CLAIMS

What is claimed is:

~~1. A mattress comprising:~~

~~a sleeping surface configured to engage a user arranged in a lying position; and~~

~~an actuation assembly configured to manipulate the sleeping surface and comprising:~~

~~a flexible bladder containing a fluid, and~~

~~a pair of electrodes at least partially separated by the flexible bladder,~~

~~wherein~~

~~the pair of electrodes are configured to manipulate the fluid for changing a shape of the flexible bladder, and~~

~~the sleeping surface is responsive to the shape of the flexible bladder.~~

~~2. The mattress of claim 1, wherein the flexible bladder and the pair of electrodes are components of a Peano-HASEL actuator.~~

~~3. The mattress of claim 1, wherein a stiffness of the sleeping surface is responsive to the shape of the flexible bladder.~~

~~4. The mattress of claim 1, wherein~~

~~in a first configuration, the flexible bladder has a first shape,~~

~~in a second configuration, the flexible bladder has a second shape, and~~

~~in response to an electrical charge, the pair of electrodes move toward one another and cause the flexible bladder to transition between the first shape and the second shape.~~

~~5. The mattress of claim 4, wherein the second shape has a height that is greater than a height of the first shape.~~

~~6. The mattress of claim 5, wherein the sleeping surface is deformed by the flexible bladder having the height of the second shape.~~

~~7. The mattress of claim 4, wherein the second shape has a length that is less than a length of the first shape.~~

8. The mattress of claim 7, wherein the sleeping surface is deformed by the flexible bladder having the length of the second shape.

9. The mattress of claim 1, wherein the pair of electrodes are configured to compress a portion of the flexible bladder in response to a receipt of an electrical charge, thereby displacing the fluid within the flexible bladder.

10. The mattress of claim 1, wherein

the flexible bladder is a first flexible bladder having a first fluid,

the pair of electrodes is a first pair of electrodes,

the actuation assembly further comprises:

a second flexible bladder containing a second fluid, and

a second pair of electrodes at least partially separated by the second flexible bladder,

the second pair of electrodes are configured to manipulate the fluid for changing a shape of the second flexible bladder, and

the sleeping surface is response to the shape of the second flexible bladder.

11. The mattress of claim 10, wherein

the first and second bladders form a continuous cavity having a first bulbous portion and a second bulbous portion, and

the first and second pairs of electrodes are interposed with the first and second bulbous portions.

12. The mattress of claim 11, wherein

the actuation assembly is a first actuation assembly, and

the mattress further comprises a third actuation assembly arranged in a matrix with the first actuation assembly.

13. The mattress of claim 12, wherein the third actuation assembly includes a third flexible bladder arranged offset from the first and second flexible bladders of the first actuation assembly.

14. The mattress of claim 1, wherein

the mattress further comprises a sensor configured to detect a user input, and

the pair of electrodes are configured to manipulate the fluid for changing the shape of the flexible bladder in response to the user input.

15. The mattress of claim 14, wherein the user input comprises an audible input or a force input.

16. The mattress of claim 15, wherein

the user input is an audible input,

in response to the audible input exceeding a threshold value, the pair of electrodes manipulate the fluid for defining a transitioned shaped of the flexible bladder, and

the sleeping surface is deformed by the flexible bladder being in the transitioned shape such that the sleeping surface gently rolls the user in the lying position.

17. The mattress of claim 15, wherein

the user input is a force input,

the force input displaces the pair of electrodes, and

the sensor is configured to detect the user input based on a change in capacitance between the pair of electrodes.

18. A mattress comprising:

a sleeping surface configured to engage a user arranged in a lying position; and

an actuation assembly configured to manipulate the sleeping surface and comprising a shapeable material configured for repeated transitioning between a first shape and a second shape in response to the shapeable material receiving energy from an energy source,

wherein the sleeping surface is responsive to the shapeable material being in the first shape or the second shape.

19. The mattress of claim 18, wherein

the energy source comprises a light source,

the light source is configured to emit light directed toward the shapeable material, and

the shapeable material is configured to transition from the first shape to the second shape upon the receipt of light from the light source.

