guard, for example, with no protection in between. A knee pad that protects the front of the knee, and

omits the back of the knee altogether, has limited use. Further, robust armor elements which cover a joint when straight, may allow gaps or voids to open when the same joint is bent. These segmented systems are not helpful when dealing with military fragments such as grenades and mortar shells, which spray combatants with showers of sharp metal pieces. Covering extremities properly requires the full coverage of joints (not segmented with gaps), so that these types of threats may be repelled.

[0006] There is a need for an improved armor system to wholistically address protection, mobility, and coverage area, allowing users to select systems which better suit their perceived threat condition.

Further, a system which significantly covers more surface area than a protective torso vest, is advantageous and should include armouring an entire body with extremities and joints, while allowing full range of movement, and preventing gapping or voids in armor coverage from opening up during movement or bending of joints.

[0007] Such a system would provide tremendous extra benefit to wearers in various situations, allowing joints and mobile areas to be covered and contoured with armor, and allowing the armor assembly to move, elongate, shorten, expand, etc. so that the wearer can still reasonably or rigorously perform the task duty or activity while wearing the protective armor.

[0008] Two examples of situations generally not currently covered by available armor systems follow. Example A is a soldier who is being attacked with fragmenting munitions. Fragmentation/penetration is the leading cause of combat casualties, indiscriminately spraying soldiers with sharp metal fragments of various sizes. An injured soldier stops shooting back, as well as 2-3 more soldiers as the injured soldier now requires the attention of several others for care and evacuation. Additional armor protection can greatly reduce the risk of casualties from fragmented munitions. There is a need to protect a greater body surface area while avoiding gaps between armour panels.

[0009] Example B is a law enforcement person wearing a traditional stab resistant vest. These vests can be bulky and uncomfortable. In close quarters a perpetrator could stab or slash the law enforcement person under the arm, where there is a major artery, inflicting significant damage which can result in death from blood loss. There is a need to provide for a more pliable and flexible vest that is easier to conceal (ensuring concealment of the law enforcement status). There is also a need to provide coverage at areas under arms or in groin areas where large arteries have no coverage currently.

[00010] It is an object of the invention to substantially overcome, or at least ameliorate, one or more of the above disadvantages.

SUMMARY

[00011] In a first aspect, the invention provides a body armor system comprising at least two of; improved armor body surface coverage area, improved armor mobility, improved armor protection levels, whereby a user may select an armour system with improved clarity of least two of; armor coverage, armor mobility, armor protection, which better suits the users threat situation.

[00012] Preferably, this invention provides a process for classifying armor systems by protection, mobility, and body surface coverage areas in a simplified way for individuals and risk managers to understand.

[00013] Preferably, this invention provides for a way to classify threat levels and protection levels where said threat/protection is not within an industry standard currently (such as shark bite resistance).

[00014] Preferably, the invention provides an assessment of statistically collected data from threats, and divides them into statistical categories of at least half, with a statistical low half and high half. Protection levels are designed to address those statistical half's, such as the first protection level is designed to resist the effects the lowest half statistical threat, the second level of protection is designed to resist deleterious effects of the highest half level of statistical threat.

[00015] Preferably, threats to protect against may also include bug bites, UV exposure, wind exposure, rain/snow exposure, hiding the body's thermal signature from enemy vision/detection, etc.

[00016] Preferably, the invention provides an assessment of human mobility during a particular activity. This could be swimming, running, soldiering tasks, or law enforcement tasks. The armor systems' effect on human mobility can be classified in at least 2 or potentially more categories. The first category means you can function doing the task minimally – such as a gentle walk. The highest category of mobility means you can perform at the highest level of activity for a reasonably sustained period – such as all out sprinting for a similar time frame you could otherwise without the armor. Optional other categories such as a median category of mobility may be in between the low and the high level of activity – such as mid-level jogging, but not sprinting.

[00017] Preferably, this invention provides for assessing overall breathability, added thermal burden, chafing, reduction in range of motion, and other potential aspects related to garment comfort and mobility.

[00018] Additional considerations for mobility and comfort may include – the garments ability to resist soaking up water weight, the garments' buoyancy in water, the garments' ability to slide over the ground crawling, etc.

[00019] Preferably, the invention provides simplified assessments of covered body area based on critical nature. For example, critical zone 1 may include protection for the torso, head or neck, as damage there can be fatal or debilitating. Critical zone 2 may be the upper extremities such as the shoulders/upper arms, upper legs, and also the lower torso typically omitted from upper torso vests. Significant damage to these areas can be demobilized, and severing major arteries here can be fatal in relatively short periods of time. Critical zone 3 may be the lower arms (elbows to wrists), and the lower legs (knees to ankles). Damage to these areas may be debilitating, but statistically much more survivable, and generally allowing more time to treat when compared to injury to zones 2 and 1. Hands and feet may be another protection zone or combined with critical zone 3.

[00020] Preferably, the protective armor may harm an animal by biting/stinging, such as hard outer plates where the animals' teeth are sensitive to pressure against them, causing the animal to relent in the attack in either intensity or duration or both.

[00021] Preferably, the armor system comprises at least two protective armor elements which substantially overlap with one another to comprise the total required armor thickness.

[00022] Preferably, the armor shapes allow folding lines between at least three external geometric angles and at least one geometric internal angle, without crossing folding lines between alternate geometric angles.

[00023] Preferably, armor shapes feature a leading edge and a trailing edge, where the leading edge will substantially align with the trailing edge.

[00024] Preferably, the overall armor thickness designed to resist a threat is divided into two or more subcomponent layers, where two 50% thick layers overlap to 100% thickness, or three 33.3% thick layers overlap to 100% thickness, etc.

[00025] Preferably, if an armor system is divided into 2 subcomponent layers, then at least 2 subcomponent layers are required for appropriate protection.

[00026] Preferably, if an armor system is divided into 3 subcomponent layers, then at least 3 subcomponent layers are required for appropriate protection.

[00027] Preferably the armor system constitutes an improved body surface area coverage system beyond upper torso vests and/or helmets.

[00028] Preferably the armor system constitutes better mobility pliability and comfort by utilizing multiple overlapping armor shapes where at least two complimentary shapes are required to cover the entire surface area to be covered.

[00029] Preferably the armor system offers a classification system which simplifies selection criteria for armor based on at least two of, protection level, mobility level, and body area coverage level.

[00030] Preferably the armor system allows coverage of upper and lower extremities in addition to torsos and helmets.

[00031] Preferably the armor system categorizes threats by recording statistical data of the threats from a probable low to a probable high and sub categorizes those threats in two or more categories. This allows users to select protection based on simplified threat deterrence expectations.

[00032] Preferably the armor system classifies human mobility possible while wearing the armor from minimally mobile and functional to the highest level of activity and exertion and potential mid-level(s) in between.

[00033] Preferably the armor rating system records threat data where threats are not currently standardized such as shark attacks, or goring from wild pigs, or kicking from horses or livestock, and compiles the data into at least two statistical groups or more for designing resilient armor matched to those threat categories

[00034] Preferably the armor rating system can measure threats in their natural habitat such as bite forces from sharks in the ocean or a horse kicking with blunt force trauma on a ranch. Those forces can be then replicated into laboratory environments for ease of testing further materials and garments.

[00035] Preferably the armor system classification can be designed for passive or stationary threats such as falling on top of coral or colliding with a tree mountain biking or skiing and replicate those forces in a laboratory to further test armor materials and/or assemblies.

[00036] Preferably the armor system allows for users to be competent in a particular activity/task whether it is running, swimming, surfing, soldiering tasks, law enforcement tasks. A competent user group may trial wearing the armor during those activities or tasks and provide feedback if the armor allows minimal functional movement, or maximum exertion for a reasonably sustained duration, or something in between those levels of mobility and exertion.

[00037] Preferably the armor system allows for multiple parts and shapes which overlap two times or more over substantially the surface area to be protected.

[00038] Preferably the shapes of each armor panel allow for multiple bending or folding lines where from outside or inside corners for significant changes in direction of the perimeter edge whereby the multiple bending and folding lines do not intersect one another.

[00039] Preferably, the armor overlaps are redundant and extended past minimum lines of overlap, to provide for at least one of maximum elongation/extension of the armor assembly, and/or minimum edge distances of armor as required by armor design or armor regulations including when the armor is maximally extended.

[00040] Preferably the armor shapes have a leading edge which substantially aligns with a trailing edge for efficiency of overlap.

