

**SIDE IMPACT PROTECTION ON CAR SEAT****CROSS REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of U.S. Application No. 63/513,831, filed on July 14, 2023, U.S. Application No. 63/520,696, filed on August 21, 2023, U.S. Application No. 63/581,870, filed on September 11, 2023, U.S. Application No. 63/586,325, filed on September 28, 2023, U.S. Application No. 63/586,914, filed on September 29, 2023, U.S. Application No. 63/590,009, filed on October 13, 2023, U.S. Application No. 63/593,255, filed on October 26, 2023, U.S. Application No. 63/593,267, filed on October 26, 2023, U.S. Application No. 63/594,252, filed on October 30, 2023, U.S. Application No. 63/597,310, filed on November 8, 2023, U.S. Application No. 63/601,806, filed on November 22, 2023, U.S. Application No. 63/601,808, filed on November 22, 2023, U.S. Application No. 63/607,906, filed on December 8, 2023, U.S. Application No. 63/614,211, filed on December 22, 2023, U.S. Application No. 63/614,245, filed on December 22, 2023, U.S. Application No. 63/623,848, filed on January 23, 2024, U.S. Application No. 63/624,861, filed on January 25, 2024, U.S. Application No. 63/550,880, filed on February 7, 2024, U.S. Application No. 63/553,977, filed on February 15, 2024, U.S. Application No. 63/555,950, filed on February 21, 2024, U.S. Application No. 63/561,020, filed on March 4, 2024, U.S. Application No. 63/567,967, filed on March 21, 2024, U.S. Application No. 63/568,132, filed on March 21, 2024, U.S. Application No. 63/632,234, filed on April 10, 2024, U.S. Application No. 63/633,096, filed on April 12, 2024, U.S. Application No. 63/633,401, filed on April 12, 2024, U.S. Application No. 63/633,416, filed on April 12, 2024, U.S. Application No. 63/635,674, filed on April 18, 2024, U.S. Application No. 63/641,742, filed on May 2, 2024, U.S. Application No. 63/649,011, filed on May 17, 2024, U.S. Application No. 63/662,715, filed on Jun 21, 2024, and U.S. Application No. 63/662,717, filed on June 21, 2024, which is incorporated herein by reference in its entirety.

**FIELD**

[0001] Embodiments of the present disclosure relate to child seats, and more particularly to systems, assemblies, and methods for side impact protection for a child seats in a vehicle.

## BACKGROUND

[0002] A child seat is designed to protect a child from injury or death during a collision of a vehicle. Existing child restraint systems commonly include a base portion and a seat portion detachably installed on the base portion. When a child seat is secured on a vehicle by a lower anchor or a vehicle belt, the base portion must be adjusted to a proper reclined angle. In addition, depending on the type of seat that is being used, the seat may be positioned either in a forward-facing or a rearward-facing orientation.

## BRIEF DESCRIPTION

[0003] According to an embodiment, a child seat for installation on a vehicle seat includes a seat portion, a back portion extending from the seat portion, and a headrest. The seat portion, the back portion, and the headrest, in combination, define an interior of the child seat. The child seat includes a combination side impact protection (SIP) assembly having at least two of a first SIP device arranged at the headrest, a second SIP device arranged at an exterior of at least one of the seat portion and the back portion, and a third SIP device arranged at an interior of at least one of the seat portion and the back portion.

[0004] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the back portion.

[0005] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the seat portion.

[0006] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is engageable with a vehicle belt of the vehicle seat.

[0007] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat includes an opening associated with a vehicle belt path and the second SIP device is connected to the child seat proximate the opening.

[0008] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged behind the opening associated with the vehicle belt path.

[0009] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is transformable relative to the child seat between a first configuration and a second configuration.

[0010] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the back portion.



[0011] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is a shoulder SIP device.

[0012] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is a torso SIP device.

[0013] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the seat portion.

[0014] In addition to one or more of the features described above, or as an alternative, in further embodiments the headrest is movable relative to the back portion and the third SIP device is movably coupled to the headrest.

[0015] In addition to one or more of the features described above, or as an alternative, in further embodiments at least one of the first SIP device, the second SIP device, and the third SIP device is transformable between a first configuration, in which the at least one of the first SIP device, the second SIP device, and the third SIP device does not protrude into the interior of the child seat, and a second configuration in which the at least one of the first SIP device, the second SIP device, and the third SIP device extends into the interior of the child seat.

[0016] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly includes the first SIP device and the second SIP device.

[0017] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the back portion of the child seat.

[0018] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the seat portion of the child seat.

[0019] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly further includes the third SIP device.

[0020] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the back portion of the child seat.

[0021] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the seat portion of the child seat.

[0022] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly includes the first SIP device and the third SIP device.

[0023] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the back portion of the child seat.

[0024] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the seat portion of the child seat.

[0025] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly further includes the second SIP device.

[0026] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the back portion of the child seat.

[0027] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the seat portion of the child seat.

[0028] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly includes the second SIP device and the third SIP device.

[0029] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the seat portion of the child seat.

[0030] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is arranged at the back portion of the child seat.

[0031] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the back portion of the child seat.

[0032] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is arranged at the seat portion of the child seat.

[0033] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly includes the first SIP device, the second SIP device arranged at the back portion, and the third SIP device arranged at the back portion.

[0034] In addition to one or more of the features described above, or as an alternative, in further embodiments the combination SIP assembly further includes a fourth SIP device arranged within the interior of the seat portion.

[0035] In addition to one or more of the features described above, or as an alternative, in further embodiments the first SIP device is one of a plurality of first SIP devices arranged at the headrest.

[0036] In addition to one or more of the features described above, or as an alternative, in further embodiments the plurality of first SIP devices are arranged at opposite sides of the headrest.

[0037] In addition to one or more of the features described above, or as an alternative, in further embodiments the plurality of first SIP devices are arranged at a same side of the headrest.

[0038] In addition to one or more of the features described above, or as an alternative, in further embodiments the second SIP device is one of a plurality of second SIP devices arranged at the exterior of at least one of the seat portion and the back portion.

[0039] In addition to one or more of the features described above, or as an alternative, in further embodiments the plurality of second SIP devices are arranged at the exterior of the back portion.

[0040] In addition to one or more of the features described above, or as an alternative, in further embodiments the third SIP device is one of a plurality of third SIP devices arranged at the interior of at least one of the seat portion and the back portion.

[0041] In addition to one or more of the features described above, or as an alternative, in further embodiments the plurality of third SIP devices are arranged at the interior of the back portion.

[0042] In addition to one or more of the features described above, or as an alternative, in further embodiments the plurality of third SIP devices are arranged at the interior of the seat portion.

[0043] In addition to one or more of the features described above, or as an alternative, in further embodiments at least one of the plurality of third SIP devices is arranged at the interior of the back portion and at least one of the plurality of third SIP device is arranged at the interior of the seat portion.

[0044] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat is receivable on a support base and the child seat is rotatable relative to the support base between a plurality of positions.

[0045] According to an embodiment, a child seat system positionable on a vehicle seat includes a child seat having a seat portion and a back portion extending from the seat portion. At least one side impact protection (SIP) device is positionable about the back portion. The at least one SIP device is aligned with a shoulder of an occupant of the child seat.

[0046] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat includes a seat shell defining the seat portion and the back portion and the at least one SIP device is affixed to the seat shell.

[0047] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat includes a headrest and the at least one SIP device is positioned at an interior surface of the back portion, adjacent to the headrest.

[0048] In addition to one or more of the features described above, or as an alternative, in further embodiments the headrest is movable relative to the back portion between a raised position and a lowered position and the at least one SIP device is sized and positioned such that the headrest is freely movable relative to the back portion between the raised position and the lowered position.

[0049] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat includes a headrest and the at least one SIP device is attached to the headrest.

[0050] In addition to one or more of the features described above, or as an alternative, in further embodiments the headrest is movable relative to the back portion between a raised position and a lowered position and the at least one SIP device is movable with the headrest.

[0051] In addition to one or more of the features described above, or as an alternative, in further embodiments the headrest includes a belt guide and the at least one SIP device is positioned adjacent to the belt guide.

[0052] In addition to one or more of the features described above, or as an alternative, in further embodiments soft goods are arranged about the headrest. The soft goods include at least one cutout arranged a position adjacent to the at least one SIP device.

[0053] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device has a body including a mounting surface positionable adjacent to the back portion, an occupant facing surface engageable by the occupant of the child seat, and a side portion extending between the mounting surface and the occupant facing surface. The side portion is contoured to facilitate movement of the occupant about the at least one SIP device.

[0054] In addition to one or more of the features described above, or as an alternative, in further embodiments a transition is arranged between the occupant facing surface and the side portion. The transition is shaped to facilitate forward movement of the occupant.

[0055] In addition to one or more of the features described above, or as an alternative, in further embodiments the transition is rounded.

[0056] In addition to one or more of the features described above, or as an alternative, in further embodiments the transition is sloped.

[0057] According to an embodiment, a child seat system positionable on a vehicle seat includes a child seat having a seat portion and a back portion extending from the seat portion. The seat portion and the back portion define an interior of the child seat. At least one

side impact protection (SIP) device is arranged within the interior of the child seat. The at least one SIP device is configured to contact a hip of an occupant of the child seat.

[0058] In addition to one or more of the features described above, or as an alternative, in further embodiments the child seat includes a seat shell defining the seat portion and the back portion and the at least one SIP device is affixed to the seat shell.

[0059] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is positioned about the child seat such that an upper surface of the at least one SIP device forms an armrest for the occupant of the child seat.

[0060] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is arranged at the seat portion.

[0061] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device defines a portion of a belt path for receiving a vehicle belt.

[0062] In addition to one or more of the features described above, or as an alternative, in further embodiments wherein the seat portion is configured as a booster and is removably couplable to the back portion.

[0063] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device includes padding positioned directly adjacent to a hip of the occupant of the child seat.

[0064] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is arranged at the back portion.

[0065] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is transformable between a first configuration and a second configuration. The at least one SIP device is coupled to the child seat in both the first configuration and the second configuration.

[0066] In addition to one or more of the features described above, or as an alternative, in further embodiments in the first configuration, the at least one SIP device is retracted and is not configured to restrict movement of the occupant within the child seat, and in the second configuration, the at least one SIP device extends into the interior of the child seat and is configured to contact the hip of the occupant.

[0067] In addition to one or more of the features described above, or as an alternative, in further embodiments in the first configuration, the at least one SIP device is flush with an

adjacent surface of the child seat, and in the second configuration, the at least one SIP device protrudes beyond the adjacent surface of the child seat into the interior.

[0068] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is translatable between the first configuration and the second configuration.

[0069] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is rotatable between the first configuration and the second configuration.

[0070] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device has a rigid body.

[0071] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device has a structurally modifiable body.

[0072] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device has a wedge shape.

[0073] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is arranged at the seat portion at a position spaced from the back portion.

[0074] According to an embodiment, a child seat system positionable on a vehicle seat includes a child seat having a seat portion and a back portion extending from the seat portion. An opening formed in the child seat defines a portion of a belt path for receiving a vehicle belt. At least one side impact protection (SIP) device is connected to an exterior of the child seat proximate the opening.

[0075] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device includes a guide portion operable to engage the vehicle belt. The guide portion is positioned to guide the vehicle belt along the belt path.

[0076] In addition to one or more of the features described above, or as an alternative, in further embodiments the guide portion is positioned to guide the vehicle belt toward the opening.

[0077] In addition to one or more of the features described above, or as an alternative, in further embodiments the guide portion is a slot formed in a body of the at least one SIP device and the vehicle belt is receivable within the slot.

[0078] In addition to one or more of the features described above, or as an alternative, in further embodiments the guide portion includes a guide member extending from the at

least one SIP device and the vehicle belt is receivable between the guide member and the at least one SIP device.

[0079] In addition to one or more of the features described above, or as an alternative, in further embodiments the guide member is movable relative to the at least one SIP device between a first position, in which the vehicle belt is free to move relative to the guide portion, and a second position, in which the vehicle belt is locked within the guide portion.

[0080] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is movably coupled to the child seat. The at least one SIP device is movable between a first position in which the vehicle belt is free to move relative to the at least one SIP device, and a second position, in which the vehicle belt is locked in engagement with the at least one SIP device.

[0081] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is arranged at the back portion of the child seat.

[0082] In addition to one or more of the features described above, or as an alternative, in further embodiments the at least one SIP device is arranged near an interface between the back portion and the seat portion.

[0083] In addition to one or more of the features described above, or as an alternative, in further embodiments a rear surface of the at least one SIP device is flush with the exterior of the back portion.

[0084] In addition to one or more of the features described above, or as an alternative, in further embodiments the back portion of the child seat includes a back, a first upright side member arranged at a first side of the back, and a second upright side member arranged at a second side of the back, and a rear surface of the at least one SIP device is flush with the back.

[0085] In addition to one or more of the features described above, or as an alternative, in further embodiments the back portion of the child seat includes a back, a first upright side member arranged at a first side of the back, and a second upright side member arranged at a second side of the back, and a contour of the rear surface of the at least one SIP device corresponds to a contour of the back portion over a height of the at least one SIP device.

[0086] In addition to one or more of the features described above, or as an alternative, in further embodiments at least one SIP device is configured to rotate the child seat in response when a force is applied to the at least one SIP device.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0087] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0088] FIG. 1 is a perspective view of a child restraint system according to an embodiment;

[0089] FIG. 2A is a perspective view of a child seat including at least one head SIP device covered by soft goods according to an embodiment;

[0090] FIG. 2B is a perspective view of a child seat including at least one head SIP device with the soft goods removed according to an embodiment;

[0091] FIG. 3A is a front view of a headrest of a child seat including a plurality of head SIP devices according to an embodiment;

[0092] FIG. 3B is a perspective view of a head SIP device of FIG. 3A according to an embodiment;

[0093] FIG. 4A is a perspective view of a headrest including a head SIP device according to an embodiment;

[0094] FIG. 4B is a detailed perspective view of the head SIP device of FIG. 4A according to an embodiment;

[0095] FIG. 5A is a top perspective view of a headrest including a head SIP device according to an embodiment;

[0096] FIG. 5B is a side perspective view of the head SIP device of FIG. 5A according to an embodiment;

[0097] FIG. 6A is a side perspective view of a headrest including a head SIP device and a secondary body of compressible material in overlapping arrangement with the head SIP device according to an embodiment;

[0098] FIG. 6B is a side perspective view of the head SIP device and secondary body of compressible material of FIG. 6A according to an embodiment;

[0099] FIG. 7A is a top perspective view of a headrest including a head SIP device according to an embodiment;

[0100] FIG. 7B includes a schematic diagram of the head SIP device of FIG. 7A according to an embodiment;

[0101] FIG. 8A is a top perspective view of a headrest including a head SIP device according to an embodiment;

[0102] FIG. 8B includes a schematic diagram of the head SIP device of FIG. 8A according to an embodiment;



[0103] FIG. 9A is a top perspective view of a headrest including a head SIP device according to an embodiment;

[0104] FIG. 9B includes a schematic diagram of the head SIP device of FIG. 9A according to an embodiment;

[0105] FIG. 10A is a front view of a child seat including a headrest having at least one head SIP according to an embodiment;

[0106] FIG. 10B is a perspective view of the headrest of FIG. 10A according to an embodiment;

[0107] FIG. 10C is a side view of the head SIP device of FIG. 10A according to an embodiment;

[0108] FIG. 11A is a front view of a child seat including a headrest having at least one head SIP according to an embodiment;

[0109] FIG. 11B is a perspective view of the headrest of FIG. 11A according to an embodiment;

[0110] FIG. 11C is a side view of the head SIP device of FIG. 11A according to an embodiment;

[0111] FIG. 12A is a perspective view of a headrest of a child seat having a plurality of head SIP devices arranged at an area thereof according to an embodiment;

[0112] FIG. 12B is a perspective view of the headrest of FIG. 12A when an occupant is arranged within the child seat according to an embodiment;

[0113] FIG. 13A is a perspective view of a child seat including a headrest having a head SIP assembly according to an embodiment;

[0114] FIG. 13B is a front view perspective view of the headrest of FIG. 13A according to an embodiment;

[0115] FIG. 13C is a top view of the headrest of FIG. 13A according to an embodiment;

[0116] FIG. 13D is a perspective view of the head SIP assembly of FIG. 13A separated from the headrest according to an embodiment;

[0117] FIG. 13E is a top view of the head SIP assembly of FIG. 13D according to an embodiment;

[0118] FIG. 14 is a top view of a child positioned relative to a headrest of a child seat having a head SIP assembly according to an embodiment;

[0119] FIG. 15A is a perspective view of a child seat including a headrest having a head SIP assembly according to an embodiment;

[0120] FIG. 15B is a front view perspective view of the headrest of FIG. 15A according to an embodiment;

[0121] FIG. 15C is a top view of the headrest of FIG. 15A according to an embodiment;

[0122] FIG. 15D is a perspective view of the head SIP assembly of FIG. 15A separated from the headrest according to an embodiment;

[0123] FIG. 15E is a top view of the head SIP assembly of FIG. 15D according to an embodiment;

[0124] FIG. 16A is a perspective view of a child seat including a headrest having a head SIP assembly according to an embodiment;

[0125] FIG. 16B is a front view perspective view of the headrest of FIG. 16A according to an embodiment;

[0126] FIG. 16C is a top view of the headrest of FIG. 16A according to an embodiment;

[0127] FIG. 16D is a perspective view of the head SIP assembly of FIG. 16A separated from the headrest according to an embodiment;

[0128] FIG. 16E is a top view of the head SIP assembly of FIG. 16D according to an embodiment;

[0129] FIG. 17A is a perspective view of a child seat including a headrest having a head SIP assembly according to an embodiment;

[0130] FIG. 17B is a front view perspective view of the headrest of FIG. 17A according to an embodiment;

[0131] FIG. 17C is a top view of the headrest of FIG. 17A according to an embodiment;

[0132] FIG. 17D is a perspective view of the head SIP assembly of FIG. 17A separated from the headrest according to an embodiment;

[0133] FIG. 17E is a top view of the head SIP assembly of FIG. 17D according to an embodiment;

[0134] FIG. 18A is a perspective view of a child seat including a headrest having a head SIP assembly according to an embodiment;

[0135] FIG. 18B is a front view perspective view of the headrest of FIG. 18A according to an embodiment;

[0136] FIG. 18C is a top view of the headrest of FIG. 18A according to an embodiment;

[0137] FIG. 18D is a perspective view of the head SIP assembly of FIG. 18A separated from the headrest according to an embodiment;

[0138] FIG. 18E is a top view of the head SIP assembly of FIG. 18D according to an embodiment;

[0139] FIG. 19A is a perspective view of a child seat including a headrest having a head SIP assembly having a plurality of head SIP devices arranged to contact the same side of an occupant's head according to an embodiment;

[0140] FIG. 19B is a front view perspective view of the headrest of FIG. 19A according to an embodiment;

[0141] FIG. 19C is a top view of the headrest of FIG. 19A according to an embodiment;

[0142] FIG. 19D is a perspective view of the head SIP assembly of FIG. 19A separated from the headrest according to an embodiment;

[0143] FIG. 19E is a top view of the head SIP assembly of FIG. 19D according to an embodiment;

[0144] FIG. 20A is a perspective view of a child seat including a headrest having a head SIP assembly having a plurality of head SIP devices arranged at the same side of an occupant's head according to an embodiment;

[0145] FIG. 20B is a front view perspective view of the headrest of FIG. 20A according to an embodiment;

[0146] FIG. 20C is a top view of the headrest of FIG. 20A according to an embodiment;

[0147] FIG. 20D is a perspective view of the head SIP assembly of FIG. 20A separated from the headrest according to an embodiment;

[0148] FIG. 20E is a top view of the head SIP assembly of FIG. 20D according to an embodiment;

[0149] FIG. 21A is a perspective view of a child seat including a headrest having a head SIP assembly having a plurality of head SIP devices arranged at the same side of an occupant's head according to an embodiment;

[0150] FIG. 21B is a front view perspective view of the headrest of FIG. 21A according to an embodiment;

[0151] FIG. 21C is a top view of the headrest of FIG. 21A according to an embodiment;

[0152] FIG. 21D is a perspective view of the head SIP assembly of FIG. 21A separated from the headrest according to an embodiment;

[0153] FIG. 21E is a top view of the head SIP assembly of FIG. 21D according to an embodiment;

[0154] FIG. 22A is a perspective view of a child seat including a headrest having a head SIP assembly having a plurality of head SIP devices arranged at the same side of an occupant's head according to an embodiment;

[0155] FIG. 22B is a front view perspective view of the headrest of FIG. 22A according to an embodiment;

[0156] FIG. 22C is a top view of the headrest of FIG. 22A according to an embodiment;

[0157] FIG. 22D is a perspective view of the head SIP assembly of FIG. 22A separated from the headrest according to an embodiment;

[0158] FIG. 22E is a top view of the head SIP assembly of FIG. 22D according to an embodiment;

[0159] FIG. 23A is a perspective view of a child seat including a headrest having a head SIP assembly having a plurality of head SIP devices arranged at the same side of an occupant's head according to an embodiment;

[0160] FIG. 23B is a front view perspective view of the headrest of FIG. 23A according to an embodiment;

[0161] FIG. 23C is a top view of the headrest of FIG. 23A according to an embodiment;

[0162] FIG. 23D is a perspective view of the head SIP assembly of FIG. 23A separated from the headrest according to an embodiment;

[0163] FIG. 23E is a top view of the head SIP assembly of FIG. 23D according to an embodiment;

[0164] FIG. 24A is a side view of a headrest of a child seat including a control mechanism and at least one head SIP assembly in a first configuration according to an embodiment;

[0165] FIG. 24B is a top view of the headrest of FIG. 24A according to an embodiment;

[0166] FIG. 24C is a side view of a headrest of a child seat including a control mechanism and at least one head SIP assembly in a second configuration according to an embodiment;

[0167] FIG. 24D is a top view of the headrest of FIG. 24C according to an embodiment;

[0168] FIG. 25A is a side view of a headrest of a child seat including a control mechanism and at least one head SIP assembly in a first configuration according to an embodiment;

[0169] FIG. 25B is a top view of the headrest of FIG. 25A according to an embodiment;

[0170] FIG. 25C is a side view of a headrest of a child seat including a control mechanism and at least one head SIP assembly in a second configuration according to an embodiment;

[0171] FIG. 25D is a top view of the headrest of FIG. 25C according to an embodiment;

[0172] FIG. 26A is a perspective view of a child seat including a headrest having a head SIP assembly including a plurality of head SIP devices arranged at the same side of an occupant's head in a first configuration according to an embodiment;

[0173] FIG. 26B is a front view perspective view of the headrest of FIG. 26A according to an embodiment;

[0174] FIG. 26C is a top view of the headrest of FIG. 26A according to an embodiment;

[0175] FIG. 26D is a perspective view of the headrest of FIG. 26A in a second configuration according to an embodiment;

[0176] FIG. 26E is a front view perspective view of the headrest of FIG. 26D according to an embodiment;

[0177] FIG. 26F is a top view of the headrest of FIG. 26D according to an embodiment;

[0178] FIG. 27A is a perspective view of a child seat including a headrest having a head SIP assembly including a plurality of head SIP devices arranged at the same side of an occupant's head when an installation belt is arranged at a first position about the child seat according to an embodiment;

[0179] FIG. 27B is a perspective view of the child seat of FIG. 27A when an installation belt is arranged at a second position about the child seat according to an embodiment;

[0180] FIG. 28A is a perspective view of a headrest of a child seat having a head SIP device formed from a friction material according to an embodiment;

[0181] FIG. 28B is a front view of the headrest of FIG. 28A according to an embodiment;

[0182] FIG. 29A is a perspective view of a headrest of a child seat having a head SIP device arranged at a front end of the headrest according to an embodiment;

[0183] FIG. 29B is a perspective view of a headrest of a child seat having another head SIP device arranged at a front end of the headrest according to an embodiment;

[0184] FIG. 30A is a perspective view of a child seat including a headrest having a head SIP device in a first configuration according to an embodiment;

[0185] FIG. 30B is a top view of the child seat of FIG. 30A according to an embodiment;

[0186] FIG. 31A is a perspective view of the child seat of FIG. 30A having a head SIP device in a second configuration according to an embodiment;

[0187] FIG. 31B is a top view of the child seat of FIG. 31A according to an embodiment;

[0188] FIG. 32A is a front perspective view of a headrest of a child seat of having at least one head SIP device covered by soft goods according to an embodiment;

[0189] FIG. 32B is a side perspective view of the headrest of FIG. 32A according to an embodiment;

[0190] FIG. 32C is a top view of the headrest of FIG. 32A according to an embodiment;

[0191] FIG. 33A is a front perspective view of a back portion of a child seat having at least one shoulder SIP device arranged at an interior surface thereof according to an embodiment;

[0192] FIG. 33B is a side perspective view of the back portion including at least one shoulder SIP device of FIG. 33A according to an embodiment;

[0193] FIG. 33C is a side perspective view of at least one shoulder SIP device of FIG. 33A according to an embodiment;

[0194] FIG. 34A is a front view of a shoulder SIP device according to an embodiment;

[0195] FIG. 34B is a front perspective view of the shoulder SIP device of FIG. 34A according to an embodiment;

[0196] FIG. 35A is a perspective view of a child seat including a shoulder SIP device of FIGS. 34A-34B arranged at a back portion according to an embodiment;

[0197] FIG. 35B is a top view of the child seat of FIG. 35A according to an embodiment;

[0198] FIG. 36A is a front view of a shoulder SIP device according to another embodiment;

[0199] FIG. 36B is a front perspective view of the shoulder SIP device of FIG. 36A according to an embodiment;

[0200] FIG. 36C is a perspective view of a child seat including a shoulder SIP device of FIGS. 36A-36B arranged at a back portion according to an embodiment;

[0201] FIG. 36D is a top view of the child seat of FIG. 36C according to an embodiment;

[0202] FIG. 37A is a front view of a child seat having at least one shoulder SIP device arranged at an interior surface of a back portion when a headrest is in a lowered position according to an embodiment;

[0203] FIG. 37B is a front view of the child seat of FIG. 37A when the headrest is in a raised position according to an embodiment;

[0204] FIG. 38A is a top perspective view of a child seat having at least one torso SIP device arranged at an interior surface of a back portion of the child seat according to an embodiment;

[0205] FIG. 38B is a front perspective view of the child seat of FIG. 38A according to an embodiment;

[0206] FIG. 38C is a side perspective view of the child seat of FIG. 38A with soft goods installed about the child seat according to an embodiment;

[0207] FIG. 39 is a top perspective view of a child seat having at least one torso SIP device arranged at an interior surface of a seat portion of the child seat according to an embodiment;

[0208] FIG. 40A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of the child seat according to an embodiment;

[0209] FIG. 40B is a front view of the child seat of FIG. 40A according to an embodiment;

[0210] FIG. 41A is a perspective view of a torso SIP assembly including a plurality of torso SIP devices according to an embodiment;

[0211] FIG. 41B is a perspective view of the torso SIP assembly of FIG. 41A installed about an interior surface of a child seat according to an embodiment;

[0212] FIG. 41C is a front view of the torso SIP assembly of FIG. 41A installed about an interior surface of a child seat according to an embodiment;

[0213] FIG. 42A is a perspective view of a torso SIP assembly including a plurality of torso SIP devices according to an embodiment;

[0214] FIG. 42B is a perspective view of the torso SIP assembly of FIG. 42A installed about an interior surface of a child seat according to an embodiment;

[0215] FIG. 42C is a front view of the torso SIP assembly of FIG. 42A installed about an interior surface of a child seat according to an embodiment;

[0216] FIG. 43A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of a child seat to form an armrest according to an embodiment;

[0217] FIG. 43B is another perspective view of the child seat of FIG. 43A according to an embodiment;

[0218] FIG. 44A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of a back portion of the child seat, the at least one torso SIP device being in a first configuration according to an embodiment;

[0219] FIG. 44B is a front view of the child seat of FIG. 44A according to an embodiment;

[0220] FIG. 44C is a perspective view of the child seat of FIG. 44A with the at least one torso SIP device in a second configuration according to an embodiment;

[0221] FIG. 44D is a front view of the child seat of FIG. 44C according to an embodiment;

[0222] FIG. 45A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of a back portion of the child seat, the at least one torso SIP device being in a first configuration according to an embodiment;

[0223] FIG. 45B is a front view of the child seat of FIG. 45A according to an embodiment;

[0224] FIG. 45C is a perspective view of the child seat of FIG. 45A with the at least one torso SIP device in a second configuration according to an embodiment;

[0225] FIG. 45D is a front view of the child seat of FIG. 45C according to an embodiment;

[0226] FIG. 46 is a perspective view of a child seat having at least one torso SIP device in a second configuration according to an embodiment;

[0227] FIG. 47A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of the child seat, the at least one torso SIP device being in a first configuration according to an embodiment;

[0228] FIG. 47B is a front view of the child seat of FIG. 47A according to an embodiment;

[0229] FIG. 47C is a perspective view of the child seat of FIG. 47A with the at least one torso SIP device in a second configuration according to an embodiment;

[0230] FIG. 47D is a front view of the child seat of FIG. 47C according to an embodiment;

[0231] FIG. 48A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of the child seat, the at least one torso SIP device being in a first configuration according to an embodiment;

[0232] FIG. 48B is a front view of the child seat of FIG. 48A according to an embodiment;

[0233] FIG. 48C is a perspective view of the child seat of FIG. 48A with the at least one torso SIP device in a second configuration according to an embodiment;



[0234] FIG. 48D is a front view of the child seat of FIG. 48C according to an embodiment;

[0235] FIG. 49A is a perspective view of a child seat having at least one torso SIP device arranged at an interior surface of the child seat, the at least one torso SIP device being in a first configuration according to an embodiment;

[0236] FIG. 49B is a front view of the child seat of FIG. 49A according to an embodiment;

[0237] FIG. 49C is a perspective view of the child seat of FIG. 49A with the at least one torso SIP device in a second configuration according to an embodiment;