20. The mattress of claim 19, wherein the shapeable material is configured to transition from the second shape to the first shape upon the cessation of light from the light source.

21. The mattress of claim 19, wherein the light source comprises light waves in one or both of an ultraviolet or a visible spectrum.

22. The mattress of claim 18, wherein the shapeable material comprises a photopolymer or a light-activated resin.

23. The mattress of claim 18, wherein

the energy source comprises a heat source,

the heat source is configured to emit heat directed toward the shapeable material, and

the shapeable material is configured to transition from the first shape to the second shape upon the receipt of heat from the heat source.

24. The mattress of claim 23, wherein the heat source is configured to emit heat via Joule heating.

25. The mattress of claim 18, wherein the shapeable material comprises a blend of high-strength polymer fishing lines and sewing thread.

26. The mattress of claim 18, wherein the shapeable material is defined by a coiled structure.

27. The mattress of claim 26, wherein

the coiled structure has a first length when the shapeable material is in the first shape,

the coiled structure has a second length when the shapeable material is in the second shape, and

the second length is 50% or less than the second length.

28. The mattress of claim 18, wherein

the shapeable material is a first shapeable material of a plurality of shapeable materials,

the plurality of shapeable materials arranged in a base frame to collectively support the sleeping surface.

29. The mattress of claim 28, wherein

the plurality of shapeable materials define a series of slats disposed along a length of the sleeping surface, and

one or more slats of the series of slats extends along a width of the sleeping surface.

30. The mattress of claim 18, wherein the shapeable material defines a cilia-like structure.

~~31. The mattress of claim 30, wherein~~

~~the cilia-like structure has a free end,~~

~~the free end is in a first position when the shapeable material is in the first shape, and~~

~~the free end is in a second position when the shapeable material is in the second shape.~~

~~32. The mattress of claim 31, wherein the sleeping surface is deformed by the free end of the cilia-like structure being in the second position.~~

~~33. The mattress of claim 30, wherein the cilia-like structure is at least partially encased in a gel.~~

~~34. The mattress of claim 18, wherein~~

~~the actuation assembly is a first actuation assembly,~~

~~a first portion of the sleeping surface is responsive to the first actuation assembly,~~

~~the mattress further comprises a second actuation assembly, and~~

~~a second portion of the sleeping surface is responsive to the second actuation assembly.~~

1~~35~~. A flexible fabric comprising:

a flexible outer layer;

a pair of electrodes integrated with the flexible outer layer; and

a flexible bladder holding a fluid;

wherein

the pair of electrodes are operable to compress the flexible bladder and displace the fluid, and

the flexible outer layer is configured to stretch upon the displacement of the fluid.

2~~36~~. The flexible fabric of claim ~~35~~ 1, wherein the flexible bladder and the pair of electrodes are components of a Peano-HASEL actuator.

3~~37~~. The flexible fabric of claim ~~35~~ 1, wherein the flexible bladder and the pair of electrodes are at least partially encased in a gel.

4~~38~~. The flexible fabric of claim ~~37~~ 3, wherein the gel defines a finger-link appendage.

5~~39~~. The flexible fabric of claim ~~38~~ 4, wherein

the pair of electrodes and the flexible bladder are components of a first actuation assembly,

the finger-link appendage is one of a series of finger-link appendages, each having another actuation assembly.

640. The flexible fabric of claim ~~37~~ 3, wherein the gel is enmeshed with a portion of the flexible fabric.

741. The flexible fabric of claim ~~35~~ 1, wherein

in a first configuration, the flexible bladder has a first shape,

in a second configuration, the flexible bladder has a second shape, and

in response to an electrical charge, the pair of electrodes move toward one another and cause the flexible bladder to transition between the first shape and the second shape.

842. The flexible fabric of claim ~~41~~ 7, wherein the flexible fabric is stretched by the flexible bladder being in the second shape.

943. The flexible fabric of claim ~~35~~ 1, wherein

the flexible fabric further comprises a sensor configured to detect a user input, and

the pair of electrodes are configured to manipulate the fluid for changing a shape of the flexible bladder in response to the user input.