[00041] Preferably pointed or curved chevron shapes may be utilized where the leading edge substantially aligns with the trailing edge of an adjacent armor panel.

[00042] Preferably the overlapping armor panels include a redundant overlap which complies with minimum edge distance from different regulatory agencies for various threats, such as two 50% thick armor panels overlapping to three layers of 50% armor thickness (150% of thickness), so that overlaps can shorten when the assembly elongates and still maintain minimum edge distances for armor design and armor regulations.

[00043] Preferably the armor shapes when overlapped allow for further expansion and further contraction and overlap as well as twisting and curving in different directions.

[00044] Preferably, the overlapping panels will fully overlap covering the substantial surface area to be protected by either two 50% thick armor panels where the overlap equates to 100% of the thickness or potentially three 33.3% thickness panels where there is a triple overlap over substantially the entire area to be covered, or four 25% thick panels with a quadruple overlap over substantially the entire area to be covered ETC. Redundant sections may be 150% for double overlapped systems, or 133% thickness for triple overlapped systems, or 125% thickness for quadrupled overlapped systems, etc., which are all more efficient than overlapping two 100% thick armor panels, which at the overlapped area is 200% of the weight/thickness required.

[00045] Preferably, an armor profile consisting of 100% of the thickness may be significantly stiff. Preferably at least two armor panels, each 50% of the required thickness are utilized in place of one 100% thick panel where the two 50% thick panels may have 200% more pliability and flexibility.

[00046] Preferably three overlapped armor panels each 33.3% thick compared to the total 100% armor thickness are significantly more flexible and pliable than a set single panel that is 100% thick.

[00047] Preferably two overlapping armor panels each 100% thick to resolve a threat will be 200% of the required thickness and weight where they overlap, which is inefficient in weight and thickness.

[00048] Preferably two 50% thick panels may overlap to cover substantially the entire surface area to be protected, and where redundant overlap of three panels is only 150% of the required weight and thickness versus 200% of the weight and thickness compared to two 100% thick panels overlapping.

[00049] Preferably three 33.3% thick panels overlap over significantly the entire surface area to be covered, whereby redundant overlaps of four panels are only 133% of the thickness and weight versus 200% of the thickness and weight where two 100% thick armor panels overlap. Preferably four 25% thick panels have redundant overlaps of 125% in thickness and weight. Preferably five 20% thick panels have redundant overlaps of 120% in thickness and weight.

[00050] Preferably the armor panel or panels may be treated topically or infused with hydrophobic materials or agents whereby surface water such as rainwater will be repelled and yet the fabric will remain breathable to water vapor.

[00051] Preferably the armor assembly includes hydrophobic properties.

[00052] Preferably treating armor panels to be hydrophobic will allow various cutting and attachment and penetration of the panels without destroying fully their ability to repel water.

[00053] Preferably the armor panel or panels are treated with a flame-retardant agent or material whereby the armor resists burning when exposed to excessive heat.

[00054] Preferably the armor system is at least partially comprised of Kevlar.

[00055] Preferably the armor system is at least partially comprised of UHMWPE materials.

[00056] Preferably the armor system is at least partially comprised of nanotech materials.

[00057] Preferably the armor system is at least partially comprised of graphene materials.

[00058] Preferably the armor system is at least partially comprised of composite materials.

[00059] Preferably the armor system is at least partially comprised of abrasion resistant metals.

[00060] Preferably the armor system is at least partially comprised of high strength alloys.

[00061] P

[00062] Preferably, the armor system utilizes adjacent or overlapped armor elements which are separated from colliding in the same plane by an intermediary layer of material. The intermediary material may be an additional complete (or incomplete) layer(s) of the garment, separating one plane/layer of armor elements from another plane/layer of armor elements.

[00063] Preferably, the armor system utilizes adjacent or overlapped armor elements which are separated from colliding in the same plane by fixing opposite edges of each panel to opposing base and cover materials.

[00064] Preferably, armor elements may be rigid, semi rigid, or flexible.

[00065] Preferably, armor elements may include more rigid element and less rigid elements in the same armor element.

[00066] Preferably, armor elements may include shock absorbing materials.

[00067] Preferably, armor elements may be comprised of high strength materials, in one or numerous layers, where high strength materials include high strength fabrics such as made from aramid fibers, UHMWPE fibers, carbon fibers, glass fibers, nano tech fibres, graphene fibers, etc.

[00068] Preferably the armor assembly consists of a base layer continually overlapping armor panels each attached to the base layer on significantly one side or edge of the armor panel and continuous elastic tethers which span substantially the length of the garment which tethers are attached to each of the overlapping armor panels at locations substantially opposite of the attachment to the base layer whereby none of the armor panels are attached to each other and all of the armor panels are held in relative position to one another and the majority of external geometric angles of each panel are fixed to either the elastic base material or the elastic tether whereby the armor panel is held substantially outstretched.

[00069] Preferably the armor assembly consists of a base layer continually overlapping armor panels each attached to the base layer on significantly one side or edge of the armor panel and an external elastic cover material, which covers substantially the surface area of the garment, is attached to each of the overlapping armor panels at locations substantially opposite of each armor panels attachment to the base layer, whereby none of the armor panels are attached directly to each other, and all of the armor panels are held in relative position to one another, and the majority of external geometric angles of each armor panel are fixed to either the elastic base material or the elastic cover material, whereby the armor panel is held substantially outstretched.

[00070] P

[00071] Preferably, in a second aspect the armor system has armor elements which are held in relative position by elastic tethers, connected to the armor element at its perimeter and/or opposite poles of the armor element, and connected to the armor system (first) base or (second) cover layers at substantially opposing sides such as outside seams or central seams, which tethers serve to keep the armor element

outstretched, and also serves to keep armor elements from colliding with adjacent armor elements on the same plane.

[00072] Preferably, either the elastic base material, cover material, elastic tethers, etc. have elastic limits within, allowing a maximum amount of expansion/elongation which preserves a minimum overlap of one armor element to another, preventing compromise of minimal edge distances as required by armor design or armor regulators.

[00073] Preferably, the elastic tethers are more elastic than base or cover layers (first or second layers).

[00074] Preferably the elastic tethers are connected between armor panels and the (first) base material.

[00075] Preferably, the elastic tethers are connected between armor panels, and other armor panels.

[00076] Preferably the armor system is comprised of multiple layers of material which may each be elastic. Each layer may be progressively larger to outermost, so that elasticity of multiple layers doesn't multiply the compressive force on the wearer. For example, putting on 3 layers of an elastic sock all the same size, will make each progressive sock layer stretch further, and exert progressively more compressive pressure on the wearer (3x the compressive force vs. a single sock). Putting on 3 layers of an elastic sock, whereby each sock layer is larger than the last, will reduce or eliminate the cumulative compressive force exerted on the wearer, vs. 3 same size layers overlapped.

[00077] Preferably, the armor system may be comprised of multiple layers of material, where by one or more layers may be less elastic and protective adjacent to the wearer may be significantly large/loose, and held in conformity to the wearer by at least one outermost elastic cover layer, which hold the loose protective layers close to and conforming to the wearer, while still allowing the wearer to move and flex joints where the elastic outer layer will expand and contract as required. For example, if three socks were worn together. The first sock could be non-elastic and oversized so that the fabric would need to be folded over or gathered together to take out the slack material, a second sock could be similarly non elastic and oversized and need to be folded over or gathered together to take out the slack material, and a third elastic sock could be placed over these first two in slight compression, holding both previous layers closer to the wearers body. In this embodiment the first two layers are exerting no compressive force to the wearer, and only the outermost layer is exerting a compressive force, whereby 3 layers of material are present but only one layer is exerting a compressive force, which allows the assembly to be more mobile/comfortable.

[00078] Preferably, the armor system features elongation control in specific planes/directions, designed and strategically placed, to maintain the integrity of the system.

[00079] Preferably, the elongation control can be achieved by various methods, including specific fabric designs to stretch in one plane and not another, or by adding fabrics/stitched threads/infused glue/attached other materials which are specifically less or non-elastic, to the elastic base material, in linear or shaped assemblies to control elongation.

[00080] Another embodiment of elongation control is to include a harness system such as using non/less elongating material like nylon flat strap or other non/fewer elongating elements in an integrated harness system. The harness may be adjustable and yet connected to an armor system garment, which could be a full body suit, or smaller garment such as a shirt or pants. An integrated harness can allow better weight distribution of armor elements to the wearer, improved adjustment of fit, and additional support to carry other external equipment and gear which can be affixed to the exterior of the armor system.