[0238] FIG. 49D is a front view of the child seat of FIG. 49C according to an embodiment;

[0239] FIG. 49E is a top view of the child seat of FIG. 49C according to an embodiment;

[0240] FIG. 50A is a perspective view of a child seat including at least one external SIP device arranged at a support base according to an embodiment;

[0241] FIG. 50B is a side view of the child seat of FIG. 50A according to an embodiment;

[0242] FIG. 51A is a perspective view of a child seat including at least one external SIP device arranged at a support base according to an embodiment;

[0243] FIG. 51B is a side view of the child seat of FIG. 51A according to an embodiment;

[0244] FIG. 52A is a perspective view of a child seat including at least one external SIP device arranged at an exterior surface of the child seat according to an embodiment;

[0245] FIG. 52B is a side view of the child seat of FIG. 52A according to an embodiment;

[0246] FIG. 53A is a side view of a child seat including at least one external SIP device arranged at an exterior surface of a seat portion of the child seat according to an embodiment;

[0247] FIG. 53B is a perspective view of the child seat of FIG. 53A according to an embodiment;

[0248] FIG. 54A is a side view of a child seat including at least one external SIP device arranged at an exterior surface of a back portion of the child seat near a belt path opening according to an embodiment;

[0249] FIG. 54B is a perspective view of the child seat of FIG. 54A according to an embodiment;

[0250] FIG. 55A is a front perspective view of a child seat including at least one external SIP device arranged at an exterior surface of a back portion of the child seat near a belt path opening according to an embodiment;

[0251] FIG. 55B is a rear perspective view of the child seat of FIG. 55A according to an embodiment;

[0252] FIG. 55C is a front view of the child seat of FIG. 55B according to an embodiment;

[0253] FIG. 55D is a side perspective view of the child seat of FIG. 55A according to an embodiment;

[0254] FIG. 55E is a top view of the child seat of FIG. 55A positioned on a vehicle seat adjacent to a vehicle door according to an embodiment;

[0255] FIG. 55F is another rear perspective view of the at least one external SIP device of FIG. 55A according to an embodiment;

[0256] FIG. 56A is a perspective view of a child seat including at least one external SIP device arranged at an exterior surface of a back portion of the child seat near a belt path opening according to an embodiment;

[0257] FIG. 56B is a side view of the child seat of FIG. 56A according to an embodiment;

[0258] FIG. 57 is a perspective view of an external SIP device having a slot for engaging a vehicle belt according to an embodiment;

[0259] FIG. 58 is a perspective view of an external SIP device having a clip for engaging a vehicle belt according to an embodiment;

[0260] FIG. 59 is a perspective view of an external SIP device having a rotatable clip for engaging a vehicle belt according to an embodiment;

[0261] FIG. 60 is a perspective view of an external SIP device rotatable into engagement with a vehicle belt according to an embodiment;

[0262] FIG. 61A is a perspective view of an infant car seat having at least one external SIP device arranged at a handle hub according to an embodiment;

[0263] FIG. 61B is a side view of an infant car seat having at least one external SIP device arranged at an exterior surface of a seat portion according to an embodiment;

[0264] FIG. 61C is a top perspective view of the at least one external SIP device of FIG. 61B according to an embodiment;

[0265] FIG. 62A is a perspective view of a child including at least one external SIP device arranged at an exterior surface of a back portion of the child seat, the at least one external SIP device being in a first configuration according to an embodiment;

[0266] FIG. 62B is a perspective view of the child seat of FIG. 62A with the at least one external SIP device in a second configuration according to an embodiment;

[0267] FIG. 63A is a perspective view of a child including an external SIP device arranged at an exterior surface of a back portion of the child seat, the external SIP device being in a first configuration according to an embodiment;

[0268] FIG. 63B is a perspective view of the child seat of FIG. 63A with the external SIP device in a second configuration according to an embodiment;

[0269] FIG. 63C is a perspective view of the child seat of FIG. 63A with the external SIP device in a third configuration according to an embodiment;

[0270] FIG. 64A is a perspective view of a child including an external SIP device arranged at an exterior surface of a back portion of the child seat, the external SIP device being in a first configuration according to an embodiment;

[0271] FIG. 64B is a perspective view of the child seat of FIG. 64A with the external SIP device in a second configuration according to an embodiment;

[0272] FIG. 64C is a perspective view of the child seat of FIG. 64A with the external SIP device in a third configuration according to an embodiment;

[0273] FIG. 65A is a front perspective view of a child seat including at least one SIP device and an actuation mechanism operably coupled to the at least one SIP device according to an embodiment;

[0274] FIG. 65B is a perspective view of the actuation mechanism of FIG. 65A in an unactuated configuration and at least one SIP device operably coupled to the actuation mechanism in a first configuration according to an embodiment;

[0275] FIG. 65C is a front perspective view of the child seat of FIG. 65A when the actuation mechanism is actuated and the at least one SIP device is in a second configuration according to an embodiment;

[0276] FIG. 65D is a perspective view of the actuation mechanism in the actuated configuration and at least one SIP device operably coupled to the actuation mechanism in a second configuration according to an embodiment;

[0277] FIG. 66A is a front perspective view of a child seat including at least one SIP device and an actuation mechanism operably coupled to the at least one SIP device according to an embodiment;

[0278] FIG. 66B is a perspective view of the actuation mechanism of FIG. 66A in an unactuated configuration and at least one SIP device operably coupled to the actuation mechanism in a first configuration according to an embodiment;

[0279] FIG. 66C is another front perspective view of the child seat of FIG. 66A when the actuation mechanism is unactuated and the at least one SIP device is in a first configuration according to an embodiment;

[0280] FIG. 66D is a side view of the actuation mechanism in the unactuated configuration and at least one SIP device operably coupled to the actuation mechanism in a first configuration according to an embodiment;

[0281] FIG. 66E is a front perspective view of the child seat of FIG. 66A with the actuation mechanism in an actuated configuration and the at least one SIP device in a second configuration according to an embodiment;

[0282] FIG. 66F is a perspective view of the actuation mechanism of FIG. 66E in the actuated configuration and the at least one SIP device operably coupled to the actuation mechanism in the second configuration according to an embodiment;

[0283] FIG. 66G is another front perspective view of the child seat of FIG. 66E when the actuation mechanism is actuated and the at least one SIP device is in a second configuration according to an embodiment;

[0284] FIG. 66H is a side view of the actuation mechanism in the actuated configuration and at least one SIP device operably coupled to the actuation mechanism in a second configuration according to an embodiment;

[0285] FIG. 67A is a front view of a child seat having at least one SIP device transformable between a first configuration and a second configuration in response to movement of the headrest according to an embodiment;

[0286] FIG. 67B is a rear perspective view of the child seat of FIG. 67A according to an embodiment;

[0287] FIG. 67C is a detailed perspective view of an actuation mechanism of the child seat of FIG. 67A in an unactuated position and of the at least one SIP device in a first configuration according to an embodiment;

[0288] FIG. 67D is a detailed front view of an actuation mechanism of the child seat of FIG. 67A in an unactuated position and of the at least one SIP device in a first configuration according to an embodiment;

[0289] FIG. 67E is a front view of the child seat of FIG. 67A having at least one SIP device in a second configuration and an actuation mechanism in an actuated configuration according to an embodiment;

[0290] FIG. 67F is a rear perspective view of the child seat of FIG. 67E according to an embodiment;

[0291] FIG. 67G is a detailed perspective view of an actuation mechanism of the child seat of FIG. 67E in an actuated configuration and of the at least one SIP device in a second configuration according to an embodiment;

[0292] FIG. 67H is a detailed front view of the actuation mechanism of the child seat of FIG. 67E in an actuated configuration and of the at least one SIP device in a second configuration according to an embodiment;

[0293] FIG. 68A is a perspective view of a child seat including a headrest having a head SIP assembly including a plurality of head SIP devices arranged at the same side of an occupant's head in a first configuration according to an embodiment;

[0294] FIG. 68B is a front view perspective view of the headrest of FIG. 68A according to an embodiment;

[0295] FIG. 68C is a top view of the headrest of FIG. 68A according to an embodiment;

[0296] FIG. 68D is a perspective view of the headrest of FIG. 68A in a second configuration according to an embodiment;

[0297] FIG. 68E is a front view perspective view of the headrest of FIG. 26D according to an embodiment;

[0298] FIG. 68F is a top view of the headrest of FIG. 68D according to an embodiment;

[0299] FIG. 69A is a side view of a headrest having at least one head SIP device according to an embodiment;

[0300] FIG. 69B is a rear view of the headrest of FIG. 69A according to an embodiment;

[0301] FIG. 70A is a front perspective view of a child seat having a headrest in a lowered position and at least one shoulder device operably coupled to the headrest according to an embodiment;

[0302] FIG. 70B is a front perspective view of the child seat of FIG. 70A with the headrest in a raised position according to an embodiment;

[0303] FIG. 71 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device and a shoulder SIP device;

[0304] FIG. 72 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device and a torso SIP device;

[0305] FIG. 73 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device and an external SIP device;

[0306] FIG. 74 is a schematic drawings of a child seat system having a combination SIP assembly including a shoulder SIP device and a torso SIP device;

[0307] FIG. 75 is a schematic drawings of a child seat system having a combination SIP assembly including a shoulder SIP device and an external SIP device;

[0308] FIG. 76 is a schematic drawings of a child seat system having a combination SIP assembly including a torso SIP device and an external SIP device;

[0309] FIG. 77 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device, a shoulder SIP device, and a torso SIP device;

[0310] FIG. 78 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device, a shoulder SIP device, and an external SIP device;

[0311] FIG. 79 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device, a torso SIP device, and an external SIP device;

[0312] FIG. 80 is a schematic drawings of a child seat system having a combination SIP assembly including a shoulder SIP device, a torso SIP device, and an external SIP device;

[0313] FIG. 81 is a schematic drawings of a child seat system having a combination SIP assembly including a head SIP device, a shoulder SIP device, a torso SIP device, and an external SIP device;

[0314] FIG. 82A is a top view of a child positioned relative to a headrest of a child seat having a plurality of head SIP devices according to an embodiment; d

[0315] FIG. 82B is a top view of a child positioned relative to the headrest of FIG. 82A during a side impact event according to an embodiment;

[0316] FIG. 83 is a perspective view of a head SIP device transformable between a stowed configuration and a deployed configuration according to another embodiment;

[0317] FIG. 84A is a front view of a child seat having a plurality of shoulder SIP devices affixed to a movable headrest in a raised position according to an embodiment;

[0318] FIG. 84B is a front view of a child seat having a plurality of shoulder SIP devices affixed to a movable headrest in a lowered position according to an embodiment;

[0319] FIG. 85 is an exploded perspective view of a shoulder SIP device of FIGS. 84A-84B according to an embodiment;

[0320] FIGS. 86A-86D are views of a torso SIP device in various configurations according to an embodiment;

[0321] FIG. 86E is a side view of a torso SIP device in a first configuration;

[0322] FIG. 86F is a side view of the torso SIP device in a second configuration;

[0323] FIG. 87A is a perspective view of a child seat having a torso SIP assembly retained in position about the child seat by a connection assembly according to an embodiment;

[0324] FIG. 87B is a detailed perspective view of the torso SIP assembly when the connection assembly of FIG. 87A is in a first position according to an embodiment;

[0325] FIG. 87C is a detailed perspective view of the torso SIP assembly when the connection assembly of FIG. 87A is in a second position according to an embodiment;

[0326] FIG. 88A is a back view of the torso SIP assembly when the connection assembly is in a first position according to an embodiment;

[0327] FIG. 88B is a back view of the torso SIP assembly when the connection assembly of FIG. 88A is in a second position according to an embodiment;

[0328] FIG. 88C is a side perspective view of the torso SIP assembly when the connection assembly is in a first position according to an embodiment;

[0329] FIG. 88D is a side view of the torso SIP assembly when the connection assembly of FIG. 88C is in a second position according to an embodiment;

[0330] FIG. 89A is a perspective view of a child seat having a torso SIP assembly and a corresponding control device associated with a torso SIP device of the torso SIP assembly according to an embodiment;

[0331] FIG. 89B is a detailed perspective view of the control device according to an embodiment;

[0332] FIG. 89C is a perspective view of a torso SIP device of the torso SIP assembly of FIG. 89A when the control device is in a first position according to an embodiment;

[0333] FIG. 89D is a perspective view of a torso SIP device of the torso SIP assembly of FIG. 89A when the control device is in a first position according to an embodiment;

[0334] FIG. 90A is a perspective view of a child seat including an external SIP device in a first position according to an embodiment;

[0335] FIG. 90B is a perspective view of a child seat including an external SIP device in a second position according to an embodiment;

[0336] FIG. 91 is a detailed perspective view of the external SIP device of FIGS. 90A-90B according to an embodiment;

[0337] FIG. 92A is a front perspective view of the external SIP device of FIG. 91 according to an embodiment;

[0338] FIG. 92B is a back perspective view of the external SIP device of FIG. 92A according to an embodiment;

[0339] FIG. 93 is a side view of the view of the external SIP device of FIG. 92A according to an embodiment;

[0340] FIG. 94 is an exploded side view of the external SIP device of FIG. 93 according to an embodiment;

[0341] FIG. 95 is a cross-sectional exploded view of the external SIP device of FIG. 94 according to an embodiment;

[0342] FIG. 96A is a side view of an external SIP device in a first configuration according to an embodiment;

[0343] FIG. 96B is a side view of the external SIP device of FIG. 96A in a second configuration according to an embodiment;

[0344] FIG. 97A and 97B are perspective views of a child seat system including an engagement member associated with an external SIP device according to an embodiment;

[0345] FIG. 98A is a perspective view of a child seat system in a rearward facing configuration and including an engagement member associated with an external SIP device according to an embodiment;

[0346] FIG. 98B is a perspective view of the child seat system of FIG. 98A in a forward-facing configuration and including an engagement member associated with an external SIP device according to an embodiment;

[0347] FIG. 99 is a perspective view of a child seat system having an external SIP device arranged at the support base according to an embodiment;

[0348] FIG. 100 is a perspective view of a child seat system having a movable external SIP device arranged at the support base according to another embodiment;

[0349] FIG. 101 is a perspective view of a child seat system having a movable external SIP device arranged at the support base according to an embodiment;

[0350] FIG. 102A and 102B are perspective views of a child seat system having a movable external SIP device arranged at the support base according to yet another embodiment;

[0351] FIG. 103 is a perspective view of a child seat system having a translatable external SIP device arranged at the support base according to another embodiment;

[0352] FIG. 104 is a perspective view of a child seat system having a pivotable external SIP device arranged at the support base according to another embodiment;



[0353] FIG. 105 is a perspective view of a child seat system having a telescoping external SIP device arranged at the support base according to another embodiment;

[0354] FIGS. 106A and 106B are perspective view of a support base having an external SIP device according to an embodiment;

[0355] FIGS. 107A and 107B are various view of a child seat system including an actuation mechanism for automatically transforming an SIP device according to an embodiment;

[0356] FIG. 108A is a plan view of a child seat system having an SIP device when the child seat is in a forward-facing configuration according to an embodiment;

[0357] FIG. 108B is a plan view of a child seat system having an SIP device when the child seat is rotating between a rearward-facing configuration and a forward-facing configuration according to an embodiment;

[0358] FIG. 109A is an exploded perspective view of a child seat system in a forward-facing configuration, the child seat having a system for automatically deploying a SIP device based on a position of the child seat relative to a vehicle seat and a configuration of the child seat according to an embodiment;

[0359] FIG. 109B is a plan view of the child seat system of FIG. 109A according to an embodiment;

[0360] FIG. 110A is an exploded perspective view of the child seat system of FIG. 109A as the child seat rotates away from a forward-facing configuration according to an embodiment;

[0361] FIG. 110B is a plan view of the child seat system of FIG. 110A according to an embodiment;

[0362] FIG. 111 is a front view of a control feature for moving an actuator of a support base according to an embodiment;

[0363] FIG. 112 is a side view of a child seat system including a child seat having at least one external SIP device at a seat portion according to an embodiment;

[0364] FIG. 113A is a schematic view of a cupholder of a child seat in an extended configuration according to an embodiment;

[0365] FIG. 113B is a schematic view of a cupholder of a child seat in an extended configuration according to an embodiment;

[0366] FIG. 113C is a schematic view of a cupholder of a child seat during a crash event according to an embodiment;

[0367] FIG. 114A is a schematic view of a cupholder of a child seat in an extended configuration according to an embodiment;

[0368] FIG. 114B is a schematic view of a cupholder of a child seat in an extended configuration according to an embodiment;

[0369] FIG. 114C is a schematic view of a cupholder of a child seat during a crash event according to an embodiment;

[0370] FIG. 115 is a view of a child seat system including a child seat having at least one external SIP device at a seat portion according to an embodiment;

[0371] FIG. 116A is a perspective view of an infant car seat having at least one external SIP device according to an embodiment;

[0372] FIG. 116B is another perspective view of an infant car seat having at least one external SIP device according to an embodiment;

[0373] FIG. 116C is another perspective view of an infant car seat with a handle in a rear position and having at least one external SIP device according to an embodiment;

[0374] FIG. 116D is another perspective view of an infant car seat with a handle in a rear position and having at least one external SIP device according to an embodiment;

[0375] FIG. 117 A is a perspective view of a child seat including an SIP device in a first configuration according to an embodiment;

[0376] FIG. 117B is a plan view of the child seat of FIG. 117A according to an embodiment;

[0377] FIG. 118A is a perspective view of a child seat including an SIP device in a second configuration according to an embodiment;

[0378] FIG. 118B is a plan view of the child seat of FIG. 118A according to an embodiment;

[0379] FIG. 119A is a perspective view of a child seat including an SIP device in a first configuration according to an embodiment;

[0380] FIG. 119B is a plan view of the child seat of FIG. 119A according to an embodiment;

[0381] FIG. 120A is a perspective view of a child seat including an SIP device in a second configuration according to an embodiment;

[0382] FIG. 120B is a plan view of the child seat of FIG. 120A according to an embodiment;

[0383] FIG. 121A is a plan view of a child seat including an SIP device in a first configuration according to an embodiment;

[0384] FIG. 121B is a plan view of a child seat including an SIP device in a second configuration according to an embodiment;

[0385] FIG. 122A is a perspective view of a child seat including an SIP device in a first configuration according to an embodiment;

[0386] FIG. 122B is a perspective view of a child seat including an SIP device in a second configuration according to an embodiment;

[0387] FIG. 123A is a plan view of a child seat including an SIP device in a first configuration according to an embodiment;

[0388] FIG. 123B is a plan view of a child seat including an SIP device in a second configuration according to an embodiment;

[0389] FIG. 124A is a plan view of a child seat including an SIP device in a first configuration according to an embodiment;

[0390] FIG. 124B is a plan view of a child seat including an SIP device in a second configuration according to an embodiment;

[0391] FIG. 125A is a plan view of a child seat including an SIP device in a first configuration according to an embodiment;

[0392] FIG. 125B is a perspective view of the SIP device in the first configuration according to an embodiment;

[0393] FIG. 125C is a perspective view of the SIP device in a second configuration according to an embodiment;

[0394] FIGS. 126A-126C are perspective views of a child seat system having a deformable SIP device at various locations according to an embodiment;

[0395] FIG. 127A is a side perspective view of a child seat system including a collapsible SIP device in a first configuration according to an embodiment;

[0396] FIG. 127B is a rear perspective view of a child seat system including a collapsible SIP device in a first configuration according to an embodiment;

[0397] FIG. 127C is a rear perspective view of a child seat system including a collapsible SIP device in a second configuration according to an embodiment;

[0398] FIG. 128A is a plan view of a child seat system including a collapsible SIP device in a first configuration according to an embodiment;

[0399] FIG. 128B is a perspective view of a portion of the SIP device in more detail according to an embodiment;

[0400] FIG. 129 is a plan view of a child seat system including a SIP device according to an embodiment;

[0401] FIG. 130 is a perspective view of a child seat system including a SIP device according to an embodiment;

[0402] FIGS. 131A-131C are various perspective views of a child seat system including an external SIP device configured as a foot and movable between a first configuration and a second configuration according to an embodiment;

[0403] FIG. 132A-132C are various views of a head SIP assembly according to an embodiment;

[0404] FIG. 133A-133C are various views of the head SIP assembly of FIGS. 132A-132C affixed to a headrest shell according to an embodiment;

[0405] FIG. 134A-134C are various views of a headrest including at least one head SIP device according to another embodiment;

[0406] FIGS. 134D and 134E are cross-sectional views of the headrest of FIG. 134C taken along lines H-H according to an embodiment;

[0407] FIGS. 135A-135C are various views of a headrest including at least one head SIP device according to another embodiment;

[0408] FIGS. 136A-136B are front and back perspective view of a shoulder SIP device according to an embodiment;

[0409] FIG. 137 is a back perspective view of a shoulder SIP device according to another embodiment;

[0410] FIG. 138 is a front view of a shoulder SIP device according to an embodiment;

[0411] FIG. 139 is a front view of a shoulder SIP device according to another embodiment;

[0412] FIG. 140A is a front perspective view of an inset associated with a shoulder SIP device according to an embodiment;

[0413] FIG. 140B is a rear perspective view of the insert of FIG. 140A according to an embodiment;

[0414] FIG. 141 is a front perspective view of a shoulder SIP device according to another embodiment;

[0415] FIGS. 142A and 142B are various perspective views of a shoulder SIP device surrounded by soft goods according to an embodiment;

[0416] FIGS. 143A and 143B are various perspective views of headrest soft goods having integral soft goods associated with a shoulder SIP device according to an embodiment;

[0417] FIG. 144A is a front view of a headrest soft goods having cutouts to accommodate a shoulder SIP device according to an embodiment;

[0418] FIG. 144B is a front view of a child seat having the headrest soft goods of FIG. 144A mounted thereto according to an embodiment;

[0419] FIGS. 145A-145E are various views of a child seat system having at least one external SIP device in a forward, rearward, and intermediate configuration according to an embodiment;

[0420] FIG. 146A is a perspective view of an external SIP device according to an embodiment;

[0421] FIG. 146B is a front view of the external SIP device of FIG. 146A according to an embodiment;

[0422] FIG. 146C is a side view of the external SIP device of FIG. 146A according to an embodiment;

[0423] FIGS. 147A and 147B are various perspective views of the external SIP device of FIGS. 146A-146C mounted to a child seat according to an embodiment;

[0424] FIG. 148A is a perspective view of an external SIP device according to an embodiment;

[0425] FIG. 148B is a back view of the external SIP device of FIG. 148A according to an embodiment;

[0426] FIG. 148C is a plan view of the external SIP device of FIG. 148A according to an embodiment;

[0427] FIG. 149A is a perspective view of a bracket surrounding a belt path opening of a child seat according to an embodiment;

[0428] FIG. 149B is a perspective view of the bracket of FIG. 149A operably coupled to the external SIP device of FIGS. 148A-148C according to an embodiment;

[0429] FIG. 150 is a perspective view of an interface between an external SIP device and a child seat according to an embodiment;

[0430] FIG. 151A is a perspective view of a child seat system having a removable seat portion and at least one torso SIP device according to an embodiment; and

[0431] FIG. 151B is a detailed view of the torso SIP device of FIG. 151A and the surrounding soft goods according to an embodiment;

[0432] FIG. 152A-152B are various views of a shoulder SIP device arranged relative to a headrest including a head SIP device according to an embodiment; and

[0433] FIG. 153 is a perspective view of a child seat system having at least one external SIP device according to an embodiment.

## DETAILED DESCRIPTION

[0434] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0435] With reference now to FIG. 1, an example of a child seat system 20 according to an embodiment is illustrated. The child seat system 20 can be detachably fixed to a vehicle seat (see FIG. 55E), such as via a latch or anchor mechanism (not shown). This latch or anchor system often used is sometimes referred to as a “lower anchor and tether for children” e.g., LATCH system. Alternatively, or in addition, the child seat system 20 may be detachably fixed to a vehicle seat via a vehicle belt (not shown) associated with the vehicle seat.

[0436] The child seat system 20 may include a support base or bottom 22 and a child seat 23 having a rigid seat shell 24 coupled to the support base 22, the seat shell 24 being adapted to receive a child. In an embodiment, the seat shell 24 is detachably connected to the support base 22, thereby allowing the seat shell 24 to be separated from the support base 22. Alternatively, the support base 22 and the seat shell 24 may be permanently connected or affixed together. As used herein the term “permanently connected” represents embodiments where the seat shell 24 is not intended to be disassembled from the support base 22 by a user and is perhaps of unitary or non-separable construction.

[0437] The seat shell 24 may include a seat portion 26 and a backrest or upright portion 28 arranged at an angle relative to the seat portion 26. The seat portion 26 and the upright portion 28 may be detachably coupled, or alternatively, may be permanently coupled. In the illustrated, non-limiting embodiment, the upright portion 28 and the seat portion 26 are integrally formed as a single unitary body. In another alternative aspect, the upright portion 28 can be rotationally connected to the seat portion 26 such that the upright portion 28 can incline and recline relative to the seat portion 26.

[0438] As shown, the upright portion 28 of the seat shell 24 includes an upright support surface 30 generally facing forward and that extends from a first end or top 32 to a second, opposite end or bottom 34 of the upright portion 28. A first upright side member 36 may be arranged at a first side 38 of the upright support surface 30 and a second upright side member 40 may be arranged at a second, opposite side 42 of the upright support surface 30. The first and second upright side members 36, 40 therefore form the left side and the right side of the upright portion 28, respectively. As shown, the first and second upright side members 36, 40 extend forward from the upright support surface 30. The first and second upright side members 36, 40 may extend generally orthogonally to the upright support surface 30, or alternatively,

may extend therefrom at another angle, such as an angle greater than 90° for example (the respective angles therefore being at least 90° for example). Accordingly, the upright support surface 30 and the first and second upright side members 36, 40 define a backrest region or upright support cavity within which an upper body of a child is received.

[0439] In embodiments where the child seat is a toddler seat, the upright side members 36, 40 may facilitate the correct positioning of a vehicle belt when the child seat system 20 is installed in a vehicle. In some embodiments, each upright side member 36, 40 has an opening 44 formed therein. The opening 44 may be configured to receive a vehicle seatbelt (not shown) to secure the child seat system 20 to a vehicle seat in a forward-facing high-back configuration.

[0440] In the illustrated, non-limiting embodiment, the upright portion 28 of the seat shell 24 includes a headrest 46. The headrest 46 is attached to or integral with the upright portion 28. The headrest 46 may be stationary or in some embodiments, may be configured to move relative to the upright support surface 30. For example, the headrest 46 may be configured to translate relative to the upright support surface 30 between a vertically retracted position and a vertically extended position, allowing for adjustment based on the size of the child positioned within the child seat system 20.

[0441] The seat portion 26 includes a seat support surface 50 facing generally upwardly and that extends from a first end or front 52 to a second end or back 54 of the seat portion 26. A first seat side member 56 may be arranged at a first side 58 of the seat support surface 50 and a second seat side member 60 may be arranged at a second, opposite side (not shown) of the seat support surface 50. The first seat side member 56 and the second seat side member 60 extend upwardly and form the left side and the right side of the seat portion 26. The seat support surface 50 and the first and second seat side member 56, 60 in combination define a region within which at least part of a lower body of a child may be received.

[0442] As shown, the seat side members 56, 60 extend at an angle from the seat support surface 50. The angle of the first seat side member 56 relative to the seat support surface 50 may but need not be the same as the angle of the first upright side member 36 relative to the upright support surface 30. Similarly, the angle of the second seat side member 60 relative to the seat support surface 50 may but need not be the same as the angle of the second upright side member 40 relative to the upright support surface 30. In an embodiment, the first upright side member 36 and the first seat side member 56 are integrally formed with each other and the seat shell 24, and the second upright side member 40 and the second seat side member 60 are integrally formed with each other and the seat shell 24.

[0443] In the illustrated, non-limiting embodiment, each seat side member 56, 60 has a slot 66 formed therein configured to function as a lap belt guide during at least one mode of use of the child seat 23. The slot 66 may be configured to receive and position a lap belt portion of a vehicle restraint or a separate restraint belt to attach the child seat system 20 to a vehicle seat 10 when the child seat 23 is in a forward-facing high-back configuration as illustrated in FIG. 1.

[0444] The child seat 23 may be movable relative to the support base 22 while the child seat 23 is coupled to the support base 22. In an embodiment, the child seat 23 is rotatable relative to the support base 22 between a plurality of configurations. For example, the child seat 23 may be rotatable between a first rotational configuration, such as a configuration in which the child seat 23 is in a facing-forward position, and a second rotational configuration, such as a configuration in which the child seat 23 is in a rearward-facing position. However, it should be appreciated that embodiments where the child seat 23 is positionable in one or more additional configurations between the first rotational configuration and a second rotational configuration are also within the scope of the disclosure. Further, embodiments where the child seat 23 is not rotatable relative to the support base 22 are also contemplated herein.

[0445] Alternatively, or in addition, the child seat 23 may be movable relative to the support base 22 to adjust an incline of the child seat 23. The child seat 23 may be movable along an incline path between a first position, such as an upright position, and a second position, such as a reclined position. However, it should be appreciated that the first position and the second position may both be positions arranged at an incline, the positions having varying degrees of incline. Embodiments where the child seat 23 may be arranged in any of a plurality of positions between the upright position and the reclined position, as well as embodiments where the incline of the child seat 23 is not adjustable relative to the support base 22, are also contemplated herein. It should be appreciated that a child seat system 20 as illustrated and described herein with reference to FIG. 1, is intended as an example only, and that a child seat system 20 having other configurations are also within the scope of the disclosure. For example, although the child seat 23 of the child seat system 20 is illustrated and described as a toddler seat, in other embodiments, the child seat may be an infant car seat for use by a child less than 2 years old, having a height less than or equal to than 35 inches and/or a weight less or equal to 40 pounds.