~~44. A mattress comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric defines sleeping surface configured to engage a user arranged in a lying position, and~~

~~the stretching of the flexible outer layer is configured to cause movement of the user.~~

~~45. A hospital bed comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric defines a recovery surface configured to engage a user arranged in a convalescing position, and~~

~~the stretching of the flexible outer layer is configured to cause movement of the user.~~

~~46. The hospital bed of claim 45, wherein the movement is configured to rotate the user for the prevention for bed sores.~~

~~47. A surgical table comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric defines a surgical surface configuration to engage a user arranged in a surgical position, and~~

~~the stretching of the flexible outer later is configured to cause movement of the user.~~

~~48. The surgical table of claim 47, wherein the movement is configured to arrange the user into a position adapted to conduct a surgical operation on the user.~~

~~49. The surgical table of claim 48, wherein the stretching is caused in response to a signal from an computing device.~~

~~50. The surgical table of claim 49, wherein the signal is prompted in response to a preprogrammed surgical routine.~~

~~51. The surgical table of claim 49, wherein the signal is prompted in response to an input from a medical professional.~~

~~52. A car seat comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric defines a sitting surface configured to engage a user arranged in a seated position, and~~

~~the stretching of the flexible outer layer is configured to cause movement of the user.~~

~~53. A garment comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric is configured to be worn by a user, and~~

~~the stretching of the flexible outer layer is configured to resist movement of the user.~~

~~54. An insole comprising:~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric defines a stepping surface configured engage a foot of a user, and~~

~~the stretching of the flexible outer layer is configured to cause movement of the foot of the user.~~

~~55. A bullet-proof vest comprising~~

~~the flexible fabric of claim 35, and~~

~~wherein~~

~~the flexible fabric is configured to be worn by a user, and~~

~~the stretching of the flexible outer layer is configured to resist movement of the user.~~

10~~56~~. A method for manipulating a flexible fabric, comprising:

transitioning a flexible bladder from a first shape to a second shape by compressing a portion of the flexible bladder between a pair of electrodes, and

in response to the flexible bladder being in the second shape, causing a deformation of a flexible fabric.

11~~57~~. The method of claim ~~56~~ 10, further comprising applying an electric charge to the pair of electrodes to move the pair of electrodes closer to one another.

12~~58~~. The method of claim ~~56~~ 10, wherein

the method further comprises detecting a user input, the user input comprising an audible input or a force input, and

the transitioning occurs in response to the detection of the user input.

13~~59~~. The method of claim ~~58~~ 12, wherein

the flexible fabric defines a sleeping surface configured to engage a user arranged in a lying position,

the user input is the audible input, and

the method further includes, in response to the audible input, rolling the user using the deformation of the flexible fabric.

14~~60~~. The method of claim ~~58~~ 12, wherein

the flexible fabric defines a sleeping surface configured to engage a user arranged in a lying position,

the user input is a force input,

the detecting of the user input further comprising detecting a pressure distribution of the user on the sleeping surface.

15~~61~~. The method of claim ~~60~~ 14, wherein the detecting of the pressure distribution comprises using a wavefront sensor to measure localized movements of the user.

16~~62~~. The method of claim ~~56~~ 10, further comprising, in response to the flexible bladder being in the second shape, pressing the flexible bladder against the flexible fabric.

17~~63~~. The method of claim ~~56~~ 10, further comprising stiffening the flexible fabric using the deformation caused by the flexible bladder being the second shape.

18~~64~~. The method of claim ~~56~~ 10, wherein

the first shape has a first dimension,

the second shape has a second dimension larger than the first dimension,

the transitioning further comprises transitioning the flexible bladder into an intermediate shape having an intermediate dimension, the intermediate dimension greater than the first dimension and less than the second dimension, and

the causing of the deformation further comprises causing an amount of deformation of the flexible fabric corresponding to a dimension of the flexible bladder being the first, second, or third dimension.

19~~65~~. The method of claim ~~64~~ 18, wherein the deformation is a localized deformation of the flexible fabric.