[00081] Preferably, the armor system utilizes armor elements shaped to allow bending in two substantially opposite directions, which allows the shape to conform to shapes in opposite directions (such as a bent knee). This void may occur in at least one location, or two opposing locations, or in multiple or many locations, to provide reduced cross sections in the armor element (panel) to allow better bending and contouring.

[00082] Preferably, the armor system utilizes different armor elements in different areas of the body, with different armor rigidity levels and or different armor protection profiles for different potential threats. For example, leg and knee protection may have flexible/pliable armor behind the knee, as well as at the hip joint, as well as the groin/inner thigh area, and have rigid or semi rigid armor elements at the shin and outer leg for greater blunt force protection. Similarly, an arm could utilize flexible pliable armor at the elbow joint, as well as under the arm pit, and rigid or semi rigid armor elements at the shoulder, outer arm, and forearm. Pliable / flexible armor can handle many cut/puncture/projectile threats, while semi rigid and rigid elements can better protect from blunt force threats. The rigidity/protective design of the armor elements could be determined by statistical data on likely attacks or threats to different body parts. For example - blunt force attacks to extremities, may use rigid or semi rigid armor elements, whereas slashing attacks to inner thighs or underarms may use flexible cut and puncture resistant panels.

[00083] Preferably, the armor elements in certain areas could also be used as attack elements. For example, rigid elements at the forearms and shins could be used for attacks in close quarters, using forearm strikes and shin strikes, potentially damaging an opposing combatant while protecting the wearer from harm.

[00084] Preferably, the armor system uses individual elements to be added onto existing armor systems, to provide better overall surface area coverage or to specifically cover areas unprotected by a current system. For example, an existing stab resistant vest for a person working in a prison is susceptible to pointed attacks under the arms or to the neck. Adding additional armor coverage areas, such as protective sleeves or a turtleneck ring with integral armor element can better protect the wearers. These added individual elements can preserve and enhance the effectiveness of gear already issued. It could also be selected for individuals or teams who face more severe threats. For example, a typical prison guard may wear just the vest for typical shifts at work. However, under a lock down situation during a prison fight or riot, the prison guards may “level up” the protection of the existing vest by adding extremity protection.

[00085] Preferably, the armor system utilizes armor shapes consisting of a two-dimensional armor shape comprising; at least 4 sides, at least 2 fold line segments from geometric angles along the shape perimeter, which fold line segments do not intersect along their respective mid lengths, whereby the armor panel may bend in multiple directions concurrently without intersecting fold line segments.

[00086] Preferably, the armor system utilizes armor shapes consisting of a two dimensional armor shape comprising; at least three external geometric angles along the perimeter edge of the shape and, at least one internal geometric angle along the perimeter edge of the shape, whereby the two dimensional shape may efficiently bend in substantially opposing directions concurrently.

[00087] Preferably, the armor system utilizes armor shapes consisting of a two dimensional armor shapes which are individually smaller in surface area than the body armor assembly total surface area, and which utilize trailing edges and leading edges which conform to adjacent overlapping armor panels and, which armor panel shapes are also adapted to fit the overall shape of the armor assembly.

[00088] Preferably, the improved armor system utilizes an armor assembly comprising; at least three armor panels each smaller in surface area than the armor assembly, at least two layers of armor panels, each layers' armor thickness a smaller percentage than the required total 100% armor thickness required for a particular threat and, said armor panels are shaped to conform to one another at leading and trailing edges and, said armor panels are conformed to the overall shape of the armor assembly, whereby the layers of armor panels overlap in substantially all of the armor assembly surface area and, the total percentage thickness of overlapped panels equals the 100% total armor thickness required for a particular threat, a means to hold said armor panels in relative position to one another, whereby said armor assembly has the required total armor thickness over substantially all of said armor assembly surface area and, said individual armor panels are fixed to the armor assembly and not fixed directly to one another, whereby the assembly remains pliable and optionally elastic.

[00089] Preferably, the individual armor panels are held in relative position within the overall armor assembly by means of a series of (overlapping) pockets.

[00090] Preferably, the individual armor panels are held in relative position with temporary attachments at substantially the outside geometric angles (outside corners) of the armor panel shape.

[00091] Preferably, each armor panel is edge sewn to hold multiple layers in relative position to one another.

[00092] Preferably, each armor panel is edge glued to hold multiple layers within in relative position to one another.

[00093] Preferably, each armor panel utilizes multiple layers of material substantially bonded to one another.

[00094] Preferably, each armor panel is comprised of a composite.

[00095] Preferably, the armor assembly utilizes multiple armor panels held to the base material by temporary attachments.

[00096] Preferably, each armor panel utilizes an internal fold resistant material.

[00097] Preferably, each armor panel utilizes boning to substantial external corners to keep the armor panel outstretched.

[00098] Preferably, the armor assembly utilizes a series of pockets, fixed to the base material and optionally fixed to each other, each pocket to hold the armor panels in relative position, with no attachment from the armor panels to either the pocket or the base material.

[00099] Preferably, the armor assembly utilizes a series of pockets, fixed to the base material and optionally fixed to each other, each pocket to hold the armor panels in relative position, with attachment from the armor panels to either the pocket or the base material or both.

[000100] Preferably elastic tethers are continuous along substantially the length of the garment or extremity.

[000101] Preferably the base and or cover material consists of fine netting which can repel insects.

[000102] Any of the aspects or embodiments above can be complete garment systems with integral armor elements such as a full body suit with a hood, or smaller garments such as long/short sleeve shirts, short/long pants, or can be individual elements such as added underarm, added turtleneck, added groin/inner thigh protection, etc.

[000103] Any of the above aspects or embodiments may utilize overlapping layers, armor pockets, or armor elements, in any combination, so that protection of joints and critical mobility areas allows significant expansion and contraction without compromising minimal armor thickness required. The design of elasticity and elongation control allows mobility while preserving required overlap for armor elements.

[000104] Any of the above aspects or embodiments of the armor system above may preferably be substantially nonthermal or non-insulating to the wearer, to allow use in different climates. Hot climates do not prefer insulation, and cool climates can utilize independent thermal layers underneath the armor system/garment. By creating armor system garments that are non-thermal, the wearer can choose their own insulation layers to match climate conditions, thus making the armor system suitable for multiple climates/conditions. Base (first) layers may be exceptionally breathable materials to aid in reducing heat build in the garment, or to aid flushing in water when in warm water conditions.

[000105] Any of the above aspects or embodiments may utilize elements that are thermally reflective or thermally insulating as may help conceal the position of soldiers from being detected from thermal imaging systems.

[000106] Any of the above aspects or embodiments may utilize elements that protect from hazards such as bug bites for mosquito bites such as integral netting or other systems that can enhance soldier well-being in hot and humid climates.

[000107] Any of the above aspects or embodiments of the armor system above may utilize armor elements that with designed buoyancy that is positive, neutral, or negative, depending on the desired conditions. For example, divers typically prefer suits that are neutrally buoyant or slightly negative buoyant, to distribute some of the dive weight away from the lower back, and to offset positive buoyancy from thermal suits such as neoprene. Swimmers or surfers may prefer positive buoyancy elements, to keep them at the surface, even in rough surf.

[000108] Any of the above aspects or embodiments of the armor system above have preferably low coefficient of friction from the armor elements to the carrier system, whereby the armor carrier system can expand/contract/move without being restrained by (inelastic) armor elements or may facilitate crawling on the ground when under fire.

[000109] Any of the above aspects or embodiments of the armor system above have preferably minimal or no connected surface area between the armor element and a layer of the garment, or between the armor element and a pocket enclosure. This minimal or non-connection allows the elastic

material of the garment layer, or elastic pocket material, to remain elastic and move slidably in relation to the non/less elastic armor element(s).

[000110] Any of the above aspects or embodiments of the armor system above may preferably feature closures, adjustments, buckles, zippers, etc. that may be in non-standard locations to aid the wearer's activities such as at right angles to the center front of a person. For example, an adjustable clip/buckle for the waist may be located at the hip, and not the front of the garment, for a surfer who would be lying on a board paddling, or a soldier in prone position on the ground. If the buckle were at the front for a surfer, it would press into the user's stomach, and into the board. For a soldier, a front buckle may press into the stomach and snag on ground elements in prone position or crawling.

BRIEF DESCRIPTION OF THE DRAWINGS

[000111] Figure 1 shows the typical compromises for armor systems. Protection goes up, mobility goes down. Many "experts" have cost as the 3rd leg of the triangle, where protection/mobility/cost are all in conflict with one another. However, an important missing element is the coverage area of the body – shown here clouded as new.