[0446] A child seat system, such as child seat system 20 for example, may include at least one side impact protection device. The at least one side impact protection (SIP) device may be removably connected to the child seat system 20, such as via double-sided tape,



adhesive, or a mechanical fastener for example. Alternatively, the at least one SIP device may be permanently connected to or integral therewith, such that a structure of the child seat system 20, such as the seat shell 24 of the child seat 23 for example, and the one or more SIP devices form a single unitary part. As will be described in more detail below, the one or more SIP devices may be mounted at various locations about the support base 22 and/or the child seat 23. For example, an SIP device may be located at the upright portion 28, the seat portion 26, or the headrest 46 of the child seat 23 for example. Further, such an SIP device may be arranged at an interior surface or an exterior surface of the child seat 23.

[0447] An SIP device associated with a child seat system, such as child seat system 20 for example, may be formed from a material having a hardness less than the hardness of the seat shell 24 or the support base 22. The use of a material having a reduced hardness may facilitate the absorption of energy applied to the child seat system 20 during an accident, such as a side impact collision. In some embodiments, the material of an SIP device of the child seat system 20 also has a hardness greater than the hardness of the soft goods mounted about the seat shell 24 and/or the headrest 46 to provide additional energy absorption beyond that of the soft goods. In an embodiment, an SIP device may be constructed with sacrificial features that are configured to break or deform during a collision to help absorb energy. In some embodiments, SIP devices or portions thereof may be formed of foam materials such as expanded polypropylene (EPP), expanded polystyrene (EPS), and/or expanded polyolefin (EPO) with example densities such as 30 g/l, 45 g/l, and 50 g/l. Various other materials and specifications thereof are contemplated. It should be understood that any of these materials or another material that has a reduced hardness relative to the seat shell of a child seat could be used in any exemplary embodiment of an SIP device described herein.

[0448] With continued reference to FIG. 1, in an embodiment, the child seat system 20 includes one or more SIP devices 70a, 70b operable to restrict or control movement of the head of an occupant of the child seat system 20 during a side impact collision. Such a head SIP device 70a, 70b may be arranged at an area of the child seat 23 surrounding or located adjacent to an occupant's head. In an embodiment, the at least one head SIP device 70a, 70b is associated with, and in some embodiments is mounted to, the headrest 46 of the child seat 23. As discussed further below, in some embodiments, the child seat system 20 may include one or more additional SIP devices, such as shoulder SIP devices 72a, 72b, external SIP devices 74, and/or torso SIP devices (not shown).

[0449] It should be appreciated that a configuration of a head SIP device, such as head SIP device 70 for example, as well as its positioning relative to the child seat 23, may vary

based on the orientation of the child seat 23, such as relative to a vehicle or a direction of travel. A headrest typically includes a rigid body or structure with soft goods, such as padding, cushioning, fabric, or the like, positioned about one or more surfaces of the rigid body, such as the surfaces of the rigid body that the head of an occupant of the child seat may contact. As will be described in more detail below, a head SIP device may be positioned adjacent to an inner surface of a headrest or within a head receiving region of a headrest. Unless another arrangement is noted, any embodiment described herein that includes a head SIP device locatable at such an inner surface region should be understood to position the head SIP device generally between a structural body or shell of the headrest (e.g. the relatively rigid portion of the headrest) and the soft goods that cover the headrest. Such a head SIP device may be attached to the structural body of the headrest or to the soft goods positionable thereabout.

[0450] With reference now to FIGS. 2A and 2B, a headrest 102 of a child seat 100, similar to headrest 46 of child seat 23, is shown. The headrest 102 includes a headrest back portion 104 having a headrest support surface 106, such as oriented generally parallel to the upright support surface (not shown) of an upright portion 110 of the child seat 100 for example. Additionally, the headrest 102 includes at least one headrest side member. For example, a first headrest side member 112 may extend from a first side 114 of the headrest back portion 104 and a second headrest side member 116 may extend in an opposite direction from a second side 118 of the headrest back portion 104.

[0451] The first and second headrest side members 112, 116 include inward facing surfaces 120, 122. In combination with the headrest support surface 106 of the headrest back portion 104, the inward facing surfaces 120, 122 form an inner surface of the headrest 102, and define a head receiving region 124 (please see FIG. 2B). The headrest support surface 106 may form a back portion of the inner surface, while the inward facing surfaces 120, 122 of the headrest side members 112, 116 may form a first and second headrest side portions of the inner surface. In an embodiment, the headrest support surface 106 defines the back of the head receiving region 124. The inward facing surfaces 120, 122 extend from the headrest support surface 106 to a distal first front end 126a and second front end 126b, respectively. The front ends 126a, 126b, such as arranged at the ends of the first and second headrest side members 112, 116 for example, may define a front of the head receiving region 124. In the illustrated, non-limiting embodiment, the headrest back portion 104, first headrest side member 112, and second headrest side member 116 as described herein may refer to portions of the rigid body or structure of the headrest 102. Accordingly, soft goods may be positioned in overlapping arrangement with the corresponding headrest support surface 106 and the inward facing

surfaces 120, 122 of the headrest side members 112, 116 facing the head receiving region 124 of the rigid body.

[0452] When an occupant is seated within the child seat 100, an occupant's head is arranged within the head receiving region 124 between the inward facing surfaces 120, 122 of the headrest side members 112, 116 and a back of the occupant's head is typically arranged proximate to or in contact with the headrest support surface 106. It should be appreciated that the headrest embodiments shown throughout the FIGS. herein may all include headrest back portions and headrest side members similar to those described above with reference to headrest back portion 104 and headrest side portions 112, 116 respectively. These headrests as shown throughout the FIGS. may also include head receiving regions similar to that described above with reference to head receiving region 124.

[0453] The headrest 102 may have at least one side impact protection portion arranged at any suitable position about the headrest 102. In an embodiment, the head side impact protection (SIP) portion is located within the head receiving region 124 of the headrest 102, such as between the back and the front thereof. Embodiments including a plurality of side impact protection portions are also contemplated herein. In the illustrated, non-limiting embodiment, a first head SIP portion 130a is positioned near the first headrest side member 112 and a second head SIP portion 130b is arranged near the second headrest side member 116, opposite side of the headrest 102. The head SIP portions 130a, 130b of the headrest 102 may include a protrusion generally arranged at the inner surface of the headrest 102 that extends inwardly toward the head receiving region 124. As will be described in more detail below, a head SIP portion, such as head SIP portions 130a, 130b, may include one or more head SIP devices, and in some embodiments, one of the head SIP devices may form the protrusion extending from the inner surface.

[0454] At least one head SIP device 132a, 132b may be arranged at any suitable position about the headrest. In an embodiment, a first head SIP device 132a is arranged at or adjacent to a first side portion of the inner surface of the headrest 102, such as at the first headrest side member 112, and a second head SIP device 132b is arranged at or adjacent to a second side portion of the inner surface of the headrest 102, such as the second headrest side member 116. It should be appreciated that the functionality of the head SIP devices 132a, 132b, and any further head SIP device described herein, may depend not only on the position of the head SIP devices 132a, 132b relative to the headrest 102, but also on the height and/or shape of the head SIP devices 132a, 132b. A configuration of the first head SIP device 132a and the second head SIP device 132b may but need not be substantially identical. Further, embodiments

where the headrest 102 includes only a single head SIP device, or more than two SIP devices are also within the scope of the disclosure. The at least one head SIP device 132a, 132b may be permanently or removably affixed to the headrest 102, such as to a portion of the inner surface of the headrest 102.

[0455] In an embodiment, such as shown in FIG. 2B the at least one head SIP device 132a, 132b is located at or adjacent to a surface of the rigid body, such as at a position between the rigid body and the soft goods configured to overlap the rigid body. In such embodiments, the at least one head SIP device 132a, 132b may be integrally formed with the rigid body, or alternatively, may be a separate component mounted to the rigid body. The at least one head SIP device 132a, 132b may be mountable directly to the rigid body, or may be mounted to or formed within the soft goods connectable to the rigid body. In other embodiments, the at least one head SIP device 132a, 132b may be mounted at an exterior surface of the soft goods, such that the at least one head SIP device 132a, 132b is positionable in direct contact with the occupant's head. It should be appreciated that any of the other SIP devices disclosed herein, such as with reference to FIGS. 3-33B, 68A-69B, 82A-83, 117A-118B, 122A-124B, 129 and 132A-134D for example, may be arranged at any of position about the headrest as described herein.

[0456] Examples of various head SIP devices, such as positionable within a head SIP portion of a headrest, similar to head SIP portions 130a, 130b for example, are shown in FIGS. 3A-23E and will be described in more detail below. A head SIP device may extend over the full height, or alternatively, over only a portion of a height of a headrest. In an embodiment, a height of a head SIP device, measured along a vertical axis, is at least 2 inches, and in some embodiments, at least about 2.5 inches, at least about 3 inches, at least about 3.5 inches, at least about 4 inches, at least about 4.5 inches, and at least about 5 inches.

[0457] With reference now to FIGS. 3A and 3B, the illustrated headrest 200 includes a first head SIP portion 201a including a first head SIP device arranged at a first portion of an inner surface of the headrest 200, such as at an inwardly facing surface 212 of a first headrest side member 204. Further, A second head SIP portion 201b may include a second head SIP device 202b mounted to and positioned in overlapping arrangement with a second portion of the headrest 200, such as an inwardly facing surface 214 of a second headrest side member 206. However, embodiments where at least one head SIP device 202a, 202b is arranged at another part of the headrest 200, such as a back portion 208 for example are also contemplated herein. The at least one head SIP device, 202a, 202b may have a base 210a, 210b mountable to the inwardly facing surface 212, 214 of the first headrest side member 204 and/or the second

headrest side member 206, respectively. The at least one head SIP device, 202a, 202b may alternatively or additionally have an inwardly facing surface 216a, 216b facing toward the interior of the headrest 200. The base surface 210a, 210b may but need not have a contour complementary to one or more corresponding surfaces of the headrest 200. Further, in the illustrated, non-limiting embodiment, a contour of the outer periphery of the at least one head SIP device 202a, 202b may be different than the corresponding portion of the headrest 200 to which the head SIP device 202a, 202b is mounted. For example, as shown in the FIGS., the head SIP devices 202a, 202b may be general squircle (a square with rounded corners) in shape or may be rectangular or rectangular with rounded corners.

[0458] In other embodiments, such as shown with headrest 300 in FIGS. 4A and 4B, a head SIP portion 301 of the headrest 300 may include a head SIP device 302 having a contour complementary to an adjacent portion of the headrest 300. As previously described, the headrest 300 may include a back portion 304, a first headrest side member 306 and a second headrest side member 308. In the illustrated, non-limiting embodiment, the head SIP device 302 is positioned adjacent to an interior surface 310 of the second headrest side member 308. Accordingly, the contour of an outer periphery of the head SIP device 302 may be similar, for example equal in size and/or shape, to the interior surface 310 of the headrest side member 308. In such embodiments, the head SIP device 302 may be arranged generally centrally about a headrest side member 308 and may be sized to cover or overlap a substantial majority of the surface 310 of the headrest side member 308 extending between a lateral edge of the headrest support surface 312 at the back portion 304 of the headrest 300 and a front end 314 of a headrest side member 308. In such embodiments, an outer periphery of the head SIP device 302 may be substantially flush or aligned with one or more edges, such as the front end 314 for example, of the headrest side member 308. Although not shown, it should be appreciated that another head SIP device may be arranged at another portion of the headrest 300, such as at the first headrest side member 306 for example. In such embodiments, a configuration of an additional head SIP device may, but need not be identical to the head SIP device 302 illustrated and described herein.

[0459] However, in other embodiments, such as with a headrest 400 as shown in FIGS. 5A and 5B, only a portion of a head SIP device 402 of a head SIP portion 401 (FIG. 5B) may have a contour complementary to an adjacent portion of the headrest 400, such as a headrest side member. The headrest 400 may include a back portion 404, a first headrest side member 406, and a second headrest side member (not shown), as previously described. In the illustrated, non-limiting embodiment, a head SIP device 402 is mounted to an interior surface 408 of the

first headrest side member 406. Although not shown, it should be appreciated that another head SIP device may be arranged at another portion of the headrest 400, such as at the second headrest side member for example. In such embodiments, a configuration of an additional head SIP device may, but need not be identical to the head SIP device 402 illustrated and described herein.

[0460] In the illustrated, non-limiting embodiment, only a distal end 410 of the head SIP device 402 has a contour complementary to the corresponding end 412 of the headrest side member 406. In such embodiments, the head SIP device 402a may extend over only a portion of the distance between a headrest support surface 414 of a back portion 404 of the headrest 400 and a front end 412 of a headrest side member 406. Alternatively, or additionally, the head SIP device 402 may extend over only a portion of the height of the headrest side member 406, such as between a top 416 and a bottom 418 thereof. However, in embodiments where the head SIP device 402 extends over only a portion of the headrest side member 406, the head SIP device 402 need not be arranged adjacent to the front end 412 of the headrest side member 406.

[0461] In the illustrated, non-limiting embodiment of FIGS. 3A and 3B, the thickness of the first and second head SIP devices 202a, 202b is substantially uniform over the width of each head SIP device 202a, 202b (the width being measured between a headrest support surface 209 and a front end 220 of the headrest side member 204, 206). Accordingly, when the head SIP device 202a, 202b is mounted to the headrest 200, the inwardly facing surface 216 of the head SIP device 202a, 202b is arranged at substantially the same angle relative to the headrest support surface 209 as the headrest side member 204, 206. The head SIP device 202a, 202b is illustrated as being formed from a flexible or semi-rigid foam material. However, any suitable material configured to absorb energy is within the scope of the disclosure.

[0462] In some embodiments, a head SIP device of a child seat is contoured to induce a roll of an occupant's head in the event of a side impact collision. In the non-limiting embodiment of FIGS. 4A-5B, a thickness of the illustrated respective head SIP devices 302, 402, measured between an outwardly facing surface 420 of the head SIP device 302b, 402 and an inwardly facing surface 322, 422 of the head SIP device 302, 402, may vary between opposite ends of the head SIP device 302, 402. In FIGS. 4A-4B, the thickness of the head SIP device 302 is wedge-shaped and the thickness of the head SIP device 302 gradually increases from the end closest to the headrest support surface 312 toward the front end 314 of the headrest side member 308.

[0463] The increase in thickness over the width of the head SIP device 302 may be selected to achieve a desired angle of the inwardly facing surface 322 relative to the headrest

support surface 312. In an embodiment, a maximum thickness of a wedge-shaped head SIP device 302 is about 2 inches, and in some embodiments is less than 1.5 inches, such as about 1¼ inches, about 1 inch, or about ½ inch. However, embodiments where a wedge-shaped head SIP device 302 has a maximum thickness greater than 2 inches are also within the scope of the disclosure.

[0464] In other embodiments, such as shown in FIGS. 5A and 5B, the head SIP device 402 is wedge-shaped and the thickness of the head SIP device 402 gradually decreases from the end closest to the headrest support surface 414 towards the front end 412 of the headrest side member 406. As a result, the inwardly facing surface 422 of the head SIP device 402 tapers outwardly away from a center of the headrest 400. In an embodiment, a maximum thickness of a wedge-shaped head SIP device 402 is about 1 inch, and in some embodiments is less than 1 inch, such as about ¾ inch, about .5 inch, or about ¼ inch. However, embodiments where a wedge-shaped head SIP device 402 has a maximum thickness greater than 1 inch are also within the scope of the disclosure. Although the wedge-shaped head SIP devices 302, 402 are illustrated as being formed from expanded polystyrene in the FIGS. in other embodiments, the head SIP device 302, 402 may be formed from other materials.

[0465] In an embodiment, a head SIP device of a headrest as described herein is configured to induce a roll of an occupant's head in the event of a side impact collision, such as by defining a contoured recess associated with the head receiving region of the headrest. With reference to FIGS. 5A and 5B, a recess 432 associated with the head SIP device 402 may be located immediately adjacent to the head SIP device 402. The recess 432 may be defined in part by the inwardly facing surface 422 of the head SIP device 402 and by a plane extending laterally from an inner edge of the front end 412 of the headrest 400. Further, the recess 432 may extend from a portion of the head SIP device 402 positioned closest laterally to a central longitudinal axis CLA of a head receiving region 430 to the plane extending laterally from an inner edge of the front end 412 of the headrest 400. In the non-limiting embodiment of FIGS. 5A and 5B, the portion of the head SIP device 402 positioned closest to the CLA is located at a line of intersection L between the inwardly facing surface 422 and the back portion 404. Accordingly, the line of intersection L is positioned closer to the back portion than the front end 412 of the headrest 400.

[0466] The recess 430 may further be defined by a vertical plane extending from the line of intersection L toward the plane extending laterally from an inner edge of the front end 412. This vertical plane is represented by a line 434 in FIG. 5A. In an embodiment, the line 434 is oriented substantially parallel to the CLA. At least in part due to this tapered or sloped

configuration of the head SIP device 402, the lateral dimension of the recess 432 gradually increases in a direction toward the front 412 of the headrest 400. The gradual reduction in thickness of the head SIP device 402, along with the corresponding increase in the recess 432 formed thereby, facilitates a forward roll of an occupant's head during a side impact event.

[0467] Further, in an embodiment, such as shown in FIGS. 6A and 6B, the head SIP device 502 associated with a headrest 500 may alternatively or additionally include a body of compressible material, illustrated at 504, such as a flexible foam for example. In the non-limiting embodiment illustrated in the FIGS., the body of compressible material 504 is positioned directly adjacent to the inwardly facing surface 506 of a head SIP device 502, such as a wedge-shaped member similar to 302. Although the body of compressible material 504 is illustrated as being mounted directly to the head SIP device 502, in other embodiments, such a body may be integrated into the soft goods positionable about the headrest 500 and the head SIP device 502. The compressible material 504 may provide cushioning for an occupant's head during a crash event additional to the padding of the soft goods. Although the body of compressible material 504 is illustrated as being positioned adjacent to a head SIP device 502 arranged at a second headrest side member 510, it should be understood that such a body 504 may be arranged adjacent to another head SIP device positioned at another location about the headrest 500, such as adjacent to a first headrest side member 512. Alternatively, or in addition, the body of compressible material 504 may be located at any position relative to the headrest 500 including locations where a head SIP device is not present.

[0468] With reference now to FIGS. 7A-9B, embodiments of a headrest 600, 700, 800 having a head SIP device 602, 702, 802 mountable to both a headrest support surface 604, 704, 804 of a headrest back portion 606, 706, 806 and an interior surface 608, 708, 808 of a headrest side member 610, 710, 810 are illustrated. Although not shown, it should be appreciated that another head SIP device may be arranged at another portion of each headrest 600, 700, 800, such as at the second headrest side member for example. In such embodiments, a configuration of an additional head SIP device may, but need not be identical to the head SIP device 602, 702, 802 illustrated and described herein.

[0469] In each of the embodiments, an SIP base 620, 720, 820 of the head SIP device 602, 702, 802 may have a contour complementary to a portion of both the headrest support surface 604, 704, 804 and the surface 608, 708, 808 of the headrest side member 610, 710, 810. In such embodiments, the head SIP device 602, 702, 802 may extend over only a portion of a headrest side member 610, 710, 810 between the headrest support surface 604, 704, 804 and a front end 614 of the headrest side member 610, 710, 810.



[0470] In the illustrated, non-limiting embodiment of FIGS. 7A and 7B, an inwardly facing surface 622 of the head SIP device 602 has a smooth, continuous contour, such as formed by a curvature for example. However, in other embodiments, the inwardly facing surface 722, 822 of the head SIP device 702, 802 may include one or more side impact protection portions or areas arranged at various angles relative to one another and to the headrest support surface 704, 804. In the non-limiting embodiments of FIGS. 8A and 8B and FIGS. 9A and 9B, the inwardly facing surface 722, 822 includes a first side impact protection area 724, 824 and a second side impact protection area 726, 826 arranged at a non-parallel angle to one another. An axial length of the first side impact protection area 724, 824 may be the same as an axial length of the second side impact protection area 726, 826. However, in other embodiments, the first side impact protection area 724, 824 may have a longer axial length than the second side impact protection area 726, 826, or the first side impact protection area 724, 824 may have a shorter axial length than the second side impact protection area 726, 826. In some embodiments, the first side impact protection area 724, 824 is arranged at an obtuse angle relative to the second side impact protection area 726, 826. As shown, the overall size of the first and second side impact protection area 724, 824, 726, 826 and the angle defined therebetween varies between the embodiments of FIGS. 8A-8B and the embodiment of FIGS. 9A and 9B. The overall size of the first side impact protection area 724, 824 may also be relatively larger or smaller than the overall size of the second side impact protection area 726, 826.

[0471] In a crash event, movement of an occupant's head will be driven along a path defined by the inwardly facing surface 622, 722, 822 of the head SIP devices 602, 702, 802. In embodiments where the inwardly facing surface includes a plurality of side impact protection areas, movement of an occupant's head will be driven from the first side impact protection area 724, 824 to the second side impact protection area 726, 826.

[0472] With reference to FIGS. 7A and 7B, the inwardly facing surface 622 may extend continuously from the headrest support surface 604 of the headrest 600 to a surface 608 of a headrest side member 610. As shown in FIG. 7A, a recess 630 may be at least partially defined within the head receiving region 628 by the head SIP device 602. In the illustrated, non-limiting embodiment, the recess 630 is defined in part by the inwardly facing surface 622 of the head SIP device 602 and by a plane extending laterally from an inner edge of the front end 612 of the headrest 600. Further, the recess 630 may extend from a portion of the head SIP device 602 positioned closest laterally to a central longitudinal axis CLA of a head receiving region 628 to the plane extending laterally from an inner edge of the front end 612 of the headrest 600. In

the non-limiting embodiment of FIGS. 7A and 7B, the portion of the head SIP device 602 positioned closest to the CLA is located at a line of intersection L0 (FIG. 7A) between the inwardly facing surface 622 and the headrest support surface 604 of the back portion 606. Accordingly, the line of intersection L0 is positioned closer to the back portion 606 than the front end 612 of the headrest 600. The recess 630 may further be defined by a vertical plane extending from the line of intersection L0 toward the plane extending laterally from an inner edge of the front end 12. This vertical plane, represented by a line 632 in FIG. 7A, may be oriented substantially parallel to the CLA.

[0473] With reference to the non-limiting embodiment of a head SIP device 702 of a headrest 700 illustrated in FIGS. 8A and 8B, the inwardly facing surface 722 may include the first side impact protection area 724 arranged closest to the back portion 706 of the headrest 700 and the second side impact protection area 726 extending from the first side impact protection area 724 toward the front end (not shown) of the headrest 700. The first side impact protection area 724 may converge with the second side impact protection area 726 along a vertical line of intersection, represented in FIG. 8A by L1. The line of intersection L1 may be arranged at any suitable angle relative to the back portion 706. In an embodiment, the line of intersection L1 is the portion of the head SIP device 702 positioned closest to a central longitudinal axis CLA of a head receiving region 728 (in a lateral direction).

[0474] A recess 730 is at least partially defined within the head receiving region 728 of the headrest 700 by the head SIP device 702. In the illustrated, non-limiting embodiment, the recess 730 extends from the line of intersection, L1, towards a plane extending laterally from an inner edge of the front end (not shown) of the headrest 700. A plane of the recess 730 extending between the line of intersection L1 and the plane extending laterally from an inner edge of the front end, illustrated at P1, may be coplanar with the first side impact protection area 724. The recess 730 may further be defined by the second side impact protection area 726 of the inwardly facing surface 722, and a surface 708 of the headrest side member 710 extending between an edge of the second side impact protection area 726 and the front end of the headrest 700.

[0475] In the illustrated, non-limiting embodiment, a vertical plane, represented by axis X1 in FIG. 8A extends from the front end and is positioned tangent to the inwardly facing surface 722 at the line of intersection L1 between the first and second side impact protection areas 724, 726. The axis X1 intersects the headrest support surface 704 at an intersection location I1. In an embodiment, a distance between the headrest support surface 704 and the

line of intersection L1 measured along the axis X1 is shorter than a distance between the line of intersection L1 and the front end of the headrest 700 measured along the axis X1.

[0476] With reference to FIGS. 9A and 9B, the inwardly facing surface 822 of the illustrated head SIP device 802 similarly includes a first side impact protection area 824 adjacent to the headrest support surface 804 and a second side impact protection area 826 extending from the first side impact protection area 824 toward a front end 814 of the headrest 800. In the illustrated, non-limiting embodiment, the inwardly facing surface 822 additionally includes a third side impact protection area 828 extending from an edge of the second side impact protection area 826. Although the third side impact protection area 828 is illustrated as extending substantially perpendicular to an interior surface 808 of the headrest side member 810, embodiments where the third side impact protection area 828 is angled toward a front 814 of the headrest 800 are also contemplated herein. The first side impact protection area 824 may be converge with the second side impact protection area 826 along a first vertical line of intersection, represented in FIG. 9A by L2a and the second side impact protection area 826 may converge with the third side impact protection area 828 along a second vertical line of intersection, represented by L2b. The line of intersection L2a of the head SIP device 802 may be positioned laterally closest to a central longitudinal axis CLA of a head receiving region 832.

[0477] A recess 830 is at least partially defined within the head receiving region 832 of the headrest 800 between the head SIP device 802 and the front 814 of the headrest 800. In the illustrated, non-limiting embodiment, the recess 830 extends from the first line of intersection, L2a, towards a plane extending laterally from an inner edge of the front end 814 of the headrest 800. This plane, represented by line P2, extending between the line of intersection L2a and the plane extending laterally from an inner edge of the front end 814 may be coplanar with the first side impact protection area 824. The recess 830 may further be defined by the plane extending laterally from an inner edge of the front end 814 of the headrest 800, the second side impact protection area 826, and the third side impact protection area 828 of the inwardly facing surface 822, as well as the surface 808 of the headrest side member 810 extending between an edge of the third side impact protection area 828 and the front end 814 of the headrest 800.

[0478] In the illustrated, non-limiting embodiment, a vertical plane, represented by axis X2 in FIG. 9A extends from the front end 814 and is positioned tangent to the inwardly facing surface 822 at the first line of intersection L2a of the inwardly facing surface 822. The axis X2 intersects the headrest support surface 804 at an intersection location I2. In an embodiment, a distance between the headrest support surface 804 and the first line of intersection L2a

measured along the axis X2 is shorter than a distance between the line of intersection L2a and the front end 814 measured along the axis X2.

[0479] Each of the embodiments illustrated in FIGS. 2A-9B, discloses at least one head SIP device formed from a rigid or semirigid material, such as expanded polystyrene for example. However, with reference to FIGS. 10A-11C in other embodiments, a head SIP device 902, 1002 associated with a head side impact protection portion 903, 1003 of a headrest 901, 1001 of a child seat 900, 1000 may be formed from a flexible or resilient material. In an embodiment, the one or more head SIP devices 902, 1002 arranged at the head SIP portion 903, 1003 illustrated are or include a structurally modifiable body that can be transformed into different configurations via changes in shape and/or structure. Examples of a structurally modifiable body include but are not limited to an expandable bladder or air bag. The structurally modifiable body 902, 1002 may be filled with a fluid, such as a liquid or air for example.

[0480] Similar to the previously disclosed embodiments, the headrest 901, 1001 may include a back portion 904, 1004, a first headrest side member 906, 1006, and a second headrest side member 908, 1008. An outwardly facing surface 910, 1010 of the structurally modifiable body 902, 1002 may be permanently or removably fixed to a portion of the headrest 901, 1001, such as an interior surface 912, 1012 of a headrest side member 908, 1008 for example. Although not shown, it should be appreciated that another head SIP device may be arranged at another portion of each headrest 901, 1001, such as at the first headrest side member 906, 1006 for example. In such embodiments, a configuration of the additional head SIP device may, but need not be identical to the head SIP device 902, 1002 illustrated and described herein.

[0481] The structurally modifiable body 902, 1002 when filled protrudes from the interior surface 912, 1012 of the headrest side member 908, 1008. Further, the structurally modifiable body 902, 1002 may be elastically deformable to absorb energy applied thereto during a crash event. As will be described in more detail below, the structurally modifiable body 902, 1002 may be permanently filled or inflated. Alternatively, the structurally modifiable body 902, 1002 may be transformable between a deflated or retracted configuration and an inflated or extended configuration, such as while an occupant is present within the child seat 900, 1000.

[0482] As shown in FIGS. 11A-11C, in an embodiment, the contour of the head SIP device 1002 is generally complementary to a portion of a headrest 1001 overlapped by the head SIP device 1002. For example, a portion 1014 of the head SIP device 1002 located near the front end 1016 and a bottom 1018 of a headrest side member 1008 may have generally rounded

contours, and a portion 1020 of the head SIP device 1002 positioned closest to a headrest upright support surface 1022 of the back portion 1004 may have a generally linear contour. In another embodiment shown in FIGS. 10A-10C, the head SIP device 902 has a substantially circular configuration. As shown, the head SIP device 902, 1002 may be positioned to substantially overlap with a majority of the headrest side member 908, 1008. The contours of a head SIP device 902, 1002 formed via a structurally modifiable body, such as a bladder or air bag for example, as described herein are intended as an example only. It should be understood that any of the other configurations of a head SIP device described herein, such as described with respect to FIGS. 2A-9B could alternatively be formed as a structurally modifiable body having the previously described shape in at least one configuration of the body.

[0483] Although each of the embodiments of FIGS. 2B-11C, illustrates only a single head SIP device at any given area of a headrest, in an embodiment, a plurality of head SIP devices may be arranged at the same area of a headrest, such as at the back portion or a respective side member of the headrest. For example, in the illustrated, non-limiting embodiment of FIGS. 12A and 12B, a first head SIP device 1102 and a second head SIP device 1104 are associated with or mounted to the same headrest side member 1106 of a headrest 1100. In such embodiments, the material, contour, shape, and/or hardness of the first and second head SIP devices 1102, 1104 may be the same, or alternatively, may be different. Indeed, the first and second head SIP devices 1102, 110 may include the material, contour, shape, and/or hardness of any of the other head SIP devices shown and discussed herein. Further, such first and second head SIP devices 1102, 1104 may be mounted to the headrest 1100 independently of one another.

[0484] In an embodiment, both the first and second head SIP devices 1102, 1104 are part of a single head SIP portion 1101. Although the first and second head SIP devices 1102, 1104 are illustrated and described at a respective headrest side member 1106, it should be appreciated that in other embodiments, another first head SIP device 1102 and second head SIP device 1104, may be arranged at another portion of the headrest 1100, such as at an opposite headrest side member (not shown). In such embodiments, a configuration of the first head SIP devices 1102 may but need not be identical and/or a configuration of the second head SIP devices 1104 may but need not be identical.

[0485] In embodiments including a plurality of head SIP devices arranged at a single surface of the headrest 1100, such as head SIP device 1102 and head SIP device 1104 for example, a recess 1110 (see FIG. 12A) may be at least partially defined within a head receiving region 1112 of the headrest 1100 by the plurality of head SIP devices 1102, 1104. As shown,

each of the first head SIP device 1102 and the second head SIP device 1104 has a respective inwardly facing surface 1120, 1122. Although the inwardly facing surfaces 1120, 1122 are illustrated as having a generally planar configuration, embodiments where at least one of the inwardly facing surfaces 1120, 1122 has a plurality of side impact protection areas (such as those discussed above in FIGS. 7A-9B) are also contemplated herein. The recess 1110 may be defined by a plane connecting a portion of the inwardly facing surface 1120 positioned laterally closest to a central longitudinal axis CLA of the headrest 1100 to the inwardly facing surface 1122 at the end of the second head SIP device 1104 positioned closest to first head SIP device 1102. The recess 1110 may further be defined by an end 1124 of the first head SIP device 1102 facing the second head SIP device 1104, the end 1126 of the second head SIP device 1104 facing the first head SIP device 1102, and a surface of the headrest side member 1106 extending therebetween.

[0486] In the previously described embodiments, the head SIP devices disposed at or adjacent to different portions of a headrest, such as opposite headrest side members for example, are separate devices individually mounted thereto. However, in other embodiments, a plurality of head SIP devices may be integrally formed as a unitary body, also referred to herein as a head SIP assembly. For example, in the non-limiting embodiment illustrated in FIGS. 13A-13E, a head SIP assembly 1202 includes a head SIP device 1204a positionable at or adjacent to a first headrest side member 1206, another head SIP device 1204b positionable at or adjacent to a second headrest side member 1208, and a connector member 1210 coupled to both head SIP devices 1204a, 1204b. In such embodiments, the head SIP devices 1204a, 1204b arranged at the opposite headrest side members 1206, 1208 may be substantially identical or may vary.

[0487] It should be appreciated that a head SIP assembly such as head SIP assembly 1202 may be associated with one or more head SIP portions of a headrest. For example, the headrest 1201 may include a first head SIP portion 1230a arranged proximate to a first headrest side member 1206, and a second head SIP portion 1230b arranged proximate to a second headrest side member 1208. When the head SIP assembly 1202 is installed within a head receiving region 1228 of the headrest 1201, the first head SIP device 1204a of the head SIP assembly 1202 may be arranged within and form at least part of the first head SIP portion 1230a and the second head SIP device 1204b may be arranged within and form at least part of the second head SIP portion 1230b.

[0488] As shown, a head SIP assembly 1202 as described herein may be configured as an insert removably connected to a child seat 1200, or alternatively, permanently connected to

the child seat 1200. The head SIP devices 1204a, 1204b of a head SIP assembly 1202 may be formed from at least one material, and the connector member 1210 may be formed from a material different than the head SIP devices 1204a, 1204b. However, embodiments where the head SIP devices 1204a, 1204b and the connector member 1210 are formed from the same material are also within the scope of the disclosure.

[0489] In an embodiment, the connector member 1210 includes a body portion 1212, positionable adjacent to a headrest support surface 1223 of the back portion 1214 of the headrest 1201, and two side portions 1216, 1218, positionable in overlapping arrangement with each headrest side member 1206, 1208, respectively. In such embodiments, an outer surface of the head SIP assembly 1202 may include a complementary contour to one or more surfaces of the headrest 1201 to which the head SIP assembly 1202 is connectable. For example, the outer surface of the head SIP assembly 1202 may be contoured to match the headrest support surface 1223, the surface of the first headrest side member 1206, and/or the surface of the second headrest side member 1208, and contact each of the headrest support surface 1223, the surface of the first headrest side member 1206, and the surface of the second headrest side member 1208. However, embodiments where the connector member 1210 is only configured to contact a portion of the headrest 1201, such as one or more of the headrest support surface, and the two headrest side members are also contemplated herein.

[0490] In the illustrated, non-limiting embodiment of FIGS. 13A-13E, each head SIP device 1204a, 1204b of the head SIP assembly 1202 may extend from the body portion 1212 of the connector member 1210, over a substantial length or even the entire length of a side portion 1216, 1218 of the head SIP assembly 1202. In the illustrated, non-limiting embodiment, the head SIP devices 1204a, 1204b extend to or substantially to the front end 1234a, 1234b of the side portions 1216, 1218. It should be appreciated that when the head SIP assembly 1202 is installed about a headrest 1201, an end of the head SIP devices 1204a, 1204b may be flush with the front ends 1233a, 1233b of the headrest 1201, or alternatively, may be offset therefrom by a distance. An outwardly facing surface 1220a, 1220b of a head SIP device 1204a, 1204b may be complementary to and abut the side portion 1216, 1218, and in some embodiments, the body portion 1212 of the connector member 1210. As shown in FIGS. 13D and 13E, the inwardly facing surface 1222a, 1222b of the head SIP devices 1204a, 1204b may be defined by a plurality of different side impact protection areas arranged at different angles relative to the headrest support surface 1223. A first side impact protection area 1224a, 1224b of each inwardly facing surface 1222a, 1222b is positioned closest to, and in some embodiments is directly adjacent to, the body portion 1212 of the connector member 1210. In the illustrated,

non-limiting embodiment, the first side impact protection area 1224a, 1224b is oriented substantially perpendicular to the body portion 1212 and the headrest support surface 1223.

[0491] As shown, a second side impact protection area 1226a, 1226b extending from the first side impact protection area 1224a, 1224b to the end of the side portions 1216, 1218 may be arranged at a non-parallel angle relative to the first side impact protection area 1224a, 1224b. In an embodiment, the angle  $\alpha$  between the first side impact protection area 1224a, 1224b and the respective second side impact protection area 1226a, 1226b is obtuse. As shown, the thickness at the second side impact protection area 1226a, 1226b of a head SIP devices 1204a, 1204b may gradually reduce toward the forward end 1230 of the head SIP assembly 1202. The angle  $\alpha$  and variation in thickness form an outward slope that increases the clearance defined by the opposing head SIP devices 1204a, 1204b over the length of the head SIP devices 1204a, 1204b.

[0492] In an embodiment, each of the head SIP devices 1204a, 1204b may form a recess 1232a, 1232b within the head receiving region 1228 of the headrest 1201, such as between the head SIP device 1204a, 1204b and a front end 1234a, 1234b of the headrest 1201. The first side impact protection areas 1224a, 1224b may abut the second side impact protection areas 1226a, 1226b at a line of intersection represented by L3a and L3b, respectively. The lines of intersection L3a and L3b may be opposing portions of the head SIP device 1204a, 1204b that are positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1228. Each recess 1232a, 1232b extends from a corresponding generally vertically oriented line of intersection L3a, L3b toward a plane extending laterally from an inner edge of the front ends 1234a, 1234b of the headrest side members 1206, 1208. A plane of each recess 1232a, 1232b extending from the lines of intersection L3a, L3b toward the planes including the front ends 1233a, 1233b, represented by lines P3a and P3b, may be coplanar with the first side impact protection surfaces 1224a, 1224b of each respective head SIP device 1204a, 1204b. The recess 1232a, 1232b may further be defined by the second side impact protection area 1226a, 1226b and the plane extending laterally from an inner edge of the front ends 1233a, 1233b.

[0493] In the illustrated, non-limiting embodiment, a vertical plane, represented by axis X3a in FIG. 13E extends from the front end 1233a of the headrest side member 1206 or the front end 1234a of a side portion 1216 and is positioned tangent to the inwardly facing surface 1222a at the line of intersection L3a. The axis X3a may intersect the headrest support surface 1204 at an intersection location I3a. Similarly, a vertical plane, represented by axis X3b extends from the front end 1233b of the headrest side member 1208 or the front end 1234b of a side portion 1218 and is positioned tangent to the inwardly facing surface 1222b at the line of



intersection L3b. The axis X3b may intersect the headrest support surface 1204 at an intersection location I3b. In an embodiment, a distance between the headrest support surface 1204 and the line of intersection L3a, L3b, is less than the distance between the line of intersection L3a, L3b and the front end 1234a, 1234b of a headrest side member 1206, 1208 measured along a respective axis X3a, X3b.

[0494] Another embodiment of a head SIP assembly 1302 mounted to a headrest 1301 is illustrated in FIG. 14. Similar to the previous embodiment, the head SIP assembly 1302 includes a connector member 1306 having a body portion 1308, a first side portion 1310 and a second side portion 1312, and head SIP devices 1304a, 1304b. The head SIP devices 1304a and 1304b are arranged adjacent to the first and second side portions 1310, 1312 of the connector member 1306, respectively, as previously described. When the head SIP assembly 1302 is mounted to a headrest 1301, the first side portion 1310 may be arranged at or adjacent to a first headrest side member 1314, the second side portion 1312 may be in overlapping arrangement with a second headrest side member 1316, and the body portion 1308 is arranged at a headrest support surface of a back portion 1318 of the headrest 1301. In the illustrated, non-limiting embodiment of FIG. 14, each head SIP device 1304a, 1304b of the head SIP assembly 1302 may extend from the body portion 1308 of the connector member 1306, over at least half of a length of a side portion 1310, 1312 of the head SIP assembly 1302, and in some embodiments, over a substantially entire length of a side portion 1310, 1312 of the head SIP assembly 1302. However, the side portion 1310, 1312 of the connector member 1306 may have a length equal to or different from a length of a corresponding headrest side member 1314, 1316.

[0495] Similar to the previous embodiment, each head SIP device 1304a, 1304b includes an inwardly facing surface 1320a, 1320b including a first side impact protection area 1322a, 1322b positioned closest to the body portion 1308 of the connector member 1306 and a second side impact protection area 1324a, 1324b extending forward, away from the first side impact protection area 1322a, 1322b. In the illustrated, non-limiting embodiment, the first side impact protection area 1322a, 1322b is arranged at a non-perpendicular angle relative to the body portion 1308. In an embodiment, the angle  $\beta$  between the body portion 1308 and the first side impact protection area 1322a, 1322b may be between about 65 and about 85 degrees. The second side impact protection area 1324a, 1324b extending from the first side impact protection area 1322a, 1322b at a line of intersection L4a, L4b may have a curved configuration, such as a concave curvature for example. As a result, the thickness of the head SIP device 1304a, 1304b gradually decreases over the second side impact protection area 1324a, 1324b toward a front

end 1326a, 1326b of the headrest 1301. The line of intersection L4a, L4b may be the portion of the head SIP device 1304a, 1304b positioned closest to a central longitudinal axis CLA of a head receiving region 1328 (in a lateral direction).

[0496] In an embodiment, each of the head SIP devices 1304a, 1304b may form a recess 1330a, 1330b within the head receiving region 1328 of the headrest 1201 for guiding movement of an occupant's head during a side impact event. Each recess 1330a, 1330b extends from a corresponding line of intersection L4a, L4b toward a plane extending laterally from an inner edge of the front ends 1326a, 1326b of the headrest side members 1314, 1316. The plane of the recess 1330a, 1330b extending from the line of intersection L4a, L4b toward the plane extending laterally from an inner edge of the front ends 1326a, 1326b, represented by lines P4a and P4b, may be coplanar with the first side impact protection surface 1322a, 1322b of each respective head SIP device 1304a, 1304b. The recess 1330a, 1330b may further be defined by the second side impact protection area 1324a, 1324b, and by a surface of at least one of the side portions 1310, 1312 and the headrest side members 1314, 1316 extending between the edge of a respective second side impact protection area 1324a, 1324b and a front end 1326a, 1326b of the headrest 1301.

[0497] In the illustrated, non-limiting embodiment, a vertical plane, represented by axis X4a from the front end 1326a of the headrest side member 1314 and is positioned tangent to the inwardly facing surface 1320a at the line of intersection L4a. Further, the axis X4a may intersect the headrest support surface 1304, or the adjacent body portion 1308 of the connector member 1306, at an intersection location I4a. Another vertical plane, represented by axis X4b extends from the front end 1326b of the headrest side member 1316 and is positioned tangent to the inwardly facing surface 1320b at the line of intersection L4b. The axis X4b may intersect the headrest support surface 1304 or the adjacent body portion 1308 at an intersection location I5b. In an embodiment a distance between the headrest support surface 1304 and the line of intersection L4a, L4b, is less than the distance between the line of intersection L5a, L5b and the front end 1326a, 1326b of a headrest side member 1314, 1316 measured along a respective axis X4a, X4b.

[0498] With reference now to FIGS. 15A-15E, another example of a head SIP assembly 1402 having head SIP devices 1404a, 1404b is shown. The head SIP devices 1404a and 1404b are respectfully arranged adjacent to a first side portion 1408 and the second side portion 1410 of a connector member 1406 of the head SIP assembly 1402. The connector member 1406 also includes a body portion 1416 that connects the first side portion 1408 and second side portion 1410. As shown, the head SIP assembly 1402 is positionable adjacent to a headrest 1401 such

that the first side portion 1408 is arranged at or adjacent to a first headrest side member 1412, the second side portion 1410 is arranged at or adjacent to a second headrest side member 1414, and the body portion 1416 is arranged at a headrest support surface 1418 of a back portion 1420 of the headrest 1401.

[0499] Each head SIP device 1404a, 1404b includes an inwardly facing surface 1420a, 1420b including a first side impact protection area 1422a, 1422 positioned closest to the body portion 1416 and a second side impact protection area 1424a, 1424b extending forward, away from the first side impact protection area 1422a, 1422. As shown, the first side impact protection area 1422a, 1422 may be arranged substantially perpendicular to the body portion 1416 of the connector member 1406 and the headrest support surface 1418. A second side impact protection area 1424a, 1424b extending from the first side impact protection area 1422a, 1422 may be arranged at a non-parallel angle relative to the first side impact protection area 1422a, 1422. In an embodiment, the angle  $\alpha$  (see FIG. 15E) between the first side impact protection area 1422a, 1422 and the second side impact protection area 1424a, 1424b is obtuse (e.g., greater than 90 degrees).

[0500] In the illustrated, non-limiting embodiment, the head SIP devices 1404a, 1404b are mounted near a rear of the head SIP assembly 1402, such as at an interface between the body portion 1416 and the side portions 1408, 1410 of the connector member 1406 for example. Each head SIP device 1404a, 1404b may extend over only a portion of a length of each side portion 1408, 1410 and/or headrest side member 1412, 1414. As shown, the head SIP devices 1404a, 1404b may extend to a center of a side portion 1408, 1410 and/or headrest side member 1412, 1414. In the illustrated, non-limiting embodiment, at least one head SIP device 1404a, 1404b extends over less than half of the length of a respective side portion 1408, 1410. However, embodiments where the at least one head SIP device 1404a, 1404b is longer or shorter are also contemplated herein.

[0501] As a result of the positioning and configuration of the head SIP devices 1404a, 1404b, the side portions 1408, 1410 of the connector member 1406 may extend beyond an end of the head SIP devices 1404a, 1404b toward a front end of the headrest 1401 as shown. In other embodiments, an end of the side portions 1408, 1410 of the connector member 1406 may be flush with the head SIP devices 1404a, 1404b. As shown in FIGS. 15A-15E, a length of the side portions 1408, 1410 of the connector member 1406 may be equal to the headrest side members 1412, 1414. However, in other embodiments, the side portions 1408, 1410 will be shorter than the headrest side members 1412, 1414. Accordingly, in such a configuration, the

headrest side members 1412, 1414 will extend beyond the side portions 1408, 1410 of the connector member 1406.

[0502] In the illustrated, non-limiting embodiment, the head SIP device 1404a forms a first recess 1430a within the head receiving region 1428 and the head SIP device 1404b forms a second recess 1430b within the head receiving region 1428. The first side impact protection area 1422a, 1422b may abut the second side impact protection area 1424a, 1424b of each head SIP device 1401a, 1404b at a generally vertical line of intersection represented by L5a and L5b (FIG. 15C), respectively. The line of intersection L5a, L5b may be the portion of the head SIP device 1404a, 1404b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1428.

[0503] The first recess 1430a is partially defined by the second side impact protection area 1424a and a plane extending laterally from an inner edge of the front ends 1432a, 1432b of the headrest side members 1412, 1414. A surface of either the side portion 1408 or the headrest side member 1412 extending between the edge of a respective second side impact protection area 1424a and the front end 1432a may also partly define the first recess 1430a. The recess 1430a may further be defined by a plane, represented by line P5a, extending from the line of intersection L6a to the plane extending laterally from an inner edge of the front ends 1232a, 1432b of the headrest side members 1412, 1414. This plane of the recess 1430a, extending from the line of intersection L5a toward the plane extending laterally from an inner edge of the front end 1432a may be coplanar with the first side impact protection area 1422a of the head SIP device 1404a.

[0504] Similarly, the second recess 1430b extends from the line of intersection L6b toward the plane extending laterally from an inner edge of the front ends 1432a, 1432b of the headrest side members 1412, 1414. The plane of the recess 1430b extending from the line of intersection L5b toward the plane extending laterally from an inner edge of the front ends 1432b, represented by line P5b, may be coplanar with the first side impact protection area 1422b of the head SIP device 1404b. The recess 1430b may further be defined by the plane extending laterally from an inner edge of the front ends 1432a, 1432b, the second side impact protection area 1424b, and by a surface of at least one of a side portion 1410 and a headrest side member 1414 extending between the edge of a respective second side impact protection area 1424b and the front end 1432b.

[0505] With reference to FIG. 15C, a vertical plane, represented by axis X5a extends from the front end 1432a of the headrest side member 1412 and is positioned tangent to the inwardly facing surface 1420a at the line of intersection L5a. Further, the axis X5a may

intersect the headrest support surface 1404 or the adjacent body portion 1416 of the connector member 1406 at an intersection location I5a. Another vertical plane, represented by axis X5b extends from the front end 1432b of the headrest side member 1414 and is positioned tangent to the inwardly facing surface 1420b at the line of intersection L5b. The axis X5b may intersect the headrest support surface 1404 or the adjacent body portion 1416 at an intersection location I5b. In an embodiment a distance between the intersection location I5a, I5b and the line of intersection L5a, L5b, is less than the distance between the line of intersection L5a, L5b and the front end 1432a, 1432b of a headrest side member 1412, 1414 measured along a respective axis X5a, X5b.

[0506] It should be appreciated that each of the embodiments disclosed in FIGS. 5A-9B and 12A-15E includes a head SIP device positioned at or adjacent to the back portion of the headrest. Embodiments where a head SIP device is located at the body portion of a head SIP assembly may similarly be considered positionable adjacent to the back portion of the headrest. A head SIP device having such a configuration defines a recess within the head receiving region of the headrest extending between at least one surface of the head SIP device and the front of the headrest.

[0507] With reference now to FIGS. 16A-16E, embodiments where a head SIP device is spaced or offset from the front of the headrest, such as toward the back of the head receiving region are also configured to define a recess within the head receiving region of the headrest. A head SIP assembly 1502 of a headrest 1501 shown in FIGS. 16A-16E includes head SIP devices 1504a and 1504b. The head SIP devices 1504a and 1504b are respectfully arranged adjacent to a first side portion 1508 and the second side portion 1510 of a connector member 1506 of the head SIP assembly 1502. The connector member 1506 also includes a body portion 1512 that connects the first side portion 1508 and second side portion 1510. Similar to the previous embodiments, the head SIP assembly 1502 is positionable adjacent to a headrest 1501 such that the first side portion 1508 is arranged at or adjacent to a first headrest side member 1514, the second side portion 1510 is arranged at or adjacent to a second headrest side member 1516, and the body portion 1512 is arranged at a headrest support surface 1518 of a back portion 1519 of the headrest 1501.

[0508] In the illustrated, non-limiting embodiment, a first and second head SIP device 1504a, 1504b of the head SIP assembly 1502 may be considered to be mounted near a front 1503a, 1503b of a headrest 1501, such as via the connector member 1506. Such a configuration of a head SIP device 1504a, 1504b may be particularly suitable for embodiments where the child seat 1500 is in a forward-facing orientation relative to a vehicle seat. As shown, the head

SIP devices 1504a, 1504b may be respectively positioned at locations at or proximate to front ends 1511a, 1511b of a side portion 1508, 1510 of the connector member 1506. The head SIP devices 1504a and 1504b may respectively extend from a center of the side portions 1508, 1510 to the front ends 1511a and 1511b. In the illustrated, non-limiting embodiment, at least one head SIP device 1504a, 1504b extends over less than half of the length of a respective side portion 1508, 1510. However, embodiments where the at least one head SIP device 1504a, 1504b is longer or shorter are also contemplated herein.

[0509] An outwardly facing surface 1520a, 1520b of a respective head SIP device 1504a, 1504b may be parallel with and mounted to a respective side portion 1508, 1510 of the connector member 1506. The inwardly facing surfaces 1522a, 1522b of a head SIP device 1504a, 1504b may be defined by a plurality of different side impact protection areas arranged at different angles relative to the headrest support surface 1518. In the illustrated, non-limiting embodiment, the surface 1522a, 1522b includes a first side impact protection area 1524a, 1524b oriented parallel to, or substantially parallel to, the body portion 1512 of the connector member 1506 and the headrest support surface 1518. In other embodiments, the first side impact protection area 1524a, 1524b may be arranged at an angle  $\beta$  between 3 degrees and 30 degrees relative to the body portion 1512. A second side impact protection area 1526a, 1526b of the inwardly facing surface 1522a, 1522b extending from the first side impact protection area 1524a, 1524b may have a generally rounded or curved contour, such as a convex curvature for example. In an embodiment, a thickness of the head SIP devices 1504a, 1504b may gradually reduce from the first side impact protection area 1524a, 1524b toward a respective forward end 1511a, 1511b of the head SIP assembly 1502. A first side impact protection area 1524a, 1524b may abut an adjacent second side impact protection area 1526a, 1526b at a generally vertically oriented line of intersection, illustrated at L6a, L6b. The lines of intersection L6a, L6b may be the portion of the head SIP device 1504a, 1504b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1528.

[0510] In the illustrated, non-limiting embodiment, a recess is formed within the head receiving region between a head SIP device 1504a, 1504b and a front 1503a, 1503b of the headrest 1501. As shown in FIG. 16E, each recess 1530a, 1530b may extend from a portion of the head SIP device 1504a, 1504b positioned closest to a central longitudinal axis CLA of a head receiving region 1528 to a plane extending laterally from an inner edge of the front ends 1503a, 1503b of the headrest 1501. In the illustrated, non-limiting embodiment, the portion of the head SIP device 1504a, 1504b positioned closest to a central longitudinal axis CLA is the respective line of intersection L6a, L6b. A plane defining a side of the recess 1530a, 1530b

extending from the line of intersection L6a, L6b toward the plane extending laterally from an inner edge of the front 1503a, 1503b, represented by lines 1540a, 1540b, respectively, may be parallel to the central longitudinal axis CLA. The recesses 1530a, 1530b may be further defined by the plane extending laterally from an inner edge of the front end 1503a, 1503b of the headrest 1501, the second side impact protection area 1526, 1526b, and at least one of a surface of a side portion 1508, 1510 and a headrest side member 1514, 1516 extending between the edge of a respective second side impact protection area 1526, 1526b and the front 1503a, 1503b of the headrest 1501.

[0511] As shown in FIG. 16C, a vertical plane, represented by axis X6a extends from the front 1503a of the headrest 1501 and is positioned tangent to the inwardly facing surface 1522a at the line of intersection L6a and another vertical plane, represented by axis X6b extends from the front 1503b of the headrest 1501 and is positioned tangent to the inwardly facing surface 1522b at the line of intersection L6b. The axes X6a, X6b intersect the headrest support surface 1504 or the adjacent body portion 1512 of the connector member 1506 at an intersection location I6a, I6b, respectively. In an embodiment, a distance between the intersection location I6a, I6b and the line of intersection L6a, L6b of each head SIP device 1504a, 1504b, is greater than the distance between the line of intersection L6a, L6b and the front 1503a, 1503b of the headrest 1501.

[0512] Yet another embodiment of a head SIP assembly 1602 mountable to a headrest 1601 of a child seat 1600 is illustrated in FIGS. 17A-17E. Similar to the previous embodiment, first and second head SIP devices 1604a, 1604b are mounted at an end of a connector member 1606, such as at or proximate a front end 1608 of the side portions 1610, 1612 of the connector member 1606. In an embodiment, when the head SIP assembly 1602 is installed about the headrest 1601, the head SIP devices 1604a, 1604b are positioned at or near a front 1603 of the headrest 1601. In the illustrated, non-limiting embodiment, at least one head SIP device 1604a, 1604b extends over less than half of the length of a respective side portion 1610, 1612. However, embodiments where the at least one head SIP device 1604a, 1604b is longer or shorter are also contemplated herein.

[0513] A surface 1620a, 1620b of a head SIP device 1604a, 1604b may be positioned in contact with and parallel to a side portion 1610, 1612 of the connector member 1606. An inwardly facing surface 1622a, 1622b of a head SIP device 1604a, 1604b according to the present embodiment includes a first side impact protection area 1624a, 1624b positioned closest to a body portion 1614 of the connector member 1606 and a second side impact

protection area 1626a, 1626b located near a respective front end 1608a, 1608b of the connector member 1606.

[0514] The first side impact protection area 1624a, 1624b may be oriented at a non-parallel angle relative to both a respective side portion 1610, 1612 of the connector member 1606 and the body portion 1614 extending between and connecting the side portions 1610, 1612. In an embodiment, the first side impact protection area 1624a, 1624b extends relatively inwardly, away from a respective side portion 1610, 1612. However, in other embodiments, the first side impact protection area 1624a, 1624b of a head SIP device 1604a, 1604b may have a curved configuration, such as a concave curvature or configuration or a convex curvature or configuration for example. The second side impact protection area 1626a, 1626b of the inwardly facing surface 1622a, 1622b extends from and is arranged at an angle relative to the first side impact protection area 1624a, 1624b. In an embodiment, the second side impact protection area 1626a, 1626b is oriented substantially perpendicular to the body portion 1614, or alternatively or additionally, is arranged substantially parallel to the adjacent side portion 1610, 1612 of the connector member 1606. However, embodiments where the second side impact protection area 1626a, 1626b is arranged at a non-parallel angle, such as an acute angle for example, are also contemplated herein. As shown, a distance between the head SIP devices 1604a, 1604b generally decreases toward a front end 1603 of the headrest.

[0515] With reference now to FIGS. 18A-18E, another embodiment of a head SIP assembly 1702 of a headrest 1701 of a child seat 1700 is illustrated. Similar to the embodiment of FIGS. 17A-17E, , the head SIP assembly 1702 includes first and second head SIP devices 1704a, 1704b located at distal ends of a connector member 1706, such as near front ends 1708a, 1708b of a respective side portion 1709, 1710. In the illustrated, non-limiting embodiment, a contour of inwardly facing surfaces 1720a, 1720b of a head SIP device 1704a, 1704b may vary between relative tops 1712a, 1712b and bottoms 1714a, 1714b of the head SIP device 1704a, 1704b. For example, a first side impact protection area 1722a, 1722b, located near the first, upper end 1712 of a head SIP device 1704a, 1704b may be oriented substantially parallel to the adjacent side portion 1709, 1710 of the connector member 1706. A second side impact protection area 1724a, 1724b, extending from the first side impact protection area 1722a, 1722b toward the relative bottoms 1714 of the head SIP device 1704a, 1704b may be arranged at a non-parallel angle relative to the first side impact protection area 1722. In an embodiment, the angle between the first side impact protection area 1722 and the second area 1724 is obtuse.

[0516] Although the second side impact protection area 1724 is illustrated as having a planar surface or configuration, in other embodiments, the second side impact protection area



1724 of the head SIP device 1704a, 1704b may have a curved configuration, such as a convex curvature for example. Regardless of whether the second side impact protection area 1724 has a linear or curved configuration, a thickness of the head SIP device 1704a, 1704b at the second side impact protection area 1724 may gradually reduce toward the bottom of the headrest 1701. This variation over the height of the head SIP device 1704a, 1704b may be combined with any of the other configurations extending between a front and back of a head SIP device as previously described (or as will be described later).

[0517] As an alternative to, or in addition to a head SIP assembly having a plurality of head SIP devices arranged at opposite and interconnected side portions of a connector member as previously described herein, the head SIP assembly may include a plurality of head SIP devices arranged at the same surface of the connector member, such as at the same side portion for example. In such embodiments, the plurality of head SIP devices arranged at the same side portion of a connector member may but need not be mounted to form a continuous inwardly facing surface.

[0518] With reference to FIGS. 19A-19E, a head SIP assembly 1802 mountable to a headrest 1801 is shown. A plurality of head SIP devices are arranged at a same surface of a connector member 1808. In the illustrated, non-limiting embodiment, a first head SIP device 1804a and a second head SIP device 1806a are arranged at a first side portion 1810 of a connector member 1808, and a first head SIP device 1804b and a second head SIP device 1806b are arranged at a second side portion 1812 of a connector member 1808. In such embodiments, the first head SIP devices 1804a, 1804b may include configurations (size and/or shape) that are the same or different from each other and/or the second head SIP devices 1806a, 1806b at the same side portions 1810 or 1812. Further, the first head SIP devices 1804a, 1804b may include materials that are the same or different from each other and/or the second head SIP devices 1806a, 1806b arranged at the same side portions 1810, 1812. In an embodiment, the second head SIP devices 1806a, 1806b have a reduced hardness compared to the first head SIP devices 1804a, 1804b. However, all of the first and second head SIP devices 1804a, 1804b, 1806a, 1806b are configured to absorb energy during a crash event. Although not shown, it should be understood that the first and second head SIP devices 1804a and 1806a may be arranged within a first SIP head portion and the first and second head SIP devices 1804b and 1806b are arranged within a second SIP portion.