[000112] Figure 2 depicts a human body divided up into zones – showing in sections/hatches – 1. The most life critical body areas to protect, 2. The second most critical body areas to protect, and 3 the third most critical body areas to protect.

[000113] Figure 3 depicts an example table of a body armor classification process, showing a typical soldier with torso protection and a helmet, vs. a soldier with torso, helmet, and extremity protection. From the graph you can quickly see the torso protection has a low rating for body coverage area, and the torso and extremity protection soldier has a high body coverage area but a lower mobility score. This can assist military leadership select different configurations depending on the deployment of soldiers.

[000114] Figure 4 depicts a soldier with typical armor protection areas – totaling approximately 30% body area protected.

[000115] Figure 5 depicts another soldier with added extremity protection, covering 93% of body area.

[000116] Figure 6 depicts a table showing statistical sampling of protection levels based on statistical 3rds (can be two or more) groupings of recorded threats where not standard exists currently.

[000117] Figure 7 depicts a table showing data from a group of competent participants for a particular activity or sport, whether it's soldiering tasks or surfing (near sharks). This group of competent users

would advise if they can comfortably perform minimal tasks in the armor, or the highest exertion levels in the armor, with the middle classification in between.

[000118] Figure 8 depicts a table showing body coverage areas – from lower levels, to covering the next critical areas, to covering most of the body.

[000119] Figure 9 depicts statistical sampling of collected data where particular threats do not have a protection standard currently (such as shark attacks).

[000120] Figure 10 depicts a method for collecting data for a threat where no standard exists currently. Herein is a shark biting a sensor collecting pressure, tension, and lateral shaking forces.

[000121] Figure 11 depicts a laboratory set up to replicate the same shark bite forces.

[000122] Figure 12 depicts collecting data for passive/stationary threats a person can collide with, which could be falling on a reef surfing or colliding with a tree mountain biking, etc.

[000123] Figure 13 depicts replicating the same forces with a similar human weight over natural hazard.

[000124] Figure 14 depicts a laboratory set up to replicate the same forces of Figure 13.

[000125] Figure 15 depicts a person swimming at minimal pace – minimal effort and exertion.

[000126] Figure 16 depicts a person swimming at maximum pace and exertion.

[000127] Figure 17 depicts a person walking at minimal pace and exertion

[000128] Figure 18 depicts a person running at maximum pace/exertion.

[000129] Figure 19 depicts a typical body armor panel shape from the National Institute of Justice (NIJ). This shows a typical 1 armor panel shape (typically multiple layers all the same size/shape to fill the perimeter. This large shape will bend horizontally around a person's waist, and then struggle to bend in a vertical plane from neck to belly button.

[000130] Figure 20 depicts the improved multiple armor panel shapes designed to fit the body, which together will create the same armor coverage as the NIJ standard shape.

[000131] Figure 21 depicts the same armor shapes of Figure 20, with up and down diagonal hatches, transparently overlapping. These shapes comprise the same shape as the NIJ standard, with the crisscrossed lines showing the overlap,

[000132] Figure 22A depicts a flat rectangular shape with folding lines from opposite corners where the folding lines will intersect each other.

[000133] Figure 22B shows the same rectangular shape of Figure 22A with three overlapping sheets, whereby they may curve easily in one direction but then struggle to bend efficiently in a perpendicular direction.

[000134] Figure 22C is a very recent black and white image from one of the most pliable soft armor systems available illustrating exactly the problem shown in Figure 22B. Large simple shapes don't bend well in perpendicular directions.

[000135] Figure 23A depicts an improved shape of roughly the same area as the rectangle in Figure 22A only with a leading-edge protrusion in a trailing edge recess. This shape can efficiently bend in seven different planes concurrently without said fold lines crossing each other. In the center of this shape is a dotted area which comprises approximately 10% of the surface area of the shape, which area is somewhat resistant to folding as it's perimeter boundary is defined by corner fold lines.

[000136] Figure 23B depicts the same shape as Figure 23A showing the bend lines and shading in a perspective view, where the shape can efficiently conform to the object underneath.

[000137] Figure 24 A depicts four of the same armor shapes of Figure 23A in reversed hatching, aligned top to bottom.

[000138] Figure 24 B depicts the same four armor shapes of Figure 24A efficiently overlapping, showing crisscrossed hatching where the parts efficiently overlap.

[000139] Figure 25 depicts a chevron shape which functions in having a leading edge which conforms efficiently to a trailing edge. However, the internal triangle area of this shape where fold lines meet outside corners and do not crisscross. This shows a significantly larger area of this less foldable region, as compared to the less foldable region shown in Figure 23A.

[000140] Figure 26 depicts a shape similar to a chevron only utilizing curves at the leading and trailing edge. This also depicts 3 overlapping curved chevron shapes where the overlapping area transparently shows a crisscrossed pattern.

[000141] Figure 27A shows a typical geometric shape which is inefficient in overlapping because the leading edge does not align to the trailing edge. All of the non- crisscrossed hatching is waste.

[000142] Figure 27 B shows another typical geometric shape also inefficient at overlapping. All of the non- crisscrossed hatching is waste.

[000143] Figure 27C shows a typical NIJ shape also overlapping which is inefficient because the leading edge does not conform to the trailing edge. All of the non- crisscrossed hatching is waste.

[000144] Figure 28A depicts the same armor shapes of Figure 24B collapsing/contracting – and utilizing transparent grey shading in lieu of hatching. In this figure these shapes are able to overlap even more than optimally where optimum overlap is 2 layers shown by the medium grey area, a single layer is light grey, and three overlapping layers (redundant) is a darker grey.

[000145] Figure 28B depicts the armor shapes of Figure 24 B, only expanding where gaps become apparent between overlapping armor shapes. This can be resolved by designing redundant overlaps to the maximum extent of elongation.

[000146] Figure 28 C depicts the same armor shapes of Figure 24 B only efficiently twisting and curving.

[000147] Figure 29 A depicts a schematic long pant outline with the left most leg showing overlapping armor panels whereby substantially all of the left leg is covered by at least two layers of armor panels. The right leg depicts these same overlapping armor panels depicting fixing of the armor panels to the base layer below and top or outer fixing two elongated elastic elements at substantially opposite poles/edges as the attachment to the base layer.

[000148] Figure 29 B depicts the same arrangement of Figure 29A only in section view.

[000149] Figure 30 depicts a similar arrangement to Figures 29A and Figure 29B only utilizing a cover layer of fabric to attach the opposite poles of the armor panels in lieu of elongated elastic elements.

[000150] Figure 31A depicts a layered armor section all in one section comprising 100% of the required armor thickness to deal with a threat

[000151] Figure 31B depicts the same armor profile of armor of Figure 30 A only in 50% thickness times 2 layers, where the total armor thickness is met and yet the two 50% thick layers are more pliable than the single 100% thick profile in figure 30 A.

[000152] Figure 31C depicts the same armor profile of Figure 30 A only in three 33.3% profiles totaling up to the 100% needed to be effective. This shows further pliability over the 100% section of figure 30 A.

[000153] Figure 32 depicts the inefficiency of overlapping two 100% armor profile sections. For example, two armor profiles of 12 layers each, is now 24 layers in overlap or 200% of the thickness and weight in the overlapped area (inefficient).

[000154] Figure 33 depicts 50% armor profile sections overlapping for the entire extent of the armor profile. All areas have at least 2 - 50% layers totaling to the required 100%, and where there is

redundant overlap of three layers this is only 150% of the required thickness and weight, and not 200% such as in Figure 31.

[000155] Figure 34 depicts three 33.3% armor sections overlapping over 100% of the armor area. Where there is redundant overlap of four layers there are 16 total layers, only 133% weight and thickness at the redundant area vs. 200% in Figure 31.

[000156] . Figure 35 depicts utilizing a topical or infused hydroscopic material which leaves the fabric breathable yet repels surface water such as rain.

[000157] Figure 36 depicts infusing into or a topical fire-retardant treatment to the armor layers whereby the armor is resistant to burning.

[000158] Figure 37A depicts an armored assembly similar to figure 29B with additional redundant overlap between panels where the assembly is at rest.

[000159] Figure 37 B depict the same armor assembly of Figure 37A only stretched in elongation.

[000160] Figure 37 C depicts the same armor assembly of figure 37A only significantly shortened where the armor panels may effectively almost completely overlap with one another.