[0519] The first head SIP devices 1804a, 1804b and the second head SIP devices 1806a, 1806b may have any suitable configuration. In the illustrated, non-limiting embodiment, the first head SIP devices 1804a and 1804b have a configuration substantially similar to that of

FIGS. 15A-15E. As shown in FIG. 19E, each head SIP device 1804a, 1804b includes an inwardly facing surface 1820a, 1820b including a first side impact protection area 1822a, 1822b positioned closest to a body portion 1814 of the connector member 1808 and a second side impact protection area 1824a, 1824b extending forward, away from the first side impact protection area 1822a, 1822b. As shown, the first side impact protection area 1822a, 1822b may be arranged substantially perpendicular to the body portion 1814. The second side impact protection area 1824a, 1824b extending from the first side impact protection area 1822a, 1822b may be arranged at a non-parallel angle relative to the first side impact protection area 1822a, 1822b. The angle between the first side impact protection area 1822a, 1822b and the second side impact protection area 1824a, 1824b may be greater than 90 degrees.

[0520] The second head SIP devices 1806a, 1806b may have an outer surface 1830a, 1830b complementary to the side portion 1810, 1812. An inwardly facing surface 1832a, 1832b of the second head SIP devices 1806a, 1806b may be oriented substantially parallel to the outer surface 1830a, 1830b and/or the side portion 1810, 1812 over a length of the second head SIP device 1806a, 1806b. Accordingly, a thickness of a second head SIP device 1806a, 1806b may be substantially uniform over a length thereof. Although respective back ends 1834a, 1834b of the second head SIP device 1806a, 1806b are shown abutting only a portion of an adjacent first head SIP device 1804a, 1804b, in some embodiments, the back end 1834a, 1834b of a second head SIP device 1806a, 1806b may have a contour complementary to the adjacent end of a respective first head SIP device 1804a, 1804b.

[0521] In an embodiment, each of the first head SIP devices 1804a, 1804b may form a recess 1840a, 1840b within the head receiving region 1842 of the headrest 1801 for guiding movement of an occupant's head during a side impact event. A first side impact protection area 1822a, 1822b of an inwardly facing surface 1820a, 1820b of a respective first head SIP device 1804a, 1804b may abut the second side impact protection area 1824a, 1824b at a generally vertical line of intersection represented by L7a and L7b, respectively. The line of intersection L7a, L7b may be the portion of the head SIP device 1804a, 1804b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1842.

[0522] A side of each recess 1840a, 1840b may extend from a corresponding line of intersection L7a, L7b toward a plane extending laterally from an inner edge of the front ends 1842a, 1842b of the headrest side members 1844, 1846. The plane of the recess 1840a, 1840b extending from the line of intersection L7a, L7b toward the plane extending laterally from an inner edge of the front ends 1842a, 1842b, represented by lines P7a and P7b respectively, may be coplanar with the first side impact protection surface 1822a, 1822b of each respective first

head SIP device 1804a, 1804b. The recess 1840a, 1840b may further be defined by the second side impact protection area 1824a, 1824b, the plane extending laterally from the inner edge of the front ends 1842a, 1842b, and by a surface of at least one of the side portions 1810, 1812 and the headrest side members 1844, 1846 extending between the edge of a respective second side impact protection area 1824a, 1824b and a front end 1842a, 1842b.

[0523] In the illustrated, non-limiting embodiment, a vertical plane, represented by axis X7a extends from the front end 1842a of the headrest side member 1844 and is positioned tangent to the inwardly facing surface 1820a at the line of intersection L7a. Further, the axis X7a may intersect the headrest support surface 1804, or the adjacent body portion 1814 of the connector member 1808 at an intersection location I7a. Another vertical plane, represented by axis X7b extends from the front end 1842b of the headrest side member 1846 and is positioned tangent to the inwardly facing surface 1820b at the line of intersection L7b. The axis X7b may intersect the headrest support surface 1804 or the adjacent body portion 1814 at an intersection location I7b. In an embodiment a distance between the headrest support surface 1804 and the line of intersection L7a, L7b, is less than the distance between the line of intersection L7a, L7b and the front end 1842a, 1842b of a headrest side member 1844, 1846 measured along a respective axis X7a, X7b. In the illustrated, non-limiting embodiment, the second head SIP device 1806a is arranged within the recess 1840a formed by the first head SIP device 1804a. Similarly, the second head SIP device 1806b is arranged within the recess 1840b formed by the first head SIP device 1804b.

[0524] In the non-limiting embodiment of a head SIP assembly 1902 illustrated in FIGS. 20A-20E, each side portion 1906, 1908 of a connector member 1904 of the head SIP assembly 1902 is similarly associated with a plurality of head SIP devices. As shown, the head SIP assembly 1902 includes a plurality of first head SIP devices 1910a, 1910b positioned proximate a relative rear of the connector member 1904, such as proximate interfaces between respective side portions 1906, 1908 and a body portion 1909. In an embodiment, the first head SIP devices 1910a, 1910b have a configuration substantially identical to those of the previous embodiment (FIGS. 19A-19E) and disclosed in FIGS. 15A-15E. In such a configuration, each first head SIP device 1910a, 1910b includes an inwardly facing surface 1912a, 1912b including a first side impact protection area 1914a, 1914b positioned closest to the body portion 1909 of the connector member 1904 and a second side impact protection area 1916a, 1916b extending forward, away from the first side impact protection area 1914a, 1914b. As shown, the first side impact protection area 1914a, 1914b may be arranged substantially perpendicular to the body portion 1909. The second side impact protection area 1916a, 1916b extending from the first

side impact protection area 1914a, 1914b may be arranged at a non-parallel angle relative to the first side impact protection area 1914a, 1914b. The angle between the first side impact protection area 1914a, 1914b and the second side impact protection area 1916a, 1916b may be greater than 90 degrees.

[0525] In addition, respective second head SIP devices 1920a, 1920b may be mounted to each side portion 1906, 1908 of the head SIP assembly 1902, such that the second head SIP devices 1920a, 1920b are proximate the front ends 1918a, 1918b of headrest side members 1940, 1942 when the head SIP assembly 1902 is mounted to the headrest 1901. The second head SIP devices 1920a, 1920b may have a configuration substantially identical to the SIP devices previously disclosed in FIGS. 16A-16E. An inwardly facing surface 1922a, 1922b of a respective second head SIP device 1920a, 1920b may be defined by a plurality of different areas arranged at different angles relative to the body portion 1909. In the illustrated, non-limiting embodiment, the surface 1922a, 1922b includes a first side impact protection area 1924a, 1924b oriented parallel to, or substantially parallel to, the body portion 1909 of the connector member 1904. A second side impact protection area 1926a, 1926b of the inwardly facing surface 1922a, 1922b extending from the first side impact protection area 1924a, 1924b may have a generally rounded or curved contour, such as a convex curvature for example. In an embodiment, a thickness of the head SIP devices 1920a, 1920b may gradually reduce from the first side impact protection area 1924a, 1924b toward a respective forward end 1918a, 1918b of the head SIP assembly 1902.

[0526] As shown, a clearance may exist between the first head SIP devices 1910a, 1910b and the second head SIP devices 1920a, 1920b at each side portion 1906, 1908. A combination of separate first and second head SIP devices 1910a, 1910b, 1920a, 1920b positioned near the front and rear of the connector member 1904 may be suitable to absorb energy during a crash, regardless of a direction that the child seat is mounted relative to a vehicle seat.

[0527] A first recess 1930a, 1930b (see FIGS. 20C and 20E) may be at least partially defined within a head receiving region 1928 of the headrest 1901 by the plurality of head SIP devices 1910a, 1910b, 1920a, 1920b. As shown, each first head SIP device 1910a, 1910b and each second head SIP device 1920a, 1920b has a respective inwardly facing surface 1912a, 1912b, 1922a, 1922b. The first recess 1930a, 1930b may be defined, in part, by a plane extending from a respective line of intersection L8a, L8b of the first head SIP devices 1910a, 1910b, to a respective line of intersection L9a, L9b of the second head SIP devices 1920a, 1920b. The generally vertical lines of intersection L8a, L8b may be the portion of the head SIP

device 1910a, 1910b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1928. Similarly, the generally vertical lines of intersection L9a, L9b may be the portion of the head SIP device 1920a, 1920b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 1928.

[0528] The first recesses 1930a, 1930b may be further defined by the second side impact protection area 1916a, 1916b of the first head SIP devices 1910a, 1910b, the first side impact protection area 1924a, 1924b of the second head SIP devices 1920a, 1920b, and a surface of the side portion 1906, 1908 extending therebetween. In an embodiment, each of the second head SIP devices 1920a, 1920b may form a recess 1932a, 1932b within the head receiving region 1928 of the headrest 1901. The first side impact protection area 1924a, 1924b of the inwardly facing surface 1922a, 1922b of a respective second head SIP device devices 1920a, 1920b may abut the second side impact protection area 1926a, 1926b at a line of intersection represented by L9a and L9b, respectively.

[0529] Each recess 1932a, 1932b may extend from a corresponding line of intersection L9a, L9b toward a plane extending laterally from an inner edge of the front ends 1918a, 1918b of the headrest side members 1940, 1942. This plane extending from the line of intersection L9a, L9b toward the plane extending laterally from an inner edge of the front ends 1918a, 1918b, represented by lines 1939a, 1939b, may be parallel to the CLA. The recess 1932a, 1932b may further be defined by the second side impact protection area 1926a, 1926b, the plane extending laterally from an inner edge of the front ends 1918a, 1918b, and by at least one of a surface of the side portions 1906, 1908 and a surface of the headrest side members 1940, 1942 extending between the edge of a respective second side impact protection area 1926a, 1926b and a front end 1918a, 1918b.

[0530] Similar to the previous embodiment, in the non-limiting embodiment illustrated in FIGS. 21A-21E, each side portion 2006, 2008 of a connector member 2004 of the head SIP assembly 2002 is associated with a plurality of head SIP devices. As shown, the head SIP assembly 2002 includes a plurality of first head SIP devices 2010a, 2010b positioned proximate a relative rear of the connector member 2004, such as proximate interfaces between respective side portions 2006, 2008 and a body portion 2009. A plurality of second head SIP devices 2012a, 2012b may be positioned proximate a front of the connector member 2004, such as proximate ends 2014a, 2014b of the side portions 2006, 2008. In an embodiment, the first head SIP devices 2010a, 2010b arranged proximate the rear of the connector member 2004 are interconnected with the second head SIP devices 2012a, 2012b arranged proximate respective front ends 2014a, 2014b of the connector member 2004. The first head SIP devices 2010a,

2010b may include configurations substantially similar to the head SIP device disclosed in FIGS. 15A-15E, 19A-19E, and 20A-20E.

[0531] For example, each first head SIP device 2010a, 2010b includes an inwardly facing surface 2013a, 2013b including a first side impact protection area 2016a, 2016b positioned closest to the body portion 2009 and a second side impact protection area 2018a, 2018b extending forward, away from the first area 2016a, 2016b. As shown, the first side impact protection area 2016a, 2016b may be arranged substantially perpendicular to the body portion 2009 of the connector member 2004. The second side impact protection area 2018a, 2018b extending from the first side impact protection area 2016a, 2016b may be arranged at a non-parallel angle relative to the first side impact protection area 2016a, 2016b. In an embodiment, the angle  $\alpha$  between the first side impact protection area 2016a, 2016b and the second side impact protection area 2018a, 2018b is greater than 90 degrees.

[0532] The second head SIP devices 2012a, 2012b may have configurations substantially similar to the SIP device illustrated in described in FIGS. 13A-13E. However, as shown, the second SIP devices 2012a, 2012b may extend from the first head SIP devices 2010a, 2010b to or proximate to the front ends 2034a, 2034b of the headrest side members 2036, 2038. Surfaces 2020a, 202b of the second head SIP devices 2012a, 2012b may include a plurality of different side impact protection areas arranged at different angles. First side impact protection areas 2022a, 2022b of a respective surface 2020a, 2020b of the second head SIP device 2012a, 2012b may be oriented substantially perpendicular to the body portion 2009. The first side impact protection area 2022a, 2022b of the second head SIP devices 2012a, 2012b may be laterally offset from a first side impact protection area 2016a, 2016b of the adjacent first head SIP devices 2010a, 2010b such that a lateral clearance D1 between the first side impact protection area 2022a, 2022b of aligned second head SIP devices 2012a, 2012b of the head SIP assembly 2002 is greater than a lateral clearance D2 between the first side impact protection area 2016a, 2016b of aligned first head SIP devices 2010a, 2010b of the head SIP assembly 2002. Respective second side impact protection areas 2024a, 2024b of the surfaces 2020a, 2020b of the second head SIP device 2012a, 2012b extend from the first side impact protection areas 2022a, 2022b toward the front of the headrest 2001. Further, the second side impact protection area 2024a, 2024b may have a smooth or curved contour, such as a convex curvature. In an embodiment, a thickness of the second SIP device 2012a, 2012b at the second side impact protection area 2024a, 2024b gradually reduces toward the front end 2013a, 2013b of the connector member 2004.

[0533] It should be appreciated that the material or hardness of the first head SIP devices 2010a, 2010b may be the same or may be different than the hardness of the second head SIP devices 2012a, 2012b, regardless of whether the first head SIP device 2010a, 2010b and the second head SIP device 2012a, 2012b are separately located about a connector member 2004 or are interconnected.

[0534] A contoured recess 2030a, 2030b for controlling movement of an occupant's head during a side impact event (see FIGS. 21C and 21E) may be at least partially defined within a head receiving region 2028 of the headrest 2001 by the plurality of head SIP devices 2010a, 2010b, 2012a, 2012b. As shown, each first head SIP device 2010a, 2010b and each second head SIP device 2012a, 2012b has a respective inwardly facing surface 2013a, 2013b, 2020a, 2020b. The first recess 2030a, 2030b may be defined, in part, by a plane extending from a respective line of intersection L10a, L10b of the first head SIP devices 2010a, 2010b, to a respective line of intersection L11a, L11b of the second head SIP devices 2012a, 2012b. The generally vertical lines of intersection L10a, L10b, L11a, L11b may represent a portion of each head SIP device 2010a, 2010b, 2012a, 2012b positioned laterally closest to a central longitudinal axis CLA of the head receiving region 2028 of the headrest 2001. The first recesses 2030a, 2030b may be further defined by the second side impact protection area 2018a, 2018b of the first head SIP devices 2010a, 2010b, the first side impact protection area 2022a, 2022b of the second head SIP devices 2012a, 2012b, and a surface of the side portion 2006, 2008 extending therebetween.

[0535] Each of the second head SIP devices 2012a, 2012b may also form a recess 2032a, 2032b within the head receiving region 2028 of the headrest 1901. The first side impact protection area 2022a, 2022b of the inwardly facing surface 2020a, 2020b of a respective second head SIP device devices 2012a, 2012b may abut the second side impact protection area 2018a, 2018b at a line of intersection represented by L11a and L11b, respectively. Each recess 2032a, 2032b may be partially defined by a plane extending from a corresponding line of intersection L11a, L11b toward a plane extending laterally from an inner edge of the front ends 2034a, 2034b of the headrest side members 2036, 2038. This plane extending from the line of intersection L11a, L11b toward the plane extending laterally from the inner edge of the front ends 2034a, 2034b may be coplanar with the first side impact protection surface 2022a, 2022b of each respective second head SIP device 2012a, 2012b. The recess 2032a, 2032b may further be defined by the second side impact protection area 2024a, 2024b, the plane extending laterally from the inner edge of the front ends 2034a, 2034b, and at least one of a surface of the side portions 2006, 2008 and a surface of the headrest side members 2036, 2038 extending

between the edge of a respective second side impact protection area 2024a, 2024b and a front end 2034a, 2034b.

[0536] With reference now to FIGS. 22A-22E, another embodiment of a head SIP assembly 2102 having a first head SIP device 2104a, 2104b and a second head SIP device 2106a, 2106b arranged at respective side portions 2108, 2110 of a connector member 2111 is illustrated. The first head SIP devices 2104a, 2104b may have an inwardly facing surface 2112a, 2112b including a first side impact protection area 2114a, 2114b and a second side impact protection area 2116a, 2116b arranged at a non-parallel angle to one another. A generally vertical line of intersection L12a, L12b is arranged at the interface between the first and second side impact protection areas 2114a, 2114b, 2116a, 2116b, respectively. The line of intersection L12a, L12b may be the portion of the first head SIP device 2104a, 2104b positioned laterally closest to a central longitudinal axis CLA of a head receiving region. Further, a distance between the line of intersection L12a, L12b and the back portion 2138 of the headrest 2101 may be less than a distance between the line of intersection L12a, L12b and a front end 2130a, 2130b of the headrest side members 2132, 2134 measured along a line extending from a respective front end 2130a, 2130b and positioned tangent to the line L12a, L12b.

[0537] The second head SIP devices 2106a, 2106b have an inwardly facing surface 2118a, 2118b including a first side impact protection area 2120a, 2120b and a second side impact protection area 2122a, 2122b arranged at a non-parallel angle to one another. A generally vertical line of intersection L13a, L13b is arranged at the interface between the first and second side impact protection areas 2120a, 2120b, 2122a, 2122b, respectively. The line of intersection L13a, L13b may be the portion of the second head SIP device 2106a, 2106b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 2126. Further, a distance between the line of intersection L13a, L13b and the back portion 2138 of the headrest 2101 may be greater than a distance between the line of intersection L13a, L13b and a front end 2130a, 2130b of the headrest side members 2132, 2134 measured along a line extending from a respective front end 2130a, 2130b and positioned tangent to the line L13a, L13b.

[0538] Similar to the previous embodiment, a first recess 2124a, 2124b (see FIGS. 21C and 21E) may be defined within a head receiving region 2126 of the headrest 2101 by the plurality of head SIP devices 2104a, 2104b, 2106a, 2106b. As shown, a side of the first recess 2124a, 2124b may be defined by a plane extending from a respective line of intersection L12a, L12b of the first head SIP devices 2104a, 2104b, to a respective line of intersection L13a, L13b



of the second head SIP devices 2106a, 2106b. The first recesses 2124a, 2124b may be further defined by the second side impact protection area 2116a, 2116b of the first head SIP devices 2104a, 2104b, the first side impact protection area 2120a, 2120b of the second head SIP devices 2106a, 2106b, and a surface of the side portion 2106, 2108 extending therebetween.

[0539] In an embodiment, each of the second head SIP devices 2106a, 2106b may form a recess 2128a, 2128b within the head receiving region 2126 of the headrest 2101. Each recess 2128a, 2128b may have a side defined by a plane extending from a corresponding line of intersection L13a, L13b toward a plane extending laterally from an inner edge of the front ends 2130a, 2130b of the headrest side members 2132, 2134. This plane extending from the line of intersection L13a, L13b toward the plane extending laterally from the inner edge of the front ends 2130a, 2130b, represented by line 2150a, 2150b (see FIG. 22E), may be parallel to the central longitudinal axis CLA. The recess 2128a, 2128b may further be defined by the second side impact protection area 2122a, 2122ba, and the plane extending laterally from the inner edge of the front ends 2130a, 2130b of the headrest side members 2132, 2134. In embodiments where the end of the second head SIP devices 2106a, 2106b is offset from the front ends 2130a, 2130b of the headrest 2101, the second recesses 2128a, 2128b may also be defined by at least one of a surface of the side portions 2108, 2110 and a surface of the headrest side members 2132, 2134 extending between the edge of a respective second side impact protection area 2122a, 2122b and a front end 2130a, 2130b.

[0540] In the illustrated embodiment, the head SIP assembly 2102 includes a third head SIP device 2140a, 2140b arranged at a same side portion 2108, 2110 of a connector body 2112 as a first head SIP device 2104a, 2104b and a second head SIP device 2106a, 2106b. In such an embodiment, the third head SIP devices 2140a, 2140b may have a similar material or hardness, or alternatively, a different hardness or hardness than at least one of the first head SIP device 2104a, 2104b and the second head SIP device 2106a, 2106b. As shown, the third head SIP devices 2140a, 2140b may be positioned forward of at least one of the first and second head SIP devices 2104a, 2104b, 2106a, 2106b. In the non-limiting embodiment, the third head SIP device 2108a, 2108b is installed within the first recess 2124a, 2124b. A configuration of the third head SIP device 2140a, 2140b may be substantially equal to the contour of the first recess 2124a, 2124b such the respective first head SIP device 2104a, 2104b, the second head SIP device 2106a, 2106b, and the third head SIP device 2140a, 2140b, in combination, form a smooth, substantially continuous inwardly facing surface. Further, the third head SIP device 2140a, 2140b may be permanently or removably connected to the connector member 2111 or to the first and second head SIP devices 2104a, 2104b, 2106a, 2106b.

[0541] In yet another embodiment of a head SIP assembly 2202 mountable to a headrest 2201 of a child seat 2200 illustrated in FIGS. 23A-23E, each side portion 2206, 2208 of the connector member 2204 includes a first head SIP device 2210a, 2210b, a second head SIP device 2212a, 2212b, a third head SIP device 2214a, 2214b, and a fourth head SIP device 2216a, 2216b. The first head SIP device 2210a, 2210b may be arranged proximate a relative rear of the connector member 2204, such as at interfaces between the respective side portion 2206, 2208 and a body portion 2218. the third head SIP devices 2214a, 2214b may be arranged proximate, but offset from, a front end 2226a, 2226b of a headrest side member 2228, 2230. The first and third head SIP devices 2210a, 2210b, 2214a, 2214b may have any suitable configuration, such as similar to any of the head SIP devices of previous embodiments described herein. Further, the first and third head SIP devices 2210a, 2210b, 2214a, 2214b may include the same or different materials of the same or different hardnesses.

[0542] As shown, the first head SIP devices 2210a, 2210b may have an inwardly facing surface 2220a, 2220b including a respective first and second side impact protection areas arranged at a non-parallel angle to one another. A generally vertical line of intersection L14a, L14b is arranged at the interface between the first and second side impact protection areas, respectively. The line of intersection L14a, L14b may be the portion of the first head SIP device 2210a, 2210b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 2222. Further, a distance between the line of intersection L14a, L14b and the back portion 2224 of the headrest 2201 may be less than a distance between the line of intersection L14a, L14b and a front end 2226a, 2226b of the headrest side members 2228, 2230b along a line extending from a respective front end 2226a, 2226b and positioned tangent to the line L14a, L14b.

[0543] The third head SIP devices 2214a, 2214b have an inwardly facing surface 2231a, 2231b including a first and second side impact protection area arranged at a non-parallel angle to one another. A generally vertical line of intersection L15a, L15b is arranged at the interface between the first and second side impact protection areas, respectively. The line of intersection L15a, L15b may be the portion of the second head SIP device 2214a, 2214b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 2222. Further, a distance between the line of intersection L15a, L15b and the back portion 2224 of the headrest 2201 may be greater than a distance between the line of intersection L15a, L15b and a front end 2226a, 2226b of the headrest side members 2228, 2230 measured along a line extending from a respective front end 2226a, 2226b and positioned tangent to the line L15a, L15b.

[0544] Similar to the previous embodiment, a first recess 2232a, 2232b (see FIGS. 23C and 23E) may be at least partially defined within a head receiving region 2222 of the headrest 2201 by the plurality of head SIP devices 2210a, 2210b, 2214a, 2214b. As shown, the first recess 2232a, 2232b may be partially defined by a plane extending from a respective line of intersection L14a, L14b of the first head SIP devices 2210a, 2210b, to a respective line of intersection L15a, L15b of the third head SIP devices 2214a, 2214b. The first recesses 2232a, 2232b may be further defined by the side impact protection areas of the respective head SIP devices 2210a, 2210b, 2214a, 2214b arranged therebetween and the corresponding surface of the side portion 2206, 2208.

[0545] Each of the third head SIP devices 2214a, 2214b may form a recess 2234a, 2234b within the head receiving region 2222 of the headrest 2201. Each recess 2234a, 2234b may extend from a corresponding line of intersection L15a, L15b toward a plane extending laterally from an inner edge of the front ends 2226a, 2226b of the headrest side members 2228, 2230. The side of the recess 2234a, 2234b formed by this plane extending from the line of intersection L15a, L15b toward the plane extending laterally from an inner edge of the front ends 2226a, 2226b, represented by line 2240a, 2240b, may be parallel to the central longitudinal axis CLA of the head receiving region 2222. The recess 2234a, 2234b may further be defined by part of the inwardly facing surface 2231a, 2231b, the plane extending laterally from an inner edge of the front ends 2226a, 2226b of the headrest side members 2228, 2230, and by at least one of a surface of the side portions 2206, 2208 and a surface of the headrest side members 2228, 2230 extending between an edge of third head SIP devices 2214a, 2214b and a front end 2130a, 2130b.

[0546] The second head SIP devices 2212a, 2212b may be positioned between the first and third head SIP devices 2210a, 2210b, 2214a, 2214b, such as within the first recesses 2232a, 2232b, respectively. Accordingly, a contour of the second head SIP devices 2212a, 2212b may but need not match the contour of the first recesses 2232a, 2232b. The fourth head SIP devices 2216a, 2216b may be positioned between the third head SIP devices 2214a, 2214b and the front ends 2226a, 2226b of the headrest side members 2228, 2230. In an embodiment, the fourth head SIP devices 2216a, 2216b are located within a respective recess 2234a, 2234b. A contour of the fourth head SIP devices 2216a, 2216b may but need not match the contour of the recesses 2234a, 2234b. The second and fourth head SIP devices 2212a, 2212b, 2216a, 2216b may have any suitable configuration. Further, the second and fourth head SIP devices 2212a, 2212b, 2216a, 2216b may include the same or different materials of the same or different hardnesses. It should be appreciated that the second and fourth head SIP devices may be removably mounted to the headrest, and that in some embodiments neither the second nor the fourth head

SIP device or only one of the second head SIP device and the fourth head SIP Device may be connected to the connector member.

[0547] In an embodiment, the second head SIP devices 2212a, 2212b may be connected to the respective first head SIP devices 2210a, 2210b, and a hardness of the second head SIP devices 2212a, 2212b may be less than a hardness of the first head SIP devices 2210a, 2210b. Alternatively, or in addition, the fourth head SIP devices 2216a, 2216b may be connected to the third head SIP devices 2214a, 2214b, and a hardness of the fourth head SIP devices 2216a, 2216b may be less than a hardness of the third head SIP device 2214a, 2214b. It should be appreciated that any head SIP devices, or combination of head SIP devices described herein with respect to a head SIP assembly may alternatively be mounted directly to the headrest absent a connector member.

[0548] With reference now to FIGS. 132A-133C, another embodiment of a head SIP assembly 11800 is illustrated. As shown, the head SIP assembly 11800 includes a connector member 11802 having a central body portion 11804, a first side portion 11806 extending from a first side of the body portion 11804, and a second side portion 11808 extending from a second opposite side of the body portion 11804. A first head SIP device 11810a may be arranged at or adjacent to the first side portion 11806 of the connector member 11802 and a second head SIP device 11810b may be arranged at or adjacent to the second side portion 11808 of the connector member 11802. In the illustrated, non-limiting embodiment, the head SIP devices 11810a, 11810b are mounted near a rear of the head SIP assembly 11800, such as at an interface between the body portion 11804 and the respective side portions 11806, 11808 of the connector member 11802 for example.

[0549] In an embodiment, a cutout or notch is formed at the bottom of the head SIP assembly 11800. As shown, a first cutout 11817a is formed directly underneath the first head SIP device 11810a, and a second cutout 11817b is formed directly underneath the second head SIP device 11810b. The cutouts 11817a, 11817b may form part of a vehicle belt path when the child seat system is in a forward-facing configuration, such as in a booster mode of operation. Accordingly, a bottom 11821a, 11821b of the first head SIP device 11810a and the second head SIP device 11810b may define a portion of the vehicle belt path.

[0550] As shown in FIGS. 133A-133C, the head SIP assembly 11800 may be removably or permanently connectable to the structural shell 11820 of a headrest. The headrest shell 11820 may include a shell back portion 11822 and at least one shell headrest side member, such as a first shell headrest side member 11824 and a second shell headrest side member 11826 disposed at opposite sides of the back portion 11822 and extending toward a front of the

headrest shell 11820. The head SIP assembly 11800 is positionable directly adjacent to the inner surface of the shell 11820 of the headrest. For example, the body portion 11804 of the connector member 11802 is positionable adjacent to a back portion 11822 of the headrest shell 11820, the first side portion 11806 of the connector member 11802 and the first head SIP device 11810a may be positionable adjacent to a first shell headrest side member 11824 of the headrest shell 11820 (the first side portion 11806 being in direct contact with the first shell headrest side member 11824), and the second side portion 11808 of the connector member 11802 and the second head SIP device 11810b may be positionable adjacent to a second shell headrest side member 11826 (the second side portion 11808 being in direct contact with the second shell headrest side member 11826). At least a portion of the back or outer surface 11816 of the head SIP assembly 11800 may have a contour complementary to a contour of the inner surface of the back portion 11822 and the shell headrest side members 11824, 11826 to facilitate engagement therebetween.

[0551] The headrest shell 11820 may include or be formed from a first material having a first hardness and the connector member 11802 may be formed from a second material having a second hardness. In an embodiment, the hardness of the second material is less than the hardness of the first material. In the illustrated, non-limiting embodiment, the side portions 11806, 11808 of the connector member 11802 are elongated such that a distal ends 11812a, 11812b of each side portion 11806, 11808 extend beyond respective front ends 11828a, 11828b of corresponding headrest shell side members 11824, 11826 of the headrest shell 11820. Accordingly, the distal ends 11812a, 11812b of each side portion 11806, 11808 may define a front or forward-facing extent of the headrest.

[0552] The connector member 11802 includes one or more reinforcing regions 11814a, 11814b. These reinforcing regions 11814a, 11814b may be arranged at portions of the connector member 11802 positioned near the front ends 11828a, 11828b of the shell headrest side members 11824, 11826, such as near the distal ends 11812a, 11812b of each side portion 11806, 11808 for example. As shown, the reinforcing regions 11814a, 11814b may have an increased thickness compared to an adjacent portion of the connector member 11802. This increased thickness may increase the rigidity of the connector member 11802, thereby strengthening the portion of the connector member 11802 that extends beyond the headrest shell 11820. Further, in an embodiment, the reinforcing regions 11814a, 11814b may be contoured to define one or more features configured to abut or engage the headrest shell 11820 to properly position the head SIP assembly 11800 relative thereto. Although the reinforcing regions 11814a and 11814b are illustrated as being arranged at the outer surface of the

connector member 11802, embodiments where the reinforcing regions are formed at an inner surface thereof are also contemplated herein.

[0553] Each head SIP device 11810a, 11810b may extend over only a portion of a length of each side portion 11806, 11808. As shown, the head SIP devices 11810a, 11810b may extend to a center of a side portions 11806, 11808. In the illustrated, non-limiting embodiment, at least one head SIP device 11810a, 11810b extends over about half of the length of a respective side portions 11806, 11808. However, embodiments where the at least one head SIP device 11810a, 11810b is longer or shorter are also contemplated herein.

[0554] Similar to the previously disclosed embodiments, each head SIP device 11810a, 11810b includes an inwardly facing surface 11818a, 11818b having a first side impact protection area 11830a, 11830b positioned closest to the body portion 11804, as well as a second side impact protection areas 11832a, 11832b extending forward, away from the first side impact protection areas 11830a, 11830b. As shown, the first side impact protection areas 11830a, 11830b may be arranged at an angle to the body portion 11804 of the connector member 11802. The second side impact protection areas 11832a, 11832b may be arranged at a non-parallel angle relative to respective first side impact protection areas 11830a, 11830b.

[0555] In the illustrated, non-limiting embodiment, the head SIP device 11810a forms a first recess 11834a within the head receiving region 11829 of the structural shell 11820, and the head SIP device 11810b forms a second recess 11834b within the head receiving region 11829. The first side impact protection areas 11830a, 11830b may abut respective second side impact protection areas 11832a, 11832b of each head SIP device 11810a, 11810b at a generally vertical line of intersection represented by L16a and L16b (FIG. 133C), respectively. The lines of intersection L16a, L16b may be disposed at the portions of the head SIP device 11810a, 11810b positioned laterally closest to a central longitudinal axis CLA of a head receiving region.

[0556] The first recess 11834a is partially defined by the second side impact protection area 11832a and a plane extending laterally from an inner edge of the front ends 11812a, 11812b of the side portions 11806, 11808 of the connector member 11802. A surface of the first side portion 11806 extending between the edge of a respective second side impact protection area 11832a and the front end 11812a may also partly define the first recess 11834a. The recess 11834a is further defined by a plane extending from the line of intersection L16a to the plane extending laterally from an inner edge of the front ends 11812a, 11812b of the side portions 11806, 11808. This plane is represented in FIG. 133C by line P16a. This plane of the recess 11834a, extending from the line of intersection L16a toward the plane extending laterally

from an inner edge of the front end 1182a may but need not be coplanar with the first side impact protection area 11830a of the head SIP device 11810a.

[0557] Similarly, the second recess 11834b extends from the line of intersection L16b toward the plane extending laterally from an inner edge of the front end 11812a, 11812b of the side portions 11806, 11808. The plane of the recess 11834b extending from the line of intersection L16b toward the plane extending laterally from an inner edge of the front ends 11812b, represented by line P16b, may but need not be coplanar with the first side impact protection area 11830b of the head SIP device 11810b. The recess 11834b may further be defined by the plane extending laterally from an inner edge of the front ends 11812a, 11812b, the second side impact protection area 11832b, and by a surface of the second side portion 11808 extending between the edge of a respective second side impact protection area 11832b and the front end 11812b.

[0558] With further reference to FIG. 133C, a vertical plane, represented by axis X16a extends from the front end 11812a of the first side portion 11806 and is positioned tangent to the inwardly facing surface of the head SIP device 11810a at the line of intersection L16a. Further, the plane X16a may intersect the body portion 11804 of the connector member 11802 at an intersection location I16a. Another vertical plane, represented by axis X16b extends from the front end 11812b of the second side portion 11808 and is positioned tangent to the inwardly facing surface of the head SIP device 11810b at the line of intersection L16b. The plane X16b may intersect the body portion 11804 of the connector member 11802 at an intersection location I16b. In an embodiment a distances between the intersection locations I16a, I16b and the respective lines of intersection L16a, L16b, are less than the distances between the lines of intersection L16a, L16b and the respective front ends 11812a, 11812b of side portions 11806, 11808 measured along axes X16a, X16b.

[0559] With to FIGS. 132A-133C, in an embodiment, an upper transition 11819a, 11819b and/or a lower transition 11821a, 11821b may extend between the inwardly facing surfaces 11818a, 11818b and the adjacent surface of the connector member 11802. However, it should be understood that in embodiments where a head SIP device 11810a, 11810b is mounted directly to the headrest, the upper transition 11819a, 11819b and/or the lower transition 11821a, 11821b may extend between the inwardly facing surfaces 11818a, 11818b and the inner surface of the headrest. The upper transition and/or the lower transition may be shaped or contoured such as to create a smooth profile. Further, head SIP devices 11810a, 11810b may but need not extend over an entire height of the SIP assembly 18000 and/or the headrest 18200. For example, the head SIP devices 11810a, 11810b, such as the upper

transition 11819a, 11819b thereof, may extend to a top of the SIP assembly 11800 and/or the headrest 11820 and/or the head SIP devices 11810a, 11810b, such as the lower transition 11821a, 11821b thereof, may extend to a bottom of the SIP assembly 11800 and/or the headrest 11820.

[0560] With reference now to FIGS. 134A-134D, another embodiment of a headrest 11900 including at least one head SIP device is illustrated. As shown, the headrest 11900 a back portion 11902, a first headrest side member 11904, and a second headrest side member 11906. The back portion 11902, first headrest side member 11904, and second headrest side member 11906 in combination define a head receiving region 11908 of the headrest 11900. A first head SIP device 11910a may be arranged at or adjacent to the first headrest side member 11904 and a second head SIP device 11910b may be arranged at or adjacent to the second headrest side member 11906. In the illustrated, non-limiting embodiment, the head SIP devices 11910a, 11910b are mounted near the rear of the headrest 11900, such as at an interface between the back portion 11902 and the respective headrest side members 11904, 11906 for example.

[0561] Each head SIP device 11910a, 11910b includes an inwardly facing surface 11912a, 11912b. In an embodiment, as shown, the inwardly facing surfaces 11912a, 11912b may each include a single side impact protection area. As shown, a first end 11916a, 11916b of the inwardly facing surfaces 11912a, 11912b positioned closest to the back portion 11902 may be arranged at a non-parallel angle relative thereto. The inwardly facing surfaces 11912a, 11912b may also extend at a non-parallel angle to a vertical axis. A plane of the inwardly facing surfaces 11912a, 11912b may be skewed relative to a vertical axis such that the bottom ends 11918a, 11918b of the inwardly facing surfaces 11912a, 11912b located closest to the bottom of the headrest 11900 may be positioned closer to a central longitudinal axis CLA of the head receiving region 11908 of the headrest 11900 than the ends 11920a, 11920b of the inwardly facing surface 11912a, 11912b located closest to a top of the headrest 11900.

[0562] Alternatively, or in addition, a length of the inwardly facing surface 11912a, 11912b measured parallel to the CLA may vary over a height of the inwardly facing surface 11912a, 11912b. As shown, a forward edge 11922a, 11922b of the inwardly facing surface 11912a, 11912b may be defined by a tip-over line T1. In the illustrated, non-limiting embodiment, the tip-over line T1 is arranged at an angle relative to the back portion 11902 of the headrest. For example, the tip-over line T1 may have a forward-facing configuration. Accordingly, the length of the inwardly facing surface 11912a, 11912b extending between the back portion 11902 of the headrest and the tip-over line T1 near a top of the forward edge



11922a, 11922b of the inwardly facing surface 11912a, 11912b, illustrated by LI1, is greater than a length of the inwardly facing surface 11912a, 11912b extending between the back portion 11902 of the headrest and the tip-over line T1 near a bottom of the forward edge 11922a, 11922b of the inwardly facing surface 11912a, 11912b, represented by LI2. The length LI1 may be between about 90mm and about 140mm, such as about 95mm, about 100mm, about 110mm, or about 130mm for example. The length LI2 may be between about 40 and about 90mm, such as about 50mm, about 60mm, about 70mm, about 80mm, and about 85mm for example. It should be appreciated that the ranges of LI1 and LI2 are intended as an example only and that other suitable values outside of the provided ranges are contemplated herein.

[0563] Each of the head SIP devices 11910a, 11910b may have a base surface 11914a, 11914b facing or integral with a corresponding portion of the headrest 11900. In an embodiment, the base surfaces 11914a, 11914b of the head SIP devices 11910a, 11910b, such as the surfaces near respective forward ends of the head SIP devices 11910a, 11910b for example, extend away from corresponding surfaces of the adjacent headrest side members 11904, 11906. Such a contour forms a gap or pocket between the base surfaces 11914a, 11914b near a front of each head SIP device 11910a, 11910b and a respective front end 11922a, 11922b of the headrest 11900. Inclusion of these pockets may improve the impact on an occupant's head during a crash event by facilitating a roll thereof.

[0564] With reference to FIGS. 135A-135C, another embodiment of a headrest 11950 is illustrated. As shown, the headrest 11950 includes a back portion 11952 having a headrest support surface (not shown), a first headrest side member 11954 and a second headrest side member 11956. A head SIP assembly 11960 is positionable about the headrest 11950 and includes a connector member 11962 having a central body portion 11964, a first side portion 11966 extending from a first side of the body portion 11964, and a second side portion 11968 extending from a second opposite side of the body portion 11964. A first head SIP device 11970a may be arranged at or adjacent to the first side portion 11966 of the connector member 11962 and a second head SIP device 11970b may be arranged at or adjacent to the second side portion 11968 of the connector member 11962. In the illustrated, non-limiting embodiment, the head SIP devices 11970a, 11970b are mounted near a rear of the head SIP assembly 11960, such as at an interface between the body portion 11964 and the respective side portions 11966, 11968 of the connector member 11962 for example.

[0565] Each head SIP device 11970a, 11970b may extend over only a portion of a length of each side portion 11966, 11968. As shown, the head SIP devices 11970a, 11970b may extend generally to a center of a side portions 11966, 11968. In the illustrated, non-limiting

embodiment, at least one head SIP device 11970a, 11970b extends less than half of the length of a respective side portion 11966, 11968. However, embodiments where the at least one head SIP device 11970a, 11970b is longer or shorter are also contemplated herein.

[0566] Similar to the previously disclosed embodiments, each head SIP device 11970a, 11970b includes an inwardly facing surface 11972a, 11972b having a first side impact protection area 11974a, 11974b positioned closest to the body portion 11964, as well as a second side impact protection areas 11976a, 11976b extending forward, away from the first side impact protection areas 11974a, 11974b. As shown, the first side impact protection areas 11974a, 11974b may be arranged at a non-parallel angle relative to the body portion 11964 of the connector member 11962. The second side impact protection areas 11976a, 11976b may also be arranged at a non-parallel angle relative to respective first side impact protection areas 11974a, 11974b.

[0567] In the illustrated, non-limiting embodiment, the head SIP device 11970a forms a first recess 11980a (see FIG. 135C) within the head receiving region 11961 of the head SIP assembly 11960, and the head SIP device 11970b forms a second recess 11980b within the head receiving region 11961. The first side impact protection areas 11974a, 11974b may abut respective second side impact protection areas 11976a, 11976b of each head SIP device 11970a, 11970b at a generally vertical line of intersection represented by L17a and L17b (see FIG. 135B and 135C), respectively. The lines of intersection L17a, L17b may be disposed at the portions of the head SIP device 11970a, 11970b positioned laterally closest to a central longitudinal axis CLA of a head receiving region 11961.

[0568] The first recess 11980a is partially defined by the second side impact protection area 11976a and a plane extending laterally from an inner edge of the front ends 11982a, 11982b of the side portions 11966, 11968 of the connector member 11962. A surface of the first side portion 11966 extending between the second side impact protection area 11976a and the front end 11982a may also partly define the first recess 11980a. The recess 11980a is further defined by a plane extending from the line of intersection L17a to the plane extending laterally from an inner edge of the front ends 11982a, 11982b of the side portions 11966, 11968. This plane is represented in FIG. 135C by line P17a. This plane P17a of the recess 11980a, extending from the line of intersection L17a toward the plane extending laterally from an inner edge of the front end 11982a may but need not be coplanar with the first side impact protection area 11974a of the head SIP device 11970a.

[0569] Similarly, the second recess 11980b extends from the line of intersection L17b toward the plane extending laterally from an inner edge of the front end 11982a, 11982b of the

side portions 11966, 11968. The plane of the recess 11980b extending from the line of intersection L17b toward the plane extending laterally from an inner edge of the front ends 11982a, 11982b, represented by line P17b, may but need not be coplanar with the first side impact protection area 11974a of the head SIP device 11970b. The recess 11980b may further be defined by the plane extending laterally from an inner edge of the front ends 11982a, 11982b, the second side impact protection area 11976b, and by a surface of the second side portion 11968 extending between the second side impact protection area 11976b and the front end 11982b.

[0570] With further reference to FIG. 135C, a vertical plane, represented by axis X17a extends from the front end 11982a of the first side portion 11966 and is positioned tangent to the inwardly facing surface 11972a of the head SIP device 11970a at the line of intersection L17a. Further, the plane X17a may intersect the body portion 11964 of the connector member 11962 at an intersection location I17a. Another vertical plane, represented by axis X17b extends from the front end 11982b of the second side portion 11968 and is positioned tangent to the inwardly facing surface 11972b of the head SIP device 11970b at the line of intersection L17b. The plane X17b may intersect the body portion 11964 of the connector member 11962 at an intersection location I17b. In an embodiment a distances between the intersection locations I17a, I17b and the respective lines of intersection L17a, L17b, are less than the distances between the lines of intersection L17a, L17b and the respective front ends 11982a, 11982b of a side portions 11966, 11968 measured along axes X17a, X17b.

[0571] With continued reference to FIGS. 135A-135C, in an embodiment, a clearance between the first side portion 11966 and the second side portion 11968 varies over a height of the head SIP assembly. For example, a clearance formed between the top of the first side portion 11966 and the second side portion 11968 of the head SIP assembly may be greater than a clearance formed between the first side portion 11966 and the second side portion 11968 near a bottom of the head SIP assembly. Inclusion of such a taper over a height of the head SIP assembly 11960 may control the roll of an occupant's head during a crash event.

[0572] In an embodiment, a configuration of a head SIP device or a head SIP assembly may be adjusted relative to a headrest. For example, the orientation of a head SIP device or devices may be selected based on a direction in which the child seat is mounted to a vehicle seat, i.e., rearward facing or forward facing. In the non-limiting embodiment illustrated in FIGS. 24A-24D, head SIP assemblies 2302a, 2302b are mounted to an interior surface of respective headrest side members 2304, 2305 of a headrest 2301. As shown, each head SIP assembly 2302a, 2302b includes a respective first head SIP device 2306a, 2306b and a

respective second head SIP device 2308a, 2308b. The first and second head SIP devices 2306a, 2306b, 2306a, 2306b may be connected to one another, such as via a connector member (not shown). The first head SIP device 2306a, 2306b has a first hardness and the second head SIP device 2308a, 2308b has a second hardness, the first hardness being greater than the second hardness.

[0573] A head SIP assembly 2302a or 2302b may be movable, for example rotatable about an axis, between a first configuration (FIG. 24A-B) associated with a forward-facing installation of the child seat system 2300 and a second configuration (FIG. 24C-D) associated with a rearward-facing installation of the child seat system 2300. It should be understood that the head SIP assembly 2302a, 2302b may be transformable between the first configuration and the second configuration when the soft goods are both positioned about the headrest and when the soft goods are removed from the headrest. In an embodiment, the head SIP device of the head SIP assembly 2302a, 2302b with the greater hardness, such as head SIP device 2306a or 2306b for example, is positioned near the rear of the headrest 2301 when the child seat is in a forward-facing configuration and the head SIP device 2306a, 2306b with the greater hardness may be positioned near a front 2314 of the headrest 2301 when the child seat is in a rearward-facing configuration.

[0574] As shown, in the first configuration the first head SIP device 2306a, 2306b may be arranged closest to a headrest support surface 2310 of the headrest 2301 and the second head SIP device 2308a, 2308b may be closest to a front 2314 of the headrest 2301. When the child seat system is installed in a rearward-facing direction and the head SIP assembly 2302a, 2302b is in the second configuration, the second head SIP device 2308a, 2308b may be arranged closest to the headrest support surface 2310 and the first head SIP device 2306a, 2306b may be closest to the front end 2314 of the headrest 2301. Such rotation of a head SIP assembly 2302a, 2302b may be driven by a dial 2320 or other control mechanism operably coupled to the head SIP assembly 2302 and arranged at an exterior of the child seat. Although the control mechanism 2320 is illustrated as being arranged at a second headrest side member 2305, in other embodiments, a control mechanism 2320 may be arranged at the first headrest side member 2304. Further, it should be appreciated that a single control mechanism 2320 may be operable to transform one of the plurality of head SIP assemblies 2302a, 2302b, or alternatively, the plurality of head SIP assemblies 2302a, 2302b.

[0575] In other embodiments, such as shown in FIGS. 25A-25D, an overall head accommodation space of a head SIP assembly may vary based on the direction in which the child seat system is mounted to a vehicle seat. Head SIP assemblies 2402a, 2402b may be

mounted to respective headrest side members 2404, 2406 of a headrest 2401. In the illustrated, non-limiting embodiment, each head SIP assembly 2402a, 2402b includes a respective first head SIP device 2408a, 2408b and an adjacent a second head SIP device 2410a, 2410b. The hardness of the first head SIP device 2408a, 2408b may be greater than the hardness of the second head SIP device 2410a, 2410b. Each head SIP assembly 2402a, 2402b has a first configuration (FIG. 25A-B) associated with a forward-facing installation of the child seat system 2400 and a second configuration (FIG. 25C-D) associated with a rearward-facing installation of the child seat system 2400.

[0576] In the first configuration, the second head SIP device 2410 extends from the first head SIP device 2408 over a substantial portion of a length of an adjacent headrest side member 2404, 2406. In an embodiment, a length of the second head SIP device 2410 when in the first configuration may be at least double, and in some embodiments triple or quadruple for example, the length of the first head SIP device 2408. However, in the second configuration, the length of the second head SIP device 2410 is reduced relative to the length of the second head SIP device in the first configuration. As shown, the second head SIP device 2410 may extend over only a small portion of a length of a headrest side member 2404, 2406. In an embodiment, a length of the second head SIP device 2410 when in the second configuration may be similar or equal to a length of the first head SIP device 2408.

[0577] To accommodate this transformation in length, the second head SIP device 2410 may be retractable into a corresponding cavity or may be selectively inflatable and deflatable to achieve a desired configuration. Similar to the previous embodiment, it should be understood that the head SIP assembly 2402a, 2402b may be transformable between the first configuration and the second configuration when the soft goods are both positioned about the headrest and when the soft goods are removed from the headrest. The transformation of the second head SIP device 2410a, 2410b may be controlled by a dial 2420 or other control mechanism operably coupled to the second head SIP device 2410a, 2410a and arranged at an exterior of the child seat. Although the control mechanism 2420 is illustrated as being arranged at a second headrest side member 2406, in other embodiments, a control mechanism 2420 may be arranged at the first headrest side member 2404 or another suitable location about the child seat. Further, it should be appreciated that a single control mechanism 2420 may be operable to transform a corresponding second head SIP device 2410a or 2410b, or alternatively, may be operable to transform the plurality of second head SIP devices 2410a and 2410b.

[0578] With reference now to FIGS. 26A-26F, another embodiment of at least one head SIP device transformable between a first configuration and a second configuration is illustrated.

As shown, a headrest 2502 of a child seat 2500 includes a back portion 2504 having an upright support surface 2506, a first headrest side member 2508 and a second headrest side member 2510. In the illustrated, non-limiting embodiment, first head SIP devices 2512a, 2512b and second head SIP devices 2514a, 2514b are respectively mounted at each of the headrest side members 2508, 2510. At least one of the first and second head SIP devices 2512a, 2512b, 2514a, 2514b is movable relative to the headrest 2502 between a first, retracted configuration (FIGS. 26A-26C) and a second extended or deployed configuration (FIGS. 26D-26F). In such embodiments, the at least one of the first and second head SIP device 2512a, 2512b, 2514a, 2514b may be coupled to the child seat 2500 in both the retracted configuration and the extended configuration. Further, in an embodiment, the transformable first and/or second head SIP device 2512a, 2512b, 2514a, 2514b is lockable in the retracted configuration, the extended configuration, or both.

[0579] When in the retracted configuration, an outer surface 2516a, 2516b, 2518a, 2518b of at least one of the first and second head SIP devices 2512a, 2512b, 2514a, 2514b may be substantially flush with respective surfaces 2517, 2519 of the first and second head rest side members 2508, 2510. As shown, in the retracted configuration the first and second head SIP devices 2512a, 2512b, 2514a, 2514b are retracted into a clearance 2526, 2528 defined between the headrest side member 2508, 2510 and an adjacent upright side member 2522, 2524 of a seat shell 2520 of the child seat 2500. In the extended configuration, at least one of the first and second head SIP devices 2512a, 2512b, 2514a, 2514b protrudes beyond the surfaces of the first and second headrest side members 2508, 2510 to reduce the available space within a space defined by headrest 2502 (e.g. reduce space for a child's head to move from side to side within the confines of the headrest). The first and second head SIP devices 2512a, 2512b, 2514a, 2514b may be covered by the soft goods of the headrest 2502 when in both the extended configuration and the retracted configuration. However, in other embodiments, one or more of the first and second head SIP devices 2512a, 2512b, 2514a, 2514b may protrude through the soft goods when in the extended configuration.

[0580] In the illustrated, non-limiting embodiment, the at least one first and/or second head SIP device 2512a, 2512b, 2514a, 2514b is a rigid body configured to translate along an axis between the retracted configuration and the extended configuration. However, in other embodiments, the head SIP devices 2512a, 2512b, 2514a, 2514b may be configured to rotate or move in another manner between the retracted and extended configurations. For example, in the non-limiting embodiment illustrated in FIGS. 68A-68F, first and second head SIP devices 6504a, 6504b, 6506a, 6506b arranged at a headrest 6502 of a child seat 6500 are

structurally modifiable bodies, such as bladders or airbags, transformable between a first, deflated configuration (FIGS. 68A-68C) and a second inflated configuration (FIGS. 68D-68F). It should be understood that a deflated configuration may also be referred to herein as a stowed or retracted configuration and an inflated configuration may also be referred to herein as an extended or deployed configuration. A valve (not shown) may be operable to retain fluid within the bladders when inflated. At least a portion of the first and second head SIP devices 6504a, 6504b, 6506a, 6506b engageable with an occupant may be covered by the soft goods of the headrest 6502 when in both the extended configuration and the retracted configuration. However, in other embodiments, the portion of the first and second head SIP devices 6504a, 6504b, 6506a, 6506b engageable with an occupant may protrude through the soft goods when in the extended configuration.

[0581] When in a deflated configuration, a portion of the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b may be arranged within a cavity formed in the headrest, or alternatively or additionally, may extend into the clearance 6524a, 6524b formed between the headrest side members 6514, 6516 and the upright side members 6510, 6512 of the seat shell 6508. Accordingly, as air or another fluid is provided to the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b, the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b transform and extend into the headrest cavity 6520. In other embodiments, a source 6522 arranged in fluid communication with the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b may be positioned between the headrest side members 6514, 6516 and the upright side members 6510, 6512. In such embodiments, a source may be fluidly connected to one or more of a plurality of structurally modifiable bodies, such as the plurality of structurally modifiable bodies 6504a, 6504b, 6506a, 6506b associated with a given side member 6514, 6516 of the headrest 6502. For example, a first source 6520a positioned within the clearance 6524a between the headrest side member 6514 and adjacent side member 6510 may be operably coupled to both structurally modifiable bodies 6504a and 6506a. Similarly, a second source 6520b positioned within a clearance 6524b between the headrest side member 6516 and adjacent side member 6512 may be operably coupled to both structurally modifiable bodies 6504b and 6506b.

[0582] When the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b are in a deflated configuration, the at least one source 6520a, 6520b arranged between the headrest 6502 and the seat shell 6508 is expanded, and when the structurally modifiable bodies 6504a, 6504b, 6506a, 6506b are inflated, the at least one source 6520, 6520b is deflated. Alternatively,

an individual source may be fluidly connected to each respective structurally modifiable body 6504a, 6504b, 6506a, 6506b.

[0583] It should be appreciated that the energy absorption of a SIP device in the deployed configuration may be greater than the energy absorption of the SIP device in the stowed configuration. In an embodiment, the transformation of a head SIP device between a retracted configuration and an extended configuration may occur automatically in response to installation of the child seat upon a vehicle seat. With reference to FIGS. 27A-27B, headrest 2502 and the first and second SIP devices 2512a, 2512b, 2514a, 2514b are identical to those in FIGS. 26A-26E. When a child seat such as 2500 for example, is in a forward-facing orientation (FIG. 27A), a belt 2530 operable to couple the child seat 2500 to a vehicle seat is arranged at a first location, such as near a center of the upright portion 2532 of the child seat 2500. Similarly, when the child seat 2500 is in a rearward-facing orientation (FIG. 27B), the belt 2530 operable to couple the child seat 2500 to a vehicle seat is arranged at a second location about the child seat 2500, such as near a front 2536 of the seat portion 2534. As this belt 2530 is tensioned, it applies a force to a respective actuator 2540, 2542 associated with one of the first and second locations.

[0584] In the illustrated, non-limiting embodiment, only a portion of the plurality of head SIP devices 2512a, 2512b, 2514a, 2514b arranged at the headrest 2502 are transformed between the retracted configuration and the extended configuration in response to installation of the belt at a respective location. For example, when the child seat 2500 is installed in a forward-facing orientation, the belt 2530 engages actuator 2540 causing only the second head SIP devices 2514a, 2514b arranged near a front of the headrest 2502 to transform to the extended configuration. In this forward-facing installation orientation, the first head SIP devices 2512a, 2512b located near a rear of the headrest 2502 would remain in the retracted configuration. Similarly, when the child seat 2500 is installed in a rearward-facing orientation, the belt 2530 engages actuator 2542, causing only the first head SIP devices 2512a, 2512b arranged near a rear of the headrest 2502 to transform to the extended configuration. In this rearward-facing orientation, the second head SIP devices 2514a, 2514b located near a front of the headrest 2502 would remain in the retracted configuration.

[0585] In other embodiments, transformation of at least one head SIP device between the retracted and extended configurations may occur automatically in response to the presence of an occupant within the child seat, or in response to application of a force to the child seat, such as during a side impact event for example. Although a first and second head SIP device 2512a, 2512b, 2514a, 2514b are shown at each headrest side member 2508, 2510, it should be



appreciated that embodiments having only a single head SIP device are also within the scope of the disclosure. Further, it should be appreciated that in embodiments where a plurality of head SIP devices arranged at the same portion of a headrest, such as the same headrest side member for example, are transformable, the plurality of head SIP devices may be transformable between a retracted configuration and an extended configuration simultaneously/in unison or independently.

[0586] With reference to FIGS. 82A and 82B, another embodiment of headrest 7900 having a first head SIP portion 7902a including at least one first head SIP device 7904a, and a second head SIP portion 7902b having at least one second head SIP device 7904b is illustrated. As shown, the first head SIP portion 7902a is arranged between a back portion 7906 of the headrest 7900 and a first headrest side member 7908, and the second head SIP portion 7902b is arranged between the headrest back portion 7906 and a second headrest side member 7910. Although the first and second head SIP portions 7902a, 7902b, as well as the corresponding head SIP devices 7904a, 7904b, are illustrated as separate devices not integrated into a connected SIP assembly, it should be understood that in other embodiments, such an assembly incorporating the two SIP devices 7904a, 7904b connected together may be mounted to the inner surface of the headrest 7900.

[0587] As shown, a configuration of a side impact protection device, such as head SIP devices 7904a and 7904b for example, may vary along a longitudinal axis CLA extending between the headrest back portion 7906 and a front 7930a, 7930b of the head receiving region 7905 of a headrest 7900. For example, each of the head SIP devices 7904a, 7904b includes an inwardly facing surface 7912a, 7912b having a first side impact protection area 7914a, 7914b and a second side impact protection area 7916a, 7916b arranged at an angle relative to one another.

[0588] A portion of the headrest 7900 located between the headrest back portion 7906 and the front end 7930a, 7930b of the headrest 7900 and positioned closest to a central longitudinal axis CLA of a head receiving region 7905 of the headrest 7900 in a lateral direction is referred to herein as a “head contact location,” identified at C1 and C2 in FIG. 82A. In an embodiment, the head contact location C1, C2 is the portion of the headrest configured to initially contact an occupant’s head during a side impact event.

[0589] The head contact location C1, C2 is laterally offset from the inner surface of the headrest 7900 and may be arranged at an interface between the first side impact protection area 7914a, 7914b and the second side impact protection area 7916a, 7916b of an inwardly facing surface 7912a, 7912b. In such embodiments, a line of intersection as previously described

herein with reference to FIGS. 2-23E may also be a head contact location. As shown, the head contact location C1, C2 may be positioned between a surface of the headrest back portion 7906 of the head receiving region 7905, such as headrest support surface 7918, and a center of gravity CoG of an occupant's head in a direction along the central longitudinal axis CLA. In an embodiment, the head contact location C1, C2 is offset from the headrest support surface 7918.