[000161] Figure 38A depicts an armor assembly with overlapping armor panels where substantially all of the surface area of the garment has at least two overlapping armor panels and, where armor panels are held in relative position by a series of pockets.

[000162] Figure 38A depicts the armor assembly of Figure 38A in section, depicting some armor panels set in pockets with attachment to the base layer, some with attachment to the pockets, and some armor panels held in pockets with no attachment to either the base layer nor the pocket material.

DETAILED DESCRIPTION

[000163] Figure 1 depicts the typical trade off dilemma for armor systems where the protection level or the resilience to threats goes up generally the mobility goes down and where the mobility and comfort goes up generally the protection level goes down. The coverage area is clouded as relatively new because most of the world considers ballistic and stab armor as a vest or a helmet. A vest and a helmet covers approximately 30% of body surface area leaving the lower torso and extremities exposed. Figure 1 illustrates the need for an armor coverage system which takes into account the protection level relative mobility and comfort as well as how much of the body area is covered, whereby risk managers and individuals can select systems optimized to their situation.

[000164] Figure 2 shows an image of a person depicting also their circulatory system, as well as hatched areas for critical protection areas of the body. Critical is designed as – significant damage to this area can be life threatening if not treated very quickly. For example, the hatched area 102 is the typical upper torso area protected by common body armor vests, as within this body area are numerous vital organs. The hatched area 101 depicts the head and neck over which there is a translucent profile of a helmet 106. The upper arms and shoulders 103 as well as the lower torso and upper part of the legs above the knee 103 are the second most critical area to protect. You can see from the circulatory system there are major arteries in these areas not to mention major nerves where penetrating injuries or other damage can cause serious injury or death in a relatively short period of time. For example, cutting through the femoral artery in the upper leg can cause death from bleeding within 10 minutes. This is why protection of this second most critical zone is important. The lower arms 104 and the lower legs 104 are the next most critical area to protect, there are still arteries and nerves, but they get smaller as you get further away from the upper torso. Therefore, serious cuts or damage to the lower leg or lower arm may allow significantly more time for medical attention before the injury is fatal, as compared to serious damage to critical zone 2. The final area is the hands 105 or the feet 105, again further away from the main torso. Injury to these areas allows again more time for medical attention before injuries could be fatal.

[000165] Figure 3 depicts an example table of a body armor classification process, showing a typical soldier with torso protection and a helmet, vs. a soldier with torso, helmet, and extremity protection. From the graph you can quickly see the torso protection has a low rating for-body coverage area, and the torso and extremity protection soldier has a high body coverage area but a lower mobility score. This can assist military leadership select different configurations depending on the deployment of soldiers. This graph illustrates how a risk manager or an individual could select different armor systems depending on the expected situation. For example, if a soldier is serving with an artillery crew that is relatively stationary and yet also receiving enemy artillery fire from fragmented artillery shells, this soldier may opt for a lower mobility level and a higher body protection level because the artillery crew is stationary.

[000166] Figure 4 depicts these suggested critical zones of a body with the typical helmet 106 and torso vest 107, leaving all the other body area exposed.

[000167] Figure 5 depicts the same helmet 106 and torso vest 107 with all other extremity areas 108 blacked out contrasting the typical protection areas in white, to show the significant additional protection area possible.

[000168] Figure 6 depicts the arrangement of collected threat forces for threats not already having a standardized protection system such as shark attacks, or blunt force trauma from a kicking horse. Data can be taken from those threats and classified statistically. For example, if twenty different recorded shark bites record different values for compressive force, tension force, or lateral shaking, than those forces can be plotted into statistical halves or more from the lowest forces recorded to the highest forces recorded, or even utilizing theoretical highest forces possible based on shark size and jaw muscles. This data can be grouped into statistical halves or more, whereby the lower half can be a first classification of protection, the higher statistical half of forces can be class 2 armor to withstand these higher forces. There could be additional classifications such as a median classification(s).

[000169] Figure 7 depicts mobility and comfort classification into two or more levels. Within a two level system a group of persons competent in the activity or tasks, can perform set activity or tasks wearing the armor and acknowledge if they can still perform the task or function to a minimum acceptable standard. This would be class one of mobility that you can minimally perform the task. On the highest level would be the ability to wear the armor system and perform at maximum exertion and duration while wearing the armor. This would be class two mobility in a two level system.. A three or more level system could include a median between the minimum and the maximum for exertion and duration. For example, in a three level mobility system, if walking or running is required in the activity than an armor system that allows walking at a reasonable pace would be Class one mobility. Armor that allows maximum speed sprinting for a reasonable duration would be class three mobility. And armor that allows a mid-level jog would be classification two mobility

[000170] Figure 8 depicts the coverage area of armor systems which for ballistic and stab resistance is effectively left out, with the primary solution being torso upper torso vests and helmets. Wearing an upper torso vest and a helmet protects up to approximately 30% of the body's total surface area. Classification two could be protection from a range of 31% to 63% or effectively protecting the shoulders, upper arms lower torso and upper legs. Classification three of coverage area can be protecting also the lower arms and lower legs. A further classification could be the additional protection of hands and feet, or the hands and feet protection could be included in classification three alongside the lower extremities.

[000171] Figure 9 depicts different examples of threats which could be modeled statistically for armor classification where there may be no standard protection levels currently. For example, shark bite forces, horse or livestock kicking, impact from a bull's horn for rodeo clowns or bull riders. It could also be modeled from passive or stationary threats which people can fall on or otherwise collide with such as falling on coral while surfing or colliding with a tree while skiing or mountain biking, etcetera.

[000172] Figure 10 depicts a means for collecting forces from an animal such as a shark 51 where there is a bite force sensor 52 which is measuring compressive force of the bite 55 tension force from pulling from the shark 54 or horizontal shaking and thrashing 56, all of which contribute to the devastating damage inflicted by a shark bite. Similar processes could be used to measure bite forces from dogs, bears, etc.

[000173] Figure 11 depicts a means to replicate forces from an animal such as a shark. This figure depicts an apparatus whereby there is a holding component 68 for the threat 61 (in this case a shark tooth). There is also a means to introduce a measured downward force 65 which may also include velocity and kinetic energy measurement. The armor material or assembly 62 to be tested may be held by a suitable frame or attachment 70 over an appropriate simulant 63 of the object to be covered and protected. For example, replicating a human body may utilize a ballistic gelatin, as the simulant to be protected 63. A means to introduce other forces such as lateral movement 66 can be introduced to the armor testing base 69, four may alternately be introduced to the threat 61 retention system 68. Whichever may be most suitable to replicate forces in a controlled environment.

[000174] Figure 12 depicts a person 120 colliding or falling 123 with stationary passive threats such as coral 125 shell edges 126 sea urchin 127 while in surfing areas with significant waves 121. In these areas the water can also drag a person horizontally 129 back and forth over these objects whereby injury may be puncture or cutting or abrasion.

[000175] Figure 13 depicts fixing an armor assembly or material 119 to a body simulant 130 which may be of similar average weight and utilize body simulant materials such as ballistic gel or foam etcetera where the body simulant with armor protection can be dropped down 132 onto various threats such as coral 125 or shells or barnacles 126 or sea urchins 123 as well as being dragged horizontally 129 back and forth over threat objects with a measured force to simulate a person's collision with said threats.

[000176] Figure 14 depicts controlled environment simulation similar to Figure 11, whereby a threat holder 68 holds a threat 120 in this case a piece of sharp coral whereby a controlled downward force 123 can be applied as well as controlled horizontal forces 129 which may be applied either to the armor testing base 69 or said horizontal forces 129 may be applied to the threat holder 68, or whichever means of introducing lateral loads is simplest. The armor material or assembly to be tested 62 can be appropriately fixed 70 to the protected object simulant 63 such as ballistic gelatin or foam or other. This allows various threats and various forces to be tested against armor materials or assembly and repeatable waves. This could be used for testing puncture or cutting or abrasion or blunt force trauma such as from collision with a tree or a rock.

[000177] Figure 15 depicts measurement of human mobility such as a swimming activity. In this image an individual 140 is wearing a protective garment 141 and is moving at a slow speed 143 such as a slow breaststroke or slow dog paddle whereby the armor system allows minimal yet acceptable movement in the water. Armor designed for water activities allowing this minimal movement would be classified as mobility level one.

[000178] Figure 16 depicts the same individual 140 of figure 15 wearing a different armor system 142 which allows him to swim at a much faster rate 144 IE a faster freestyle stroke. This armor system would be classification two in a two-level classification system as pertains to swimming activities, or level three in a three level system with a median level in between level one and three.