[0590] Similar to the embodiment of FIG. 14, a recess 7920a may be defined between the head contact location C1, C2 and the front 7930a of the headrest 7900. As shown, a vertical plane, represented by PT1 extending from a front end 7930a in a direction or position tangent to the head contact location C1 intersects the headrest support surface 7918 at an intersection location IT1. In an embodiment, a recess 7920a is defined between the vertical plane PT1, the second side impact protection area 1716a, and in some embodiments, the inner surface 7932a of the headrest side member 7908 extending toward the front 7930a of the headrest from head contact location C1. However, in other embodiments, the recess 7920a, 7920b may be at least partially defined by a plane extending from the head contact location C1, C2 to a plane extending laterally from an inner edge of the front end 7930a of the headrest and that is coplanar with the first side impact protection area 7914a.

[0591] In an embodiment, another recess or a second recess 7920b of the head receiving region 7905 may be defined between the head contact location C1, C2 and the front 7930b of the headrest 7900. As shown, a second vertical plane, identified at PT2, extends from a front end 7930b in a direction or position tangent to the head contact location C2 intersects the headrest support surface 7918 at an intersection location IT2. In an embodiment, the recess 7920b may be defined between the vertical plane PT2, the second side impact protection area 1716b, and in some embodiments, the inner surface 7932b of the headrest side member 7910 extending toward the front 7930b of the headrest from head contact location C2. However, in other embodiments, the recess 7920b may be at least partially defined by a plane extending from the head contact location C2 to the plane extending laterally from an inner edge of the front end 7930b of the headrest and that is coplanar with the first side impact protection area 7914b.

[0592] Contact with the head contact location C1, C2, as shown in FIG. 82B, may induce a head roll during a side impact collision. For example, during a side impact collision when a child seat system is in a rear-facing position, a head SIP device 1304a, 1304b enables earlier engagement of the headrest 1301 with the head and initiates head roll. The initiation of head roll allows for energy absorption over a longer period of time and results in off-axis

loading of the head. This off-axis loading of the head results in a reduction in pure lateral loading and peak head y-acceleration and increase in head x-acceleration.

[0593] With reference now to FIGS. 28A and 28B, another type of head SIP device suitable for use with a child seat system 2600 is illustrated. In the illustrated, non-limiting embodiment, at least one head SIP device 2602a, 2602b, 2602c is a friction surface 2604a, 2604b, 2604c such as formed via a friction material intended to produce friction between the material and an occupant's head to control or stop motion of the head. One or more head SIP devices 2602a, 2602b, 2602c in the form of a friction surface may be arranged at an interior surface of the headrest 2606. For example, a first friction surface 2604a may be arranged at or generally adjacent to the headrest support surface 2608. A second and/or third friction surface 264b, 2604c may be positioned near a bottom front 2610a, 2610b of a respective headrest side member 2612, 2614. The friction surfaces 2602a, 2602b, 2602c may be arranged at the headrest 2606 and covered by the soft goods positioned about the headrest, or alternatively, may be arranged at (e.g. on an exterior of) the soft goods. Forming a friction surface 2604a at the headrest support surface 2608 may be particularly beneficial when the child seat system 2600 is in a rearward-facing configuration in which an occupant's head is pushed toward the headrest support surface 2608 during a crash event. A friction surface 2604b, 2604c at the bottom front 2610 of the headrest side members 2612, 2614 may be beneficial when the child seat system 2600 is in a forward-facing configuration to prevent an occupant's head from sliding out of the headrest 2606 and striking a vehicle door panel. A friction surface 2604a, 2604b, 2604c as described herein may be formed by positioning a friction material between the headrest 2606 and the soft goods mountable about the headrest 2606, or in embodiments including another head SIP device or a head SIP assembly as previously described herein, the friction material 2604a, 2604b, 2604c may be arranged between the soft goods and a head SIP device or head SIP assembly.

[0594] Another type of head SIP device is operable to extend one or more dimensions of a headrest of the child seat system. With reference to FIGS. 29A and 29B, an illustrated head SIP assembly 2702 includes at least one extended wing 2704a, 2704b positionable at a respective headrest side member 2706, 2708. The extended wings 2704a, 2704b may be connectable to a headrest 2701, or alternatively, may integrally formed therewith. The extended wing 2704a, 2704b may be arranged at the front ends 2710a, 2710b of the headrest side members 2706, 2708 thereby increasing the distance (measured back to front) of the headrest 2701. Alternatively, or in addition, the extended wing 2704a, 2704b may be arranged at a bottom surface 2712a, 2712b of a respective headrest side member 2706, 2708. The extended

wings 2704a, 2704b may extend over the entire bottom surface, as shown in FIG. 29A or alternatively, may extend over only a portion thereof (FIG. 29B) to form a notch or cutout 2714 at the bottom of the headrest 2701 for receiving an occupant's shoulder.

[0595] In an embodiment, front ends 2716a, 2716b defined by the extended wings 2704a, 2704b extend at respective non-perpendicular angles to the headrest support surface 2720. Further, the front ends 2716a, 2716b protrude beyond the adjacent edges of respective upright side members 2722, 2724 of the seat shell of the child seat 2700. In an embodiment, the front end 2716a, 2716b of the extended wing may be aligned with or protrude beyond the upright side member 2722, 2724 over its entire height.

[0596] With reference to FIGS. 30A-31B, at least one head SIP device 2804a, 2804b associated with a headrest 2802 and having another configuration is shown. In the illustrated, non-limiting embodiment, the at least one head SIP device 2804a, 2804b is transformable between a first, retracted configuration (FIGS. 30A and 30B) and a second, deployed configuration (FIGS. 31A and 31B). A respective head SIP device 2804a, 2804b may be mounted to a headrest side member 2806, 2808, such as near front ends 2810a, 2810b and/or bottom surfaces 2812a, 2812b thereof. In the retracted configuration, the head SIP devices 2804a, 2804b may be located within the boundary defined by the headrest 2802. In the deployed or extended configuration, the head SIP devices 2804a, 2804b may protrude beyond the headrest side members 2806, 2808 in one or more directions. The first and second head SIP device 2804a, 2804b may be covered by the soft goods of the headrest 2802 when in both the extended configuration and the retracted configurations. However, in other embodiments, one or more of the first and second head SIP device 2804a, 2804b may protrude through the soft goods when in the extended configuration.

[0597] As shown, each head SIP device 2804a, 2804b may include a body 2820a, 2820b configured to protrude forward of the front end 2810a, 2810b of the headrest side member 2806, 2808 and downward beyond a bottom surface 2812a, 2812b near the front end 2810a, 2810b of the headrest side member 2806, 2808 when in the extended configuration. In an embodiment, the head SIP device 2804a, 2804b may be formed via a structurally modifiable body, such as an inflatable bladder or air bag, and as the structurally modifiable body transforms to an extended configuration, the structurally modifiable body will protrude beyond the front end 2810a, 2810b and/or bottom 2812a, 2812b of the headrest 2801. However, embodiments where the head SIP device 2804a, 2804b is a rigid body are also within the scope of the disclosure.

[0598] FIG. 83 illustrates another embodiment of a headrest 8000 having at least one head SIP device transformable between a first, retracted configuration and a second, deployed configuration. As shown, the headrest 8000 includes a first head SIP device 8002a mounted to a first headrest side member 8004 and a second head SIP device 8002b mounted to a second headrest side member 8006. The head SIP devices 8002a, 8002b may be positioned near front ends 8008a, 8008b of the headrest side members 8004, 8006. Similar to the embodiment of FIGS. 30A-31B, in the retracted configuration, the head SIP devices 8002a, 8002b may be located within a boundary defined by the headrest 8000. In the deployed or extended configuration, the head SIP devices 8002a, 8002b may protrude beyond the headrest side members 8004, 8006, in one or more directions. As shown, each head SIP device 8002a, 8002b may include a body 8010a, 8010b configured to protrude forward of the front end 8008a, 8008b of the headrest side member 8004, 8006.

[0599] FIGS. 122A-122B illustrate another embodiment of a headrest 10802 of a child seat 10800 having at least one head SIP device 10804 transformable between a first configuration (FIG. 122A) and a second configuration (FIG. 122B). The head SIP device 10804 may be removably connectable to the headrest 10802, or alternatively, may be permanently connected thereto. In position with the seat 10800, the head SIP device 10804 is arranged adjacent to an interior surface 10806 of the headrest 10802 and extends about a substantial entirety of the interior surface 10806. The head SIP device 10804 may be movably attached to the headrest 10802, or alternatively or in addition thereto, to a portion of a harness 10808 of the child seat 10800, such as a strap or a piece of padding affixed to a strap of the harness for example. During normal use of the child seat 10800, the head SIP device 10804 remains positioned adjacent to, and in some embodiments in contact with, the interior surface 10806 of the headrest 10802, as shown in FIG. 122A. In FIG. 122B, during a crash event, the head SIP device 10804 is configured to move with the occupant. Accordingly, the head SIP device 10804 will separate from the interior surface 10806 of the headrest 10802 with the child to protect the head against contact with another surface.

[0600] With reference now to FIGS. 123A-124B, various examples of a headrest configured to deform from a first configuration to second configuration in response to a crash event are illustrated. In FIGS. 123A-12B, a head SIP device 10902 is positioned at or adjacent to an interior surface 10904 of a headrest 10900 of a child seat. As shown, the head SIP device 10902 may extend about a substantial entirety of the interior surface 10904 of the headrest 10900. The headrest 10900 may be formed from a compressible or elastic material configured to deform, for example elongate, when a compressive force is applied thereto. In the illustrated,

non-limiting embodiment, when a force is applied to the head SIP device 10902, such as by an occupant's head during a crash event, the material of the head SIP device 10902 is displaced. As shown, the head SIP device 10902 is configured to absorb the energy applied thereto by expanding. In an embodiment, the head SIP device 10902 is configured to deform such that the head SIP device 10902 extends beyond a front end 10906 of the headrest 10900 for example. However, deformation in alternative or additional directions is also within the scope of the disclosure.

[0601] In the non-limiting embodiment of FIGS. 124A-124B, a head SIP device 11002 is similarly positioned at or adjacent to an interior surface 11004 of a headrest 11000 of a child seat. As shown, the head SIP device 11002 may extend about a substantial entirety of the interior surface 11004 of the headrest 11000. The headrest 11000 includes a central portion 11006, a first headrest side member 11008, and a second headrest side member 11010 extending from opposing sides of the central portion 11006. As shown, the portion of the head SIP device 11002 located adjacent to at least one of the first and second headrest side members 11008, 11010 has a double-walled configuration. In the illustrated, non-limiting embodiment, an end 11012a, 11012b of the head SIP device 11002 is folded back onto its inwardly facing surface 11014 to form the second wall of the portion of the head SIP device 11002 located adjacent to at least one of the first and second headrest side members 11008, 11010. The head SIP device 11002 may be formed from a flexible, bendable material to allow the formation of the fold. In each of the embodiments described herein with respect to FIGS. 83 and 122A-124B, it should be understood that the disclosed head SIP devices, when in the extended configuration, may be covered by the soft goods of the headrest, or alternatively, at least a portion thereof may be external to the soft goods.

[0602] During a crash event, an occupant's head may engage and apply a force to the head SIP device 11002. In the illustrated, non-limiting embodiment, when a force is applied to a side of the head SIP device 11002, such as the double-walled section thereof, the force may cause an adjacent end 11012a, 11012b of the head SIP device 11002 of the interior wall of the head SIP device 11002 to translate. As shown, the head SIP device 11002 is configured to absorb the energy applied thereto by unfolding.

[0603] In the non-limiting embodiment of FIGS. 30A-31B, the head SIP devices 2804a, 2804b are pivotable about an axis between the retracted configuration and the deployed configuration. However, in the embodiment illustrated FIG. 83, the head SIP devices 8002a, 8002b are movable, such as translatable for example, along an axis of each respective headrest side member 8004, 8006 between the retracted and deployed configurations. The bodies 8010a,

8010b of the head SIP devices 8002a, 8002b may be rigid bodies translatable between the retracted and deployed configurations. In such embodiments, a portion of the head SIP devices 8002a, 8002b may be receivable within an interior of the headrest 8000, or alternatively, or additionally, the head SIP devices may be collapsible into themselves, such as via a telescoping configuration. In other embodiments, the head SIP devices 8002a, 8002b may be formed via a structurally modifiable body, such as an inflatable bladder or air bag. In such embodiments, as the structurally modifiable body 8010a, 8010b transforms to the deployed configuration, the structurally modifiable body will protrude forward of the front end 8008a, 8008b of the headrest 8000.

[0604] With reference now to FIGS. 32A-32C, another example of a headrest 2900 having at least one head SIP device is illustrated. As an alternative to, or in addition to the head SIP devices previously described herein, the head SIP devices (not shown) may include one or more rigid or semi-rigid bodies positioned in overlapping arrangement with the headrest side members 2906, 2908 to control a clearance between the side members 2906, 2908 within which an occupant's head is received. In an embodiment, the head SIP devices are contoured to control the clearance such that an occupant's head is spaced or offset from a headrest support surface of a back portion 2904 of the headrest 2900 by at least a minimum distance. For example, the head SIP devices may be angled relative to one another to position an occupant's head at least about .5 inches, and in some embodiments, at least about .75 inches, about 1 inch, about 1.25 inches, and about at least 1.5 inches from the back portion 2904 of the headrest 2900. The head SIP devices may but need not span the entire headrest support surface between the adjacent headrest side members 2906, 2908.

[0605] In another embodiment, illustrated in FIG. 69A and 69B, at least one head SIP device 6602 is positioned at an exterior of the headrest 6600. In such an embodiment, the at least one head SIP device 6602 is absent coverage by soft goods. As shown, at least one SIP device 6602 may be arranged at a backside 6604 of at least a portion of the headrest 6600. For example, the head SIP device 6602 is illustrated as being positioned adjacent to a backside 6604 of a headrest side member 6606. As previously described, the head SIP device 6602 may have a rigid, semirigid, or inflatable body and may but need not have a contour complementary to the adjacent headrest side member 6606. Such a head SIP device 6602 may absorb energy during a side impact crash. In the illustrated, non-limiting embodiment, the headrest side member 6606 is shown having a lip 6608 arranged at the backside 6604 thereof and extending from a top of the headrest 6600 to a front end 6610 thereof. In an embodiment, the head SIP

device 6602 is at least partially positioned underneath the lip 6608, such as within a gap formed between the lip 6608 and the exterior surface of the headrest 6600.

[0606] It should be appreciated that the head SIP devices illustrated and described herein are intended as examples only and that a head SIP device having any suitable configuration is within the scope of the disclosure. Further, although the head SIP devices arranged at opposing sides of a head SIP assembly are generally illustrated as being substantially identical, embodiments where a configuration of the head SIP devices varies from one side of the headrest to the other is also contemplated herein. As will be described in more detail below, a shoulder SIP device may be positioned adjacent to an inner surface of an upright portion of seat shell, such as at a first or second upright side member. Unless another arrangement is noted, any embodiment described herein that includes a shoulder SIP device locatable at such an inner surface region should be understood to position the shoulder SIP device generally between the seat shell of the child seat and soft goods that cover the interior surface of the seat shell. Such a shoulder SIP device may be attached to the structural body of the headrest or to the soft goods positionable thereabout. In embodiments described herein where a shoulder SIP device is associated with, and in some embodiments is movable with, a headrest of a child seat, the shoulder SIP device may, but need not be covered by soft goods.

[0607] With reference now again to FIG. 1, alternatively, or in addition to a head SIP device 70 as illustrated and described herein, the child seat system 20 may also include one or more SIP devices 72a, 72b arranged at an interior surface of the child seat 23 operable to restrict or control movement of a shoulder of an occupant of the child seat system 20. Such SIP devices 72a, 72b, also referred to herein as “shoulder SIP devices” may be arranged at areas of the child seat 23, such as the back or upright portions 28 of the child seat 23 for example, generally aligned with and configured to contact an occupant’s shoulder or upper arm.

[0608] With reference now to FIGS. 33A and 33B, the illustrated, non-limiting embodiment of a child seat 3002 includes a seat shell 3003 having an upright portion 3004 including a support surface 3006, a first upright side member 3008, and a second upright side member 3010 as previously described. At least one shoulder SIP device is coupled to the child seat 3002. In the illustrated, non-limiting embodiment, a first shoulder SIP device 3012a is arranged at the first upright side member 3008 and a second shoulder SIP device 3012b is arranged at the second upright side member 3010. Although only a single shoulder SIP device 3012a, 3012b is illustrated and described as being arranged at each side of an occupant, it should be understood that embodiments including a plurality of shoulder SIP devices operable to engage the same shoulder of an occupant are within the scope of the disclosure.



[0609] The first and second shoulder SIP devices 3012a, 3012b may be permanently or removably coupled to the child seat 3002. In an embodiment, shown in FIG. 33C, the child seat 3002 includes at least one engagement feature 3014a, such as a rib for example, which protrudes from an interior surface of the seat shell 3003, such as at an upright side member 3008, 3010. The engagement feature 3014a may abut or engage a portion of a corresponding shoulder SIP device 3012a, 3012b to facilitate the proper positioning of the shoulder SIP devices 3012a, 3012b about the child seat 3000.

[0610] The first shoulder SIP device 3012a and the second shoulder SIP device 3012b are disposed at opposite sides of the child seat 3002 and may be substantially identical or may have varying configurations. Although the shoulder SIP devices 3012a, 3012b illustrated in FIGS. 33A-33C have a generally rounded shape, such as a circular or oval shape for example, embodiments where the one or more shoulder SIP devices 3012a, 3012b have another shape are also within the scope of the disclosure. As shown, the first and second shoulder SIP devices 3012a, 3012b may be aligned along a horizontal axis and protrude beyond an interior surface of the upright side members 3008, 3010 towards an interior of the child seat 3002. In an embodiment, a shoulder SIP device 3012a, 3012b is sized and positioned to allow the headrest 3020 (FIG. 33A) of the child seat 3002, including any soft goods associated therewith, to be freely raised and lowered without interference.

[0611] With reference now to FIGS. 34A and 34B, an example of a shoulder SIP device 3100, similar to shoulder SIP device 72 and 3012a, 3012b for example, is illustrated in more detail. As shown, the shoulder SIP device 3100 includes a body having a base or mounting surface 3102 mountable to a portion of a child seat, an occupant facing surface 3104 engageable by an occupant of the child seat, and a side portion 3106 extending between the base 3102 and the occupant facing surface 3104. In an embodiment, best shown in FIGS. 34A and 34B, an interface or transition between the occupant facing surface 3104 and the side portion 3106 of a shoulder SIP device 3100 is shaped or contoured, for example rounded or angled to facilitate movement of an occupant about the shoulder SIP device 3100. In other embodiments, this interface may include a sloped surface extending outwardly from the occupant facing surface toward the base. In an embodiment, this shape of this transition may facilitate forward movement of an occupant.

[0612] The shoulder SIP device 3100, such as those used in the exemplary embodiment of FIGS. 33A-33C, may have a constant thickness defined by the side portion 3106. In such embodiments, a distance between the occupant facing surface 3104 of the shoulder SIP device 3100 and the base 3102 is constant. In embodiments where an upright side member of a child

seat, such as upright side members 3008, 3010 for example, extends at a non-perpendicular angle to the upright support surface, such as surface 3006, the occupant facing surface 3104 of the shoulder SIP device 3100 affixed to an upright side member 3008, 3010 may also be arranged at non-perpendicular angle to the upright support surface.

[0613] In other embodiments, such as shown in FIGS. 34A and 34B, a thickness of a side portion 3106 of a shoulder SIP device 3100 may vary, such as between a front and a back of a child seat. For example, in the non-limiting embodiment of a child seat 3200 shown in FIGS. 35A-35B, a side portion 3204 of a shoulder SIP device 3202 affixed to an upright side member 3206 of the child seat 3200 may vary such that the angle of a base 3208 of the shoulder SIP device 3202 is complementary to the angle of the upright side member 3206 relative to an upright support surface 3210. Accordingly, when the base 3208 of the shoulder SIP device 3202 is mounted to the upright side member 3206 at the proper position, an occupant facing surface 3212 of the shoulder SIP device 3202 is oriented substantially perpendicular to the upright support surface 3210. Although only a single shoulder SIP device 3202 is illustrated in the FIGS. , it should be appreciated that another shoulder SIP device 3202 may be disposed at an opposite side of the seat, such as affixed to upright side member 3220 at a similar position for example.

[0614] With reference to FIGS. 36A-36D, a shoulder SIP device 3300 according to another embodiment is illustrated. Similar to the previously described embodiment, the shoulder SIP device 3300 includes a body having a base or mounting surface 3302 mountable to a portion of a child seat 3320, such as an upright side member 3322 for example, an occupant facing surface 3304 engageable by an occupant of the child seat, and a side portion 3306 extending between the base 3302 and the occupant facing surface 3304. An interface between the occupant facing surface 3304 and the side portion 3306 may be rounded as previously described. In the illustrated, non-limiting embodiment, the occupant facing surface 3304 of the shoulder SIP device 3300 has a non-planar configuration and includes a first portion or area 3308 arranged at a first angle relative to the base 3302, and a second portion or area 3310 arranged at a second angle relative to the base 3302. The first portion 3308 and the second portion 3310 may be separated from one another by a central portion 3312.

[0615] The thickness of the shoulder SIP device 3300 may be greatest at the central portion 3312 such that the first portion 3308 and the second portion 3310 slope downwardly away from the central portion 3312. The slope of the first and second portions 3308, 3310 may be equal or may be different. In an embodiment, the central portion 3312 has a generally rounded contour that forms a smooth transition between the first portion 3308 and the second

portion 3310 of the occupant facing surface 3304. Inclusion of the curved central portion 3312 and the sloped first and second portions 3308, 3310 facilitates movement of an occupant's shoulder about the shoulder SIP device 3300 during a crash event. Although only a single shoulder SIP device 3300 is illustrated in the FIGS., it should be appreciated that another shoulder SIP device 3300 may be disposed at an opposite side of the seat, such as at a similar location affixed to upright side member 3224 at a similar position for example.

[0616] Another embodiment of a shoulder SIP device suitable for use with a child seat 3400 is illustrated in FIGS. 37A-37B. As shown, at least one shoulder SIP device 3402a, 3402b associated with the child seat 3400 has an elongated body positionable at the upright portion 3406 of a seat shell 3404 of the child seat 3400. In an embodiment, a first shoulder SIP device 3402a is positioned in overlapping arrangement with a first upright side member 3408 of the child seat 3400 and a second first shoulder SIP device 3402b is positioned in overlapping arrangement with a second upright side member 3410 of the child seat 3400. Although the child seat 3400 is illustrated and described as having two separate and distinct shoulder SIP devices 3402a, 3402b, embodiments where the two bodies are integral or are connected together as a single shoulder SIP device are also contemplated herein.

[0617] Top portions 3412a, 3412b of respective shoulder SIP devices 3402a, 3402b may be aligned with a top 3403 of the upright portion 3406 of the seat shell 3404, and the shoulder SIP devices 3402a, 3402b may extend over only a portion, or alternatively, over a substantially entire height of an upright side member 3408, 3410. Bottom or lower end portions 3414a, 3414b of the shoulder SIP device 3402a, 3402b may be aligned with or arranged near a bottom of a headrest 3416 of the child seat 3400 when the headrest 3416 is in its lowermost position relative to the seat shell 3404. Although the shoulder SIP devices 3402a, 3402b are illustrated as having an outer periphery including a contour complementary to respective upright side members 3408, 3410, embodiments where the shoulder SIP devices 3402a, 3402b have another contour are also contemplated herein. Further, respective contours of occupant facing surfaces 3420a, 3420b of the shoulder SIP device 3402a, 3402b may be configured so that the headrest 3416 is movable between a lowered position (FIG. 37A) and a raised position (FIG. 37B) without interference by the shoulder SIP devices 3402a, 3402b.

[0618] Another example of a child seat 6700 is illustrated in FIGS. 70A-70B. As shown, the child seat 6700 includes a seat shell 6702 having an upright portion 6704 and a seat portion 6706 and a headrest 6708 that is movable relative to the upright portion 6704 between a first, low position (FIG. 70A) and a second, high position (FIG. 70A). In an embodiment, at least one shoulder SIP device is coupled to and extends downwardly beyond a bottom 6710 of

the headrest 6708. As shown, a first shoulder SIP device 6712a may be arranged near a first side 6714 of the headrest 6708 and a second shoulder SIP device 6712b may be arranged near a second, opposite side 6716 of the headrest 6708. The first and second shoulder SIP devices 6712a, 6712b may be any suitable size and shape. By associating the at least one shoulder SIP device 6712a, 6712b with the headrest 6708, the shoulder SIP device 6712a, 6712b is movable with the headrest 6708. Such a configuration may provide enhanced protection by adapting positions of the shoulder SIP devices 6712a, 6712b based on the height of the occupant. Further, in some embodiments, the shoulder SIP devices 6712a, 6712b may alternatively or additionally be movable relative to the headrest 6708, such as to provide improved adaptability.

[0619] With reference to FIGS. 84A-85, another example of a child seat 8100 having a headrest 8102 movable between a low position (FIG. 84A) and a high position (FIG. 84B) is illustrated. Similar to the previous embodiment, a first shoulder SIP device 8104a may be coupled to and extends downwardly beyond a bottom 8110a of a first headrest side member 8106, and a second shoulder SIP device 8104b may be coupled to and extend downwardly beyond a bottom 8110b of a second headrest side member 8108. The shoulder SIP devices 8104a, 8104b are movable with the headrest 8102 relative to the seat body of the child seat 8100, such as between a first position and a second position.

[0620] An example of a shoulder SIP device such as the shoulder SIP device 8104a is shown in detail in FIG. 85. In the illustrated, non-limiting embodiment, the shoulder SIP device 8104a includes a body 8112 formed from a housing 8114 and at least one insert 8116. As shown, the housing 8114 may include a back wall 8124 and at least one sidewall 8126 extending at an angle from the back wall 8124. In some embodiments, the back wall 8124 of the housing 8114 has a contour generally complementary to at least one of the corresponding headrest side member 8106 and an adjacent upright side member 8122 of a seat back 8120 of the child seat 8110. However, embodiments where the back wall 8124 has a different contour are also contemplated herein. As shown, the back wall 8124 may form an end of the housing 8114 and the at least one sidewall 8126 may protrude substantially perpendicularly from of the back wall 8124. Further, the at least one sidewall 8126 may include a plurality of sidewalls or a single continuous sidewall that extends about a portion of a perimeter of the back wall 8124 to define a cavity 8128 between the at least one sidewall 8126 and the back wall 8124 within which the insert 8116 is receivable.

[0621] The at least one insert 8116 may be a single insert, or alternatively, may be a plurality of inserts having similar or different configurations. The single insert, or the plurality of inserts in combination, may have a size and/or shape complementary to the cavity 8128 of

the housing 8114. The at least one insert 8116 may be permanently or removably mounted within the cavity 8128 via any suitable mounting mechanism, such as an adhesive, or one or more engagement features configured to cooperate with corresponding portions of the housing. In an embodiment, the housing 8114 is formed from a first material and the insert 8116 is formed from a second material. The hardness of the first material may be similar to, or alternatively, may be different from the hardness of the second material. In an embodiment, the first material is plastic and the second material is a foam material.

[0622] The shoulder SIP device 8104a is connectable to and movable with the headrest 8102. In an embodiment, the shoulder SIP device 8104a is mechanically coupled to the headrest 8102 via one or more fasteners, such as screws or bolts (not shown) for example. However, other suitable coupling mechanisms, such as hook and loop fasteners, magnets, or snaps for example, may be used to couple the shoulder SIP device 8104a in position. As shown, the coupling mechanism may be configured to engage a portion of the housing 8114. For example, a plurality of openings 8130 for receiving corresponding fasteners may be formed in the housing 8114, such as at a surface thereof facing toward an interior of the cavity 8128. Embodiments including a coupling mechanism arranged at another location about the housing, or alternatively or additionally, arranged at the insert are also within the scope of the disclosure. Further, embodiments where the same coupling mechanism is used to affix the at least one insert 8116 to the housing 8114 and to affix the shoulder SIP device 8104a to the headrest 8102 are also contemplated herein. It should be appreciated that shoulder SIP device 8104b arranged at the second headrest side member 8108 may have a similar construction and coupling mechanism for connecting the shoulder SIP device 8104b to the headrest 8102.

[0623] With reference now to FIGS. 136A-141, various examples of another shoulder SIP device are illustrated. In the non-limiting embodiment of FIGS. 136A-136B, the body 12002 of the shoulder SIP device 12000 similarly includes a back wall 12004 and at least one mounting wall 12006 oriented at an angle relative to the back wall 12004. The back wall 12004 may have a contour generally complementary to a portion of a headrest. However, embodiments where the back wall 12004 has a different contour are also contemplated herein.

[0624] The shoulder SIP device 12000 may be positioned relative to a child seat such that an occupant is configured to contact a forward-facing surface 12008 of the back wall 12004. Further, the mounting wall 12006 may extend at a non-parallel angle from the back wall 12004. In an embodiment, the mounting wall 12006 extends from the forward-facing surface 12008 of the back wall 12004, such as near a first end 12010 of the back wall 12004 for example. A coupling mechanism (not shown) for connecting the shoulder SIP device 12000 to

a portion of a child seat, such as to a headrest or portion of s seat shell for example, may be associated with a portion of the body 12002. Similar to the previous embodiment, the coupling mechanism may include one or more fasteners, such as screws or bolts (not shown) for example, receivable within corresponding openings 12012 formed in the mounting wall 12006.