[000179] Figure 17 depicts a person 150 wearing an armor system 151 allowing slow walking 153 which armor would be classified as level one for mobility for this activity.

[000180] Figure 18 depicts the same individual 150 as Figure 17 wearing a different armor system 155, which allows fast running 156 which armor would be classified as Level two in a two level mobility rating for this activity, or level three in a three level system with a median level in between level one and three.

[000181] Figure 19 depicts a standard single armor shape 161 which was derived from the National Institute of Justice standard (NIJ) armor shapes. Soft armor systems are typically multiple layers of a singular shaped piece of material where each layer has substantially the same surface area as the armor assembly surface area.

[000182] Figure 20 depicts this invention's utilization of multiple smaller shapes to comprise a larger shape via overlapping of those smaller shapes. The topmost shape is 162 a second overlapping shape is 163 a third overlapping shape is 164 and a fourth overlapping shape is 165. The arrow 166 depicts the direction of overlapping from top to bottom.

[000183] Figure 21 depicts the same fore shapes from Figure 20 now overlapped where the diagonal up hatching, where it overlaps diagonal down hatching, creates the appearance of Criss cross hatching where these shapes were depicted as translucent to clearly show where the overlap occurs. The call out lines for the four shapes are called out to the same locations as they are shown in Figure 20. Figure 21 is specifically substantially the same shape as Figure 19 only comprised of four different smaller shapes, each shape having 50% of the required armor thickness. You can see in Figure 21 that substantially all of the surface area of the assembly shows two layers of armor in the translucent crisscross hatched areas. The two layers of 50% armor thickness will be more pliable than one layer of 100% thick armor which is the standard. Additionally, these smaller shapes of armor (each armor

shape's surface area is smaller than the surface area of the armor assembly) will allow bending in many more planes in Figure 21, compared to the stack of singular shapes shown in Figure 19.

[000184] Figure 22A illustrates the phenomenon of bending in a single direction. The area of the rectangle 170 (armor panel shape) shown is approximately 1280 square millimeters. When drawing a folding line 171 from one opposing corner to another corner, and then connecting other corners in a folding line 172, you can see that those folding lines crisscross. Crisscrossing folding lines is extremely difficult as soft armor systems are like a stack of paper like a magazine. Consider folding a magazine one way and then another way and the difficulty of crisscrossing folding lines.

[000185] Figure 22B depicts a stack of the rectangular shapes 170 from Figure 22A, efficiently bending in one direction 174 which makes bending in a perpendicular direction 175 significantly difficult. This is like taking a stack of paper tremendously bendable and pliable and bending that stack of paper in a single direction and then trying to bend it in a perpendicular direction concurrently-this is extremely challenging to do. It also demonstrates the strength of corrugation or U-shaped structural members like a steel "C" channel. The upturned or downturned portions of the shape resist bending.

[000186] Figure 22 C is a recent image of a top rated soft armor system specifically demonstrating how bendable it is, and yet also demonstrating the limitations of large simple shapes such as the NIJ standard soft armor shape, in bending in multiple planes and directions concurrently.

[000187] Figure 23A depicts an improved armor shape 180 essentially a modified rectangle with a leading edge protrusion 191 and a trailing edge recess 192. The area of this shape is approximately 1280 square millimeters similar to the shape and Figure 22A. Within the shape you can see various folding lines 181 folding line 182 folding line 183 folding line 184 all of which intersect corners which may be inside or outside corners or areas where the perimeter edge significantly turns to a different direction, and whereby these folding lines do not crisscross other folding lines. In fact there are seven different folding lines (dotted lines) in this shape that do not intersect other folding lines. Additionally, there is a folding resistant area 185 shown with dotted hatching in the center of this shape that when other folding lines are bent will resist folding, which area is approximately 115 square millimeters, or less than 10% of the total surface area of the shape. It is also important that the leading edge profile 188 is significantly the same as the trailing edge profile 188 which will create efficient overlapping with adjacent shapes.

[000188] Figure 23B depicts the same shape 180 of Figure 23A depicting folding at the dotted lines drawn in a perspective view which illustrates extremely good conforming of the shape to complex three dimensional shapes underneath. Folding line 181 is the same as shown in Figure 23A. Folding

line 182 is the same folding line as Figure 23A. Folding lines 183 and 184 are the same as depicted in Figure 23A. When there are folds present at folding lines 183, 184, and 184 mirrored, the central area 185 (in between these dotted lines and not showing dotted line hatching here) is resistant to folding.

[000189] Figure 24A depicts two of the shapes 180 as depicted in Figure 23A with diagonal hatching up and to the right. It also depicts two of the same shape with diagonal hatching up and to the left 189. All four of these shapes are essentially the same shape.

[000190] Figure 24 B depicts these same four shapes overlapping with translucent hatching whereby the primary area of overlap 190 shows crisscross hatching where there are two layers of armor present. Herein you can see the efficiency of leading edges conforming to trailing edges.

[000191] Figure 25 depicts a simpler chevron shape 201 with a leading edge that mirrors the trailing edge. This chevron shape has an area of approximately 1420 square millimeters. And the folding resistant area 200, is approximately 350 square millimeters, which is approximately 25% of the total surface area of the shape which is not as efficient as the shape depicted in Figure 23A. This figure shows multiple chevron shapes with diagonal hatching up and to the right 201, and another chevron shape with hatching up into the left 202 and overlapping which shows as crisscrossed hatching 190.

[000192] Figure 26 depicts a gentle curve version of a chevron shape 204 with multiple curved chevron shapes 204 with diagonal hatching up and to the right and another gentle curve chevron shape with hatching up and to the left 205 where the overlapped area 190 depicts a crisscrossed hatching.

[000193] Figure 27A depicts a simple triangle shape 210 whereby the leading edge does not conform to the trailing edge thereby showing the smaller area of crisscrossed overlapped hatching whereby this overlapping shape is significantly in-efficient as opposed to shapes where the leading edge significantly conforms to the trailing edge.

[000194] Figure 27B depicts a simple circle shape 211 whereby the leading edge does not conform to the trailing edge thereby showing the smaller area of crisscrossed overlapped hatching whereby this overlapping shape is significantly in-efficient as opposed to shapes where the leading edge significantly conforms to the trailing edge.

[000195] Figure 27C depicts a typical body armor shape such as an NIJ recommended profile 212 whereby the leading edge does not conform to the trailing edge thereby showing the smaller area of crisscrossed overlapped hatching whereby this overlapping shape is significantly in-efficient as opposed to shapes where the leading edge significantly conforms to the trailing edge.

[000196] Figure 28A depicts an armor shape 212 like Figure 23A with a light grey translucent shading 212 showing where this panel does not overlap an adjacent panel. Where there is a double overlap 190 there is a darker grey 194 (compared to lighter grey 193). There is also a darkest grey 195 at a triple panel overlap 219 (redundant overlap which may be desirable to account for future expansion, or account for minimum overlap / edge distance to other panels, or as may be required as minimum edge distance for a particular threat (which may be defined by armor design or armor regulations)). This set of four panels is significantly compressed or shortened 209 in an up and down plane, which allowable compression/contraction is desirable in numerous locations on a body. Redundant overlap such as shown in Figure 28A can be designed in when the armor is at rest, and when the armor assembly is at maximum expansion there is at least double overlap and at least minimum edge distance as may be required by armor design or regulations to be effective.

[000197] Figure 28B picks the same four armor shapes 212 whereby the area of a shape not overlapping is shown as light gray 193 and where there is a double overlap 190 there is a darker grey 194. This configuration can expand 207 which is an advantage of this armor assembly.

[000198] Figure 28 C depicts these same four armor shapes 212 with light grey areas 193 where there is no overlap and darker grey area 194 where there is at least double overlap. The assembly is curved or twisting 208 showing the efficiency of the configuration.

[000199] Figure 29 A depicts a schematic pant shape whereby there is a base layer 223 and a series of overlapping armor panels with diagonal hatching up into the right 221, and overlapping panels up and to the left 196 whereby you can see that substantially all of the surface area of the base layer 223 is protected by overlapping panels at least two layers of armor panels, for substantially the entire surface area of the base layer 223. Each of the panels 221 and 196 are fixed 222 at one side/edge of the armor panel to the base layer 223, and each armor panel 221 or 196 is also fixed 224 (shown as an x) to an elastic tether 225 at a corner/side/pole opposite the fixing to base layer 222. Where the elastic tether 225 is fixed 226 to the elastic base layer 223 as shown as a "+".

[000200] Figure 29B shows the same assembly as Figure 29A only in section with dotted lines showing approximately the same length and size of armor panels in section view for greater clarity as shown in Figure 29 A in plan view. In this view you can see the base layer 223 as well as the armor panels 221 with hatching up and to the right as well as armor panels 196 with hatching up and to the left. You can also see attachment 222 from the armor panels to the base layer as well as attachment 224 from the opposite side of the armor panels to the elastic tether 225 as well as the attachment 226 of the elastic tether 225 to the base material 223.

[000201] Figure 30 depicts a similar armor assembly in section, similar to the configuration as Figure 29 B, however the assembly in Figure 30 deletes the elastic tethers and replaces it with a cover material 227 which would be substantially the same size as the base material 223 as depicted in Figure 29 A in overall surface area. The armor panels 221 with hatching up into the right as well as armor panels 196 with hatching up into the left would all be fixed 222 at one edge or side or pole to the base material 223, with opposite fixing 228 for said armor panels to the outer cover material 227. These attachment arrangements allow for the overall assembly to have maximum elongation and contraction properties.

[000202] Figure 31A depicts a typical armor assembly 330 at 100% of the thickness required to defeat a particular threat. This figure depicts the 100% thickness effect on pliability which limits its overall ability to bend. This armor panel may be held together by sewing 475 at substantially the perimeter edges.

[000203] Figure 31B depicts the 100% thickness of armor shown in Figure 30 A, except depicted as two overlapping armor panels 331 each 50% of the required armor thickness totaling up to the 100% thickness. The 50% thick panels are effectively 200% more pliable as shown by the increased bending 333, as compared to the singular 100% thick panel. These individual panels may be held together by glueing/bonding 476 at the perimeter edge similar to book binding.

[000204] Figure 31C depicts 3 overlapping 33.3% thick armor panels totaling up to the 100% required armor thickness showing even greater pliability than Figure 30B, and yet still totaling up to the required 100% armor thickness to defeat a given threat. These panels may be held together by rivets 477 or other point attachments occurring regularly around the perimeter edge or at least minimally at the corners.

[000205] Figure 32 depicts armor panels 335, covering over the entire protected area 443, whereby at the area of overlap 336 there are 24 layers of material, which is 200% of the thickness, weight, and cost of materials required to defeat a threat. Figure 32 illustrates why most armor is a single panel covering the surface area of the assembly, and not overlapping layers, because of the decrease in efficiency of weight and thickness at overlaps.

[000206] Figure 33 illustrates the benefit of using two six layer armor panels 337 which overlap at least two layers for the entire area to be covered for 440 whereby the double overlapped areas 338 all feature 12 layers of material and where there is a redundant overlap 339 there is 18 layers of material or 50% more than required in thickness and weight, and not 100% more in thickness and weight, and thus more efficient than the overlap depicted in Figure 32.

[000207] Figure 34 depicts an armor assembly utilizing at least 3 armor panels 444 of 4 layers each, totaling to the required 12 layers, Whereby there are at least triple overlaps 441 for the entire area to be covered 443 and where there is a redundant overlap 442 of four layers, this is 16 total layers which is 33% more than the required 12 layers, and again more efficient in armor weight and thickness than the overlapped arrangement of figure 32.

[000208] Figure 35 depicts armor panel 451 whereby the armor features a topical or infused hydrophobic material 453 shown as dotted hatching whereby the material is still breathable to water vapor 460, yet repels and beads water droplets 450 such as rain. By utilizing hydrophobic properties, the material may still be fixed 452 sewn punctured riveted etcetera without compromising the water repellent nature of the material. This is also advantageous in not collecting additional water weight in rainy/wet conditions.

[000209] Figure 36 depicts an armor panel 451 utilizing a topical or infused flame-retardant material 455 which resists excessive heat 461 and or prevents or reduces melting / sticking to the body or object being protected underneath. There may also be a fully attached or partially attached 452 separate material layer 454 specifically designed to prevent armor from melting and sticking to the body/object underneath.

[000210] Figure 37A depicts a similar section of material as depicted in Figure 29B only with additional redundant overlap of the armor panels, with the armor assembly at rest. The base material 223 has attachments 222 to the armor panels 221 with hatching up and to the right and to armor panels 196 with hatching up and to the left. The elastic tether 225 has attachments 224 to the armor panels at the opposite ends or edges as the armor panel attachments to two to the base material 223. There is also an attachment to 226 from the elastic tethers to the base material 223. Here you can see the double overlap sections 338, and the triple overlap redundant sections 339, which will allow the assembly to elongate without compromising the required armor thickness of at least two layers, and without compromising redundant areas such as minimum edge distances as may be required by armor design or armor regulations.

[000211] Figure 37B depicts a similar section of material as depicted in Figure 37A only expanded/elongated 470. Herein you can see the same base material 223, attachment 222 of the base material to the armor panels, attachment 224 of the elastic tether to the armor panels, and attachment 226 of the elastic tether to the base material 223. The double overlaps 338 are shown throughout the section, as well as redundant overlaps 339 in between, such as may be required for minimum edge distances by armor design or armor regulations.

[000212] Figure 37C depicts a similar section of material as depicted in Figure 37A only with the armor assembly significantly compressed together. It is the armor's ability to expand and contract, while maintaining minimum overlaps, which makes the assembly extremely versatile in covering difficult joints and mobility areas, all while maintaining required armor thicknesses.

[000213] Figure 38A depicts an armor assembly 485 with dotted lines depicting pockets 482 locations, whereby the series of pockets may hold overlapping armor panels in relative position.

[000214] Figure 38 B depicts a section of figure 38 A where there is a base material 223 some armor panels 221 with hatching up and to the right which are attached to 22 to the base material and held within pocket material 480. Some pockets are attached to the armor panels for 8/3 and some armor panels 481 and 486 are set within pockets and not attached to the base material nor attached to the pocket material.

[000215] In light of these issues, advantageously, the present invention at least in a preferred embodiment provides a more holistic armor system where conditions of protection, mobility, and coverage area may be reviewed and balanced by users to fit their threat situation. This invention in a preferred embodiment provides a more holistic solution, to better protect people in various activities that are significantly unprotected now. Soldiers are typically 30% protected by body area (torso vest and helmet), whereas this system can bring protected body area to over 90%. Trade-offs between mobility, coverage areas, protection levels, etc. can all be more readily ascertained by users, with the ability to cover an individual dramatically increased.

[000216] Advantages of at least a preferred embodiment could include:

[000217] 1. Simplified ratings/understandings of protection, mobility, and coverage areas, so users or risk managers can better select appropriate armor solutions.

[000218] 2. Additional coverage systems that can bring body surface coverage from 30% to over 90%.

[000219] 3. An enhanced armor assembly that can provide high levels of protection, mobility, and body coverage area concurrently.

[000220] 4. An elastic armor system that maintains full coverage in expansion and contraction (i.e. front and back of a knee).

[000221] 5. Strategic elongation control, designed to limit elastic expansion and contraction to controlling voids and gapping of protective elements in a garment during activity/movement.

[000222] 6. Allowing different armor panels to be used in different areas, providing different protection systems, for different threats, for different parts of a body. This can be tailored to address different

threats, different armor mobility characteristics, and different armor costs to cover different body locations.

DESCRIPTION OF TERMS

[000223] “Armor” or “armor element” can mean any protective element continuous or partial, flexible, rigid, or semi rigid, elastic etc. It can be an element separate of, attached to, or part of the garment. It is essentially the protective element of a garment designed to resist the effect of a threat.

[000224] Armor, armour panel, armor shape, armor layer, may mean a single armor shape or significantly a 2-dimensional shape which is an individual armor element, separate of other armor elements, which may be overlapped, stacked, adjacent to, other armor elements.

[000225] “Corner” or “Geometric angle” may include what is substantially a change in direction from a perimeter edge, which can mean opposite poles, perpendicular poles, rounded corners, inside or outside corners, etc.

[000226] “Threat” may be any point, blade, projectile, or blunt force, tooth, protrusion, insect bite/sting/etc., surface or object that is sharp, abrasive, smooth, pointed, etc. which surface or object can cause harm directly or indirectly.

[000227] “Carrier” or “Carrier system” or “elastic armor carrier system”, “Armor system,” “Armor assembly”, “Armor Carrier” is meant to include a complete garment, a portion of a garment, or an assembly to hold an armor element in place. It could be a long sleeve shirt, a short sleeve shirt, short pants, long pants, a complete bodysuit with or without a hood, etc. It could also be an individual armor element with an element to attach/restrain the armor element in position relative to a body. The carrier system may/may not include armor elements within.

[000228] “Rigid” may include elements that are hard, rigid, semi rigid, layered, shear thickening fluids, etc. as may be utilized to resist compression, blunt force trauma, crushing, pinching, etc.

[000229] “Seams” are meant to include any joining of armor elements and garment elements or any combination thereof, using elastic elements, non-elastic elements, accessories, straps, clips, stitching, riveting, gluing, heat/sonic fusing, folding, taping, etc as may be commonly used to join different elements of the armor system/garment together.

[000230] “High strength” in relation to thread or material includes fabrics knits weaves Aramid fibers, UHMWPE fibers, glass fibers, metal fibers, carbon fibers, graphene, or any other high strength or cut resistant or abrasion resistant fibers or elements.

[000231] “Stitching” can also mean attachment riveting gluing fusing heat welding stapling or other means of attaching fabric layers one to another or attaching elements or accessories to one another or accessories and elements to fabric layers.

[000232] “Mobile body area” includes necks, underarms, groins, front and back of knees, hips, elbows, wrists, ankles, shoulders, fingers, essentially any portion of a body which allows movement, bending, flexing, etc. in normal conditions (i.e. the lower leg /shin won’t bend in between the knee and the ankle) but will bend at the knee or at the ankle.

[000233] “Pre-existing” armor element is an armor element already in use or owned, such as bullet resistant vest, or stab resistant vest, or elbow pad or knee pad or glove or other, where the pre-existing armor element is the first armor element and the second armor element is a single or multiple armor element(s) added to or used adjacent to the preexisting element so that the number of armor elements is two or more.

[000234] “Base layer” means a first layer of material which may be elastic, partially elastic or non-elastic, and “cover layer” means a second layer of elastic, partially elastic or non-elastic material.

[000235] “Less elastic” or “non-elongating” or “less-elongating” agents may be glue, epoxy, heat fused materials such as vinyl or other heat setting agents, heat fusing of fabrics, non or less elastic threads such as polyester, nylon, UHMWPE, aramid, or other threads which resist elongation in tension.

[000236] “Elastic tether” may be strips of elastic fabric, rubber sheet, elongating plastic, elongating epoxy, flat or round strap or cord with elastic material and non-elastic material (such as knit polyester expanding flat strap), or other elastic elements which may be used to allow elongation / contraction.

[000237] “Attachment” “fixed”, “held in relative position”, etc. can mean permanent attachment such as sewing, gluing, heat fusing, riveting, taping, stapling, point glueing, folding, ultrasonic welding, or any other way known to fix two different materials together, and may also mean temporary fixing such as velcro, snaps, buttons, magnets, buckles, zippers, or other means to temporarily fix two elements together.

[000238] “Threats” may mean points, blades, teeth, abrasive material, blunt forces, sticks, poles, clubs, curbs, trees, rocks, etc. which may be natural, or manmade, mobile or fixed, where application of the threat to a person may cause damage.

[000239] “Reinforcement” may mean high strength joining processes, including thread sewing such as UHMWPE or aramid fiber thread sewing, fabric gluing which may be discontinuous, redundant rounds

of sewing, ultrasonic welding, heat fusing, folding, stapling, or additional fabric reinforcement tape, or riveting or other means to reinforce seams or joints.

[000240] “Level”, “classification”, “category”, “subcategory”, “zones”, “areas”, etc. essentially mean grouping performance levels into at least two different groups, which can be two levels such as low and high, three levels such as lowest, median, highest, or more

CLAIMS:

1. A body armor system comprising at least two of;
 - a. improved armor coverage area,
 - b. improved armor mobility,
 - c. improved armor protection levels,whereby the armor is comprised of at least two overlapping panels each a fraction of the required 100% total armor profile for a thickness required for a designed threat, whereby substantially all of the armor coverage area to be protected is covered by at least two layers panels of overlapping armor which individual fractional thicknesses total up to the required 100% armor thickness. when added together in overlap substantially equal to the total armor thickness required for a particular threat and whereby a user may utilize the improved armour system which better suits the users threat situation.
2. The armor system of claim 1, providing a means to collect threat data and group said data into at least two divided levels, for armor protection deigned to meet that level of threat.
3. The armor system of claim 1, providing a means to replicate collected threat data in order to evaluate various armour materials and assemblies' ability to resist said threat in a controlled environment.
4. The armor system of claim 1, whereby the human body surface area is divided into at least two body area zones related to prioritized importance of protecting that zone from damage for survivability.
5. The armor system of claim 1, whereby armor mobility is classified into at least two levels of mobility such as allowing minimum and maximum exertion, based on evaluations of competent users groups on the criteria of least two of; range of motion, weight, breathability, insulation, thermal burden, comfort, chafing, armor thickness, pliability, and stretch.
6. The armor system of claim 1, whereby the armor protection is defined by resilience to at least one of; puncture, perforation, cutting, abrasion, blunt force trauma, deformation depth, burning, electrocution, insect bite/sting, concussion, blast.

7. The armor system of claim 1, whereby the armor protection is defined by resilience to deleterious contact with, along, against, etc. stationary objects or threats, and categorize said data into at least two levels of severity.
8. The armor system of claim 1, whereby the armored area includes redundant armor panel overlap coverage areas, where overlaps of armor panels to adjacent armor panels exceed the minimum dimension required to meet or exceed at least one of; the dimension of maximum assembly elongation, and the dimension of minimum edge distance as required by armor design or armor regulations.
9. A two-dimensional armor shape for use with the armor system of claim 1, comprising; at least 3 external geometric angles, at least one internal geometric angle, a leading edge that substantially conforms to its trailing edge, whereby the armor shape may fold on lines between geometric angles with minimal fold intersections to other fold lines between alternate geometric angles.
10. An armor panel with a two-dimensional shape for use with the armor system of claim 1, whereby an interior fold resistant area is defined by folding along all possible geometric corners, where said folding lines do not intersect other folding lines, where by the surface area of said fold resistant area is less than 50% of the overall armor shape surface area.
11. The armor system of claim 1, whereby the armor assembly comprises; at least two armor panels, each a fractional thickness of the total armor thickness required, attachment of each said armor panel to at least one elastic base layer underneath all said armor panels, at least one elastic element on top of said armor panels, attachment of each said armor panel to said elastic element at a location substantially opposite the attachment of the panel to the base layer, whereby each armor panel is held in relative position to adjacent armor panels, and the armor assembly may elongate, contract, and curve to substantially the extent of said base material and said cover elastic element.
12. The armor system of claim 1, allowing armor panels to expand to a maximum elongation and contraction of the base material and the elastic cover element.
13. The armor system of claim 1, where the armor includes hydrophobic properties.
14. The armor system of claim 1, where the armor includes flame retardant properties.
15. An armor assembly comprising; at least three armor panels each smaller in surface area than the armor assembly, at least two layers of armor panels, each layers' armor thickness a fraction of the required total armor thickness required for a particular

threat, whereby the layers of armor panels overlap in substantially all of the armor assembly surface area and, the total thickness of overlapped panels equals the total armor thickness required for a particular threat, a means to hold said armor panels in relative position to one another, whereby said armor assembly has the required total armor thickness over substantially all of said armor assembly surface area and, said individual armor panels are fixed to the armor assembly and not fixed directly to one another, whereby the assembly remains pliable and optionally elastic.

16. A method for classification of armor comprising; a means to collect a statistical sample of threat data, a grouping of statistical data into at least two levels, a means to replicate threats in a controlled environment for testing of armor materials/assemblies, a rating name or mark assigned to armor materials or assemblies which resist each level, whereby an armor user can select appropriate armor to resist different levels of threat.
17. A method for classification of armor comprising at least two of; protection level as defined as resilience to a particular threat, mobility level as defined by feedback from a competent user group proficient in the activity/task pursued requiring protection, body coverage area level as defined by percentage of the body surface area covered, whereby an armor user may select an armor system with the ideal levels of at least two of; said protection levels, said mobility levels, and said body coverage levels, to best suit the users threat situation.
18. A two dimensional armor shape for use with the armour system of claim 1 comprising, at least 4 sides, a leading side protrusion, a trailing side recess which substantially conforms to said protrusion, whereby when armor panels leading edges overlap other armor panels trailing edges, the leading edges and trailing edges conform to one another.

John Phillip Sundnes

Patent Attorneys for the Applicant/Nominated Person

GLMR