[0625] In some embodiments, the outwardly facing surface 12014 of the back wall 12004 is a solid or substantially solid surface. However, in other embodiments, such as shown in FIG. 136B, the back wall 12004 has one or more areas of material removed from the outwardly facing surface 12014 resulting in the formation of hollow pockets 12016 at the outwardly facing surface 12014. These pockets or areas of removed material 12016 may extend through only a small portion of the thickness of the back wall 12004, or alternatively, may extend over substantially the entire thickness of the back wall 12004 while leaving a solid forward-facing surface 12008. The resulting structural ribs 12018 formed at the back wall 12004 provide the necessary structural rigidity to the shoulder SIP device 12000. Although a combination of horizontally oriented and vertically oriented structural ribs 12018 are illustrated, it should be understood that embodiments including only horizontally oriented ribs, only vertically oriented ribs, or ribs at another orientation are also contemplated herein.

[0626] The structural ribs 12018 formed by removing areas of material may have a contour complementary to the contour of the body 12002. However, in some embodiments, such as shown in FIG. 137, the outermost edge 12020 of one or more of the structural ribs 12018, such as the edge of the horizontally oriented ribs 12018 of the shoulder SIP device 12000 for example, may have a contour different than that of the body 12002. In the illustrated, non-limiting embodiment, the edge 12020 of one or more ribs 12018 is scalloped by forming small notches therein. As a result, the edge 12020 of the at least one rib 12018 is at least partially offset, such as in an internal direction, from a periphery of the back wall 12004 at that location.

[0627] Another example of a shoulder SIP device 12100 is illustrated in FIGS. 138 and 139. Similar to the embodiment of FIGS. 136A-136B, the shoulder SIP device 12100 includes a body 12102 having a back wall 12104 and at least one mounting wall 12106 extending at an angle from a forward-facing surface 12108 of the back wall 12104. Alternatively, or in addition to removing areas of material from the outward-facing surface 12114 of the back wall 12104, in the illustrated, non-limiting embodiment, one or more areas of material may be removed from the forward-facing surface 12108 of the back wall 12104 resulting in the formation of hollow pockets 12116 in the body of the shoulder SIP device 12100 (see FIG. 138). The hollow pockets 12116 may be filled with a secondary material 12122 (see FIG. 139). In an

embodiment, the hollow pockets 12116 formed in the body 12102 are filled with pieces of expanded polypropylene. However, embodiments where another suitable material is alternatively or additionally arranged within the hollow pockets 12116 are also contemplated herein.

[0628] As noted above, an occupant may directly contact a forward-facing surface 12008, 12108 of the back wall 12004, 12104, or a secondary material positioned within the pockets 12116 formed in the forward-facing surface 12008, 12108, such as secondary material 12122. However, in other some embodiments, an insert may be arranged at the forward-facing surface 12008, 12108 of the back wall 12004, 12104. With reference to FIGS. 140A-140B, an example of an insert 12250 positionable adjacent to the forward-facing surface of a back wall, such as back wall 12104 of the shoulder SIP device 12100 for example, is illustrated. As shown, the front 12252 of the insert 12250 may include a continuous or solid surface. In the illustrated, non-limiting embodiment of FIG. 140B, the rear 12254 of the insert 12250 includes one or more contoured areas 12960. However, embodiments where the rear 12954 of the insert 12250 also has a substantially solid, smooth surface are also contemplated herein.

[0629] In an embodiment, the one or more contoured areas 12260 are complementary to the one or more hollow pockets 12216 formed at the forward-facing surface 12208 of the back wall 12204. Accordingly, each contoured area 12260 may form a tight fit with a respective pocket of the body 12202. One or more grooves or recesses 12262 may be formed in the rear surface to define the various contoured areas. These grooves 12262 may be complementary to the structural ribs 12218 defined by the hollow pockets 12216. The thickness of each contoured area may be substantially identical, as shown. However, in other embodiments, the thickness of the contoured areas 12260 may vary based on the depth of the back wall 12204 and/or the depth of a corresponding pocket 12216 at that location. The exemplary insert 12250 is formed from an expanded polypropylene material; however, and suitable material is contemplated herein.

[0630] In embodiments where an insert 12250 or secondary material 12222 is integrated into the shoulder SIP device 12200, as illustrated and described herein, the insert 12250 or secondary material 12222 may be glued or affixed to the back wall 12204 using an adhesive, such as adhesive tape for example. However, any suitable type of connection, including both permanent and removable connections, are contemplated herein.

[0631] With reference to FIG. 141, another example of a shoulder SIP device 12300 is illustrated. Similar to the previous embodiment, the shoulder SIP device 12300 includes a body 12302 having a back wall 12304 and at least one mounting wall 12306 extending at an angle

from a forward-facing surface 12308 of the back wall 12304. An outward-facing surface 12310 of the back wall 12304 may be substantially solid, or alternatively, may have a plurality of pockets formed therein as previously described. In the illustrated, non-limiting embodiment, a secondary body 12320 is affixed to the outward-facing surface 12310 of the back wall 12304. The secondary body 12320 may but need not extend over an entirety of the outward-facing surface 12310. A thickness of the secondary body 12320 may be uniform over its length, or alternatively, may vary, such as based on a profile of the body 12302 for example. The secondary body 12320 may be formed from any suitable material. In an embodiment, the material of the secondary body 12320 has an increased hardness than the material of the body 12302. However, embodiments where the secondary body 12320 has the same hardness or a reduced hardness relative to the body 12302 are also contemplated herein.

[0632] With reference now to FIGS. 152A-152B, an example of a shoulder SIP device 13100 positionable adjacent to a head SIP device 13102 is illustrated. The head SIP assembly 13102 may have a configuration substantially identical to that illustrated and described with respect to FIGS. 132A-133B. As shown, the head SIP assembly 13102 includes a connector member 13104 having a central body portion 13106, a first side portion 13108 extending from a first side of the body portion 13104, and a second side portion 13110 extending from a second opposite side of the body portion 13104. A first head SIP device (not shown) may be arranged at or adjacent to the first side portion 13108 of the connector member 13104 and a second head SIP device 13112b may be arranged at or adjacent to the second side portion 13110 of the connector member 13104. In the illustrated, non-limiting embodiment, the head SIP devices 13112a, 13112b are mounted near a rear of the head SIP assembly 13102, such as at an interface between the body portion 13106 and the respective side portions 13108, 13110 of the connector member 13104 for example.

[0633] In an embodiment, a cutout or notch is formed at the bottom of the head SIP assembly 11800. As shown, a first cutout 13114a may be formed directly underneath the first head SIP device 13112a and a second cutout 13114b may be formed directly underneath the second head SIP device 13112b. The cutouts 13114a, 13114b may form part of a vehicle belt path when a child seat system associated therewith is in a forward-facing configuration, such as in a booster mode of operation. Accordingly, a bottom of the first head SIP device and the second head SIP device may define a portion of the vehicle belt path.

[0634] As shown, at least one shoulder SIP device 13100a, 13100b, similar to that described with respect to FIGS. 136A and 136B is arranged directly adjacent to the head SIP assembly 13002. However, it should be understood that the at least one shoulder SIP device



may have a configuration as described with respect to the shoulder SIP devices 6712a, 6712b, 8104a, 8104b, 12000, 12100, 12200 and 12300 of the embodiments shown in FIGS. 70A-70B, 84A-85, and 136A-141. In the illustrated, non-limiting embodiment, when mounted to a child seat, such as child seat 6700 or 8100 for example, the at least one shoulder SIP device 13100a, 13100b is movable with the headrest SIP assembly 13102 and a corresponding headrest (not shown) of the child seat.

[0635] In the illustrated, non-limiting embodiments shown in FIGS. 152A-152B, a first shoulder SIP device 13100a is positioned directly underneath a corresponding opening 13114a formed at the first side portion 13108 of the head SIP assembly 13102 and a second shoulder SIP device 13100b is positioned directly underneath a corresponding opening 13114b formed at the first side portion 13110 of the head SIP assembly 13102. Accordingly, both the head SIP assembly 13102 and a corresponding shoulder SIP device 13100a, 13100b may define at least a portion or portions of the vehicle belt path of the child seat. For example, the head SIP assembly 13102, or the head SIP devices 13112a, 13112b thereof, may define a top or upper boundary of the vehicle belt path and the shoulder SIP devices 13100a, 13100b may define a bottom or lower boundary of the vehicle belt path.

[0636] A shoulder SIP device of any of the embodiments described herein, such as any of the shoulder SIP devices 6712a, 6712b, 8104a, 8104b, 12000, 12100, 12200, 12300, and 13100a, 13100b (and further the shoulder SIP devices 12402 and 12502 described below with respect to FIGS. 142A-143B) may additionally include soft goods positioned in overlapping arrangement with at least a portion of the body of the shoulder SIP device, such as the front face of the body of the shoulder SIP device. In such embodiments, the soft goods surrounding the shoulder SIP devices 6712a, 6712b, 8104a, 8104b, 12000, 12100, 12200, 12300, 13100a, 13100b, 12402 and 12502 may form or define part of the vehicle belt path.

[0637] In the illustrated, non-limiting embodiment of FIGS. 142A-142B, a child seat 12400 includes a shoulder SIP device (not shown) at least partially covered by soft goods 12402. In an embodiment, the shoulder SIP device is substantially encapsulated by the soft goods 12402. The soft goods 12402 are separate from the other soft goods of the child seat 12400, such as from the soft goods of the headrest 12404 and the soft goods 12406 of the upright portion 12408 of the child seat 12400. As shown, the soft goods 12402 cover a substantial entirety of the body of the shoulder SIP device. However, embodiments where the soft goods 12402 extend about only a portion of the body of the shoulder SIP device are also contemplated herein. The soft goods 12402 may include padding, such as a polyurethan foam for example, positionable in overlapping arrangement with or directly adjacent to a front or

forward-facing surface of the body of the shoulder SIP device, such as surface 12008, 12108, 12208, 12308 for example.

[0638] In other embodiments, the soft goods of the shoulder SIP device, such as shoulder SIP device 6712a, 6712b, 8104a, 8104b, 12000, 12100, 12200 and 12300 may be integral with the soft goods of another portion of the child seat. With reference to FIGS. 143A-143B, a child seat 12500 having at least one shoulder SIP device 12502 mounted to and movable with a headrest 12504 is illustrated. It should be understood that the shoulder SIP device 12502 may have a configuration as disclosed with respect to any of 70A-70B, 84A-85, 136A-141. The child seat 12500 includes headrest soft goods 12506 positionable about the inner surface of the headrest 12504 that may be contacted by an occupant's head. In the illustrated, non-limiting embodiment, the headrest soft goods 12506 is elongated and has at least one pocket 12508a, 12508b formed therein at a position vertically beneath a bottom of the headrest 12504. The at least one shoulder SIP device 12502 is insertable into the at least one pocket 12508a, 12508b such that the soft goods of the pocket 12508a, 12508b substantially cover a forward-facing surface 12510 of the shoulder SIP device 12502. Although the soft goods 12508a, 12508b are suggested as being integral with the headrest soft goods 12506, in other embodiments soft goods corresponding to the shoulder SIP devices may be integral with the soft goods associated with the upright support portion a child seat.

[0639] With reference to FIGS. 144A-144B, in some embodiments, the body of the soft goods 12604 positionable about a headrest 12602 of a child seat 12600 may be elongated and extend about the upright or back portion 12608 of the child seat. For example, the headrest soft goods 12604 may also overlap all or at least a portion of the upright support surface (not shown) of the child seat 12600. The headrest soft goods 12604 includes a headrest portion 12610 positionable in overlapping arrangement with the headrest 12602 and a back portion 12612 positionable in overlapping arrangement with the back portion 12608 of the child seat 12600. To allow for proper movement of one or more shoulder SIP devices 12620a, 12620b with the headrest 12602, at least one cutout, identified at 12622, may be formed at one or more areas of the headrest soft goods 12604. In the illustrated, non-limiting embodiment, the cutouts 12622 are formed proximate to an upper end 12624 of the back portion 12612 located near the headrest portion 12604. The cutouts 12622 may be sized and shaped based on the configuration of the shoulder SIP devices 12620a, 12620b mountable to the headrest 12602 so that headrest soft goods 12604 do not interfere with movement of the shoulder SIP devices 12620a, 12620b. It should be understood that these cutouts 12622 may exist regardless of whether the shoulder

SIP devices are covered by soft goods and whether such soft goods are part of the headrest soft goods 12604.

[0640] With reference now to FIGS. 38A-49E, various examples of SIP devices suitable for use with a child seat to limit movement of the torso or hips of an occupant of the child seat are illustrated. Such SIP devices may be referred to herein as “torso SIP devices,” with these devices typically being arranged at an occupant facing surface of a child seat at an area of the child seat (either the seat portion or the back portion) generally aligned with and configured to contact an occupant at any position between along the occupant’s torso, such as between a hip and a shoulder for example. It should be understood that torso SIP devices as illustrated and described herein may be integrated into a child seat as an alternative to, or in combination with one or more of the head SIP devices and shoulder SIP devices as previously described herein. As will be described in more detail below, a torso SIP device may be positioned adjacent to an inner surface of seat shell, such as at either the upright portion or the seat portion thereof. Unless another arrangement is noted, any embodiment described herein that includes a torso SIP device locatable at such an inner surface region should be understood to position the torso SIP device generally between the seat shell of the child seat and soft goods that cover the interior surface of the seat shell. Such a torso SIP device may be attached to the seat shell or to the soft goods positionable thereabout.

[0641] In the non-limiting embodiment illustrated in FIGS. 38A-38C, a child seat 3500 includes at least one torso SIP device, and in some embodiments, a plurality of torso SIP devices. For example, a first torso SIP device 3502a and a second torso SIP device 3502b may be arranged at a child seat 3504 of the child seat 3500. As shown, the first torso SIP device 3502a may be arranged at the first upright side member 3510 of an upright portion 3508 of a seat shell 3506 of the child seat and a second torso SIP device 3502b may be arranged at a corresponding second upright side member 3512. Although only a first and second torso SIP device 3502a, 3502b are illustrated and described herein, it should be appreciated that embodiments having more than one torso SIP device associated with a same torso area of the occupant, such as at a left side or right side of the occupant for example, are also contemplated herein. In the illustrated embodiment, the first torso SIP device 3502a and the second torso SIP device 3502b are substantially identical; however, embodiments where a configuration of the first and second torso SIP devices 3502a, 3502b varies are also within the scope of the disclosure.

[0642] The first and second torso SIP devices 3502a, 3502b may be positioned adjacent to a bottom 3516 of an upright support surface 3514 of the upright portion 3508, such as upwardly adjacent or proximate the interface between the upright portion 3508 and the seat

portion 3509 for example. As shown, the torso SIP devices 3502a, 3502b may be located between a surface of the seat shell 3506 and the soft goods 3520 surrounding the seat shell 3506 (see FIG. 38C). In an embodiment, the first and second torso SIP devices 3502a, 3502b have a height that is restricted generally to the torso area of the occupant. For example, the torso SIP devices 3502a, 3502b may be positioned such that it does not extend beyond a hip of the occupant. Alternatively, in embodiments where the upright side members 3510, 3512 include an opening 3522 that defines a portion of a vehicle belt path when the child seat 3504 is mounted in a forward-facing configuration, the torso SIP devices 3502a, 3502b may be arranged vertically below the openings 3522.

[0643] The first and second torso SIP devices 3502a, 3502b may extend inwardly towards an occupant area from generally adjacent front edges 3524a, 3524b of a respective upright side members 3510, 3512. Further, the body of a torso SIP devices 3502a, 3502b may extend upward along at least a portion of the upright support surface 3514. The torso SIP devices 3502a, 3502b may span the entire width of the upright side member 3510, 3512, between the front edge 3524a, 3524b and the upright support surface 3514, or only a portion thereof. In some embodiments, a thickness of each torso SIP device 3502a, 3502b (measured perpendicular to the respective first and second upright side member 3510, 3512) is substantially uniform over its height. In such embodiments, an upper surface 3526 of the torso SIP device 3502a, 3502b is flat and may have a generally horizontal orientation.

[0644] With reference now to FIG. 39, another embodiment of a child seat 3600 having at least one torso SIP device, such as a first torso SIP device 3602a and a second torso SIP device 3602b, is illustrated. Unlike the previous embodiments where the torso SIP devices were located at the back portion of a child seat, in the illustrated, non-limiting embodiment, at least one of the first and second torso SIP devices 3602a, 3602b are located at a seat portion 3604 of the child seat 3600. For example, the first and second torso SIP devices 3602a, 3602b may be arranged at the first and second seat side members 3606, 3608 of the seat portion 3604, such as proximate a rear 3612 of the seat support surface 3610. Although not shown, the first and second torso SIP devices 3602a, 3602b may have a configuration including a uniform thickness as previously described.

[0645] Alternatively, as shown in FIG. 39, a thickness of the first and second torso SIP devices 3602a, 3602b may vary over a height of the torso SIP devices 3602a, 3602b. In the illustrated, non-limiting embodiment, the thickness of the first and second torso SIP devices 3602a, 3602b gradually increases from an upper surface 3614 of the torso SIP devices 3602a, 3602b toward the seat support surface 3610. However, it should be understood that a torso SIP

device torso SIP devices 3602a, 3602b having any suitable configuration is within the scope of the disclosure. Examples of other suitable configurations include but are not limited to a circular or oval torso SIP device, a rectangular torso SIP device, a curvilinear torso SIP device, and a polygonal torso SIP device.

[0646] In yet another embodiment illustrated in FIGS. 40A-40B, a child seat 3700 includes at least one torso SIP device. Similar to the previous embodiment, a first torso SIP device 3702a may be arranged at a first seat side member 3706 of a seat portion 3704 of the child seat 3700 and a second torso SIP device 3702b may be arranged at a second seat side member 3708 of the seat portion 3704. As shown, the torso SIP devices 3702a, 3702b, may be located adjacent or proximate a rear 3712 of the seat support surface 3710. However, embodiments where the torso SIP devices 3702a, 3702b are alternatively or additionally arranged at the upright portion 3714 of the child seat 3700, such as adjacent to a first upright side member 3716 and a second upright side member 3718, respectively are also contemplated herein.

[0647] In the illustrated, non-limiting embodiment, the torso SIP devices 3702a, 3702b have a generally rectangular body, with a thickness of the body being substantially less than a height of the body. When installed about the child seat 3700, a first upper end 3720a, 3720b of each torso SIP device 3702a, 3702b may be arranged at or directly adjacent the side member 3706, 3708, 3716, 3718 of the seat portion 3704 or the upright portion 3714, respectively. A second, lower end 3722 of each torso SIP device 3702a, 3702b may be spaced laterally towards the occupant from the first upper end 3720, thereby reducing the clearance between the torso SIP devices 3702a, 3702b. In such a configuration, each torso SIP device 3702a, 3702b is arranged at a non-parallel angle relative to the adjacent side member 3706, 3708, 3716, 3718. For example, the torso SIP devices 3702a, 3702b may be arranged at an angle between about 5 degrees and about 45 degrees relative to the seat support surface 3710. In the illustrated, non-limiting embodiment, a gap or clearance 3724a, 3724b may be formed between the side members 3706, 3708, 3715, or 3718 and the body of respective torso SIP devices 3702a, 3702b.

[0648] In the illustrated non-limiting embodiment of FIGS. 38A-40B, the disclosed first and second torso SIP devices are separate devices mounted individually about a child seat. However, in other embodiments, the first and second torso SIP devices located at opposite sides of the child seat may be integrally formed as a unitary body. For example, in the non-limiting embodiment illustrated in FIG. 41A-41C, a torso SIP assembly 3802 including one or more torso SIP devices may be mountable to a child seat 3800. As shown, the torso SIP assembly 3802 includes a first torso SIP device 3804a positionable near a torso of an occupant within the

child seat, a second torso SIP device 3804b positionable at the same height or at a different height near a torso of an occupant within the child seat 3800, and a connector body 3806 coupling the first torso SIP device 3804a and the second torso SIP device 3804b. In such embodiments, the torso SIP devices 3804a, 3804b may be formed from a first material, and the connector body 3806 may be formed from a second, different material. However, embodiments where the SIP devices 3804a, 3804b and the connector body 3806 are formed from the same material are also within the scope of the disclosure. As shown, the torso SIP assembly 3802 may be an insert removably connected to the child seat 3800, or alternatively, may be permanently connected to the child seat 3800. In embodiments where the torso SIP assembly 3802 is separable from the child seat 3800, the torso SIP assembly 3802 may function as an insert intended for use with an occupant of a desired size, such as less than 40 pounds for example. Accordingly, the torso SIP assembly 3802 may be removable as necessary to make room a larger occupant.

[0649] With reference to FIGS. 41A-41C, in the illustrated, non-limiting embodiment, the first and second torso SIP devices 3804a, 3804b have generally vertically oriented occupant facing surfaces 3810a, 3810b configured to contact an occupant. Further, the torso SIP devices 3804a, 3804b may have an outwardly facing surface or base 3812a, 3812b complementary to the curvature of the adjacent portion of the child seat 3800, such as a portion of the upright side members 3820, 3822 for example. As shown, the connector body 3806 extends between and couples the first torso SIP device 3804a and the second torso SIP device 3804b. Further, a portion of the connector body 3806 may be arranged between the first and second torso SIP devices 3804a, 3804b and a surface of the child seat, such as the upright side members 3820, 3822. In such embodiments, an occupant facing surface 3814 of the connector body 3806 may be complementary to the contour of an adjacent portion of the child seat, such as the upright side members 3820, 3822, the upright support surface 3824 of the upright portion 3825 of the child seat 3800, and/or the seat side members 3826, 3828, and/or the seat support surface 3830 of the seat portion 3832 of the child seat 3800. The first and second torso SIP devices 3804a, 3804b may be arranged within respective pockets formed in the connector body 3806. In an embodiment, the first and second torso SIP devices 3804a, 3804b are encapsulated by the connector body 3806.

[0650] Another embodiment of a torso SIP assembly 3902 suitable for use with a child seat 3900 is illustrated in FIGS. 42A-42C. As shown, the torso SIP assembly 3902 may be substantially similar to that of the previous embodiment. The torso SIP assembly 3902 includes a plurality of first torso SIP devices arranged at opposite sides of a connector body 3906. As

shown, a connector body 3906 may include a back portion 3908 and a first side portion 3910 and a second side portion 3912 extending from opposite sides of the back portion 3908. In the illustrated, non-limiting embodiment, a first torso SIP device 3904a is arranged adjacent to the first side portion 3910 and another first torso SIP device 3904b arranged adjacent to the second side portion 3912 of the connector body 3906. The first torso SIP devices 3904a, 3904b may be substantially identical.

[0651] Further, the torso SIP assembly 3902 may include at least one second torso SIP device and in some embodiments, a plurality of second torso SIP devices. In the illustrated, non-limiting embodiment, a second torso SIP device 3914a is arranged adjacent to the first side portion 3910 and another second torso SIP device 3914b arranged adjacent to the second side portion 3912 of the connector body 3906. The second torso SIP device 3914a, 3914b may be positionable within an upper torso region of the child seat 3900, such as associated with a chest of an occupant, such as between a hip and a shoulder for example. In the non-limiting embodiment, a second torso SIP device 3914a, 3914b is positioned directly adjacent to and in vertical overlapping arrangement with a corresponding first torso SIP device 3904a, 3904b. However, embodiments where a second torso SIP device 3914a, 3914b may be offset (laterally and/or vertically) from the first torso SIP devices 3904a, 3904b are also contemplated herein.

[0652] The second torso SIP devices 3914a, 3914b may be formed from a material selected to absorb crash energy. In some embodiments, a hardness of the second torso SIP devices 3914a, 3914b may be different than the hardness of the first torso SIP devices 3904a, 3904b. For example, the second torso SIP devices 3914a, 3914b may be softer or have a reduced hardness compared to the first torso SIP devices 3904a, 3904b. In other embodiments, the second torso SIP devices 3914a, 3914b may be harder than the first torso SIP device 3904a, 3904b or may have the substantially same hardness as the first torso SIP device 3904a, 3904b.

[0653] As shown, an outwardly facing surface of a second torso SIP device 3914a, 3914b and/or the connector body 3906 is complementary to a contour of the child seat 3900, such as at the upright portion 3916 of the child seat 3900. For example, the first side portion 3910 is positionable adjacent to a first upright side member 3918 and the second side portion 3912 of the connector body 3906 is positionable adjacent to a second upright side member 3920. In some embodiments, as shown in FIG. 42A, respective heights of the second torso SIP devices 3914a, 3914b, measured parallel to the side portions 3910, 3912 of the connector body 3906 for example, may vary over a height of the second torso SIP devices 3914a, 3914b. In the illustrated, non-limiting embodiment, front or forward-facing surface 3922a, 3922b of the second torso SIP devices 3914a, 3914b may be sloped between an upper end and a central

portion of a second torso SIP devices 3914a, 3914b. The angled portion of the front surface 3922 of the second torso SIP devices 3914a, 3914b may position the occupant's arms towards a front of the child seat. Such a positioning may to improve crash performance by preventing the occupant's arm from being compressed between the upright side member and the occupant's torso.

[0654] With reference now to FIG. 43A-43B, another embodiment of a child seat 4000 of a child seat system including at least one torso SIP device is illustrated. In an embodiment, torso SIP devices 4002a, 4002b are arranged at occupant facing surfaces of each upright side member 4006, 4008 of an upright portion 4004 of a seat shell 4005 of the child seat 4000. As shown, the torso SIP devices 4002a, 4002b generally have planar upper surfaces 4010a, 4010b positioned to form an armrest for an occupant of the child seat 4000. The torso SIP device 4002a, 4002b may be integrally formed with the seat shell 4005. As shown, soft goods 4012 may be positioned in overlapping arrangement with an interior facing surface of at least a portion of the torso SIP devices 4002a and 4002b.

[0655] With reference now to FIGS. 151A-151B, the illustrated child seat system 13000 includes a support base 13002 and a child seat 13004 receivable on the support base 13002. The child seat 13004 includes a seat shell 13006 that defines a seat portion 13008 and an upright portion 13010 of the child seat 13000. As shown, the upright portion 13010 includes an upright support surface 13012, a first upright side member 13014 extending from a first side of the upright support surface 13010 and a second upright side member 13016 extending from a second, opposite side of the upright support surface 13010. The seat portion 13008 may similarly include a seat support surface 13020 facing generally upwardly, a first seat side member 13022 may be arranged at a first side of the seat support surface 13020 and a second seat side member 13024 may be arranged at a second, opposite side of the seat support surface 13020.

[0656] In the illustrated, non-limiting embodiment, each seat side member 13022, 13024 has a slot 13026 formed therein configured to function as a lap belt guide during at least one mode of use of the child seat 13000. In some modes of operation of the child seat 13004, the slot 13026 may be configured to receive and position a lap belt portion of a vehicle restraint or a separate restraint belt to secure a child within the child seat 13004.

[0657] The seat portion 13008 may be removably connectable to both the support base 13002 and the back portion 13010. When separated from the remainder of the child seat system 13000, the seat portion 13008 may be configured as a booster seat positionable in direct contact with a vehicle seat and configured to support a child thereon.



[0658] A portion of the first side member 13022 arranged between the slot 13026 and part of the back portion 13008, such as the first upright support member 13014 for example, may be contoured to form an armrest when the seat portion 13008 is separated from the child seat 13004. Similarly, a portion of the second side member 13022 arranged between the slot 13026 and part of the back portion 13008, such as the second upright support member 13016 for example, may be contoured to form an armrest when the seat portion 13008 is separated from the child seat 13004. These armrest portions are identified at 13028a, 13028b, respectively.

[0659] In the illustrated, non-limiting embodiment, a first torso SIP device 13030a is permanently or removably coupled to the first armrest portion 13028a and a second torso SIP device 13030b is permanently or removably coupled to the second armrest portion 13028b. The torso SIP devices 13030a, 13030b may include one or more pieces of padding or foam and may be connected to the child seat 13004 using a chemical adhesive or via a mechanical connection, including but not limited to a snap connection, magnets, rivets, or hook and loops fasteners for example. Because the torso SIP devices 13030a, 13030b are arranged at a portion of the seat side members 13022, 13024 directly adjacent to slot 13026 formed therein, the torso SIP devices 13030a, 13030b may be considered to define a portion of the vehicle belt path extending through the seat portion 13008 of the child seat 13004.

[0660] The torso SIP devices 13030a, 13030b are illustrated as being positioned at an inward facing surface of one of the first and second armrest portion 13028a, 13028b such that the torso SIP devices 13030a, 13030b may be directly adjacent to and configured to contact a hip of the occupant. However, embodiments where the torso SIP devices 13030a, 13030b are alternatively or additionally arranged at another surface of the armrest portions 13028a, 13028b are also contemplated herein. In an embodiment, as shown in FIG. 151B, the soft goods 13032 associated with the upright portion 13010 of the child seat 13000 may be configured to at least partially overlap the torso SIP device 13030a, 13030b when the seat portion 13008 is connected to the child seat 13004.

[0661] In some embodiments, a torso SIP device is transformable between a first configuration and a second configuration. For example, a torso SIP device may be movable relative to the seat shell of a child seat between a retracted configuration and an extended configuration. In such embodiments, the torso SIP device may be coupled to the child seat in both the retracted configuration and the extended configuration. Further, in an embodiment, the torso SIP device is lockable in the retracted configuration, the extended configuration, or both. It should be understood that the torso SIP device is generally positioned between the child

seat and the soft goods when in the retracted configuration and may also be arranged between the child seat and the soft goods when in the extended configuration. However, embodiments where the torso SIP device is configured to protrude through or beyond the soft goods overlapping the child seat when in the extended configuration are also contemplated herein. Further, the torso SIP device is transformable between the extended and retracted configurations not only when the soft goods are removed from the child seat, but also when the soft goods are positioned about the child seat.

[0662] With reference to a child seat 4100 illustrated in FIGS. 44A- 44D, a first torso SIP device 4102a may be associated with a first portion of the seat shell 4104 of the child seat 4100, such as the first upright side member 4106, and a second torso SIP device 4102b may be associated with a second portion of the seat shell 4104, such as a second upright side member 4108. In an embodiment, each of the first and second upright side members 4106, 4108 has a cavity 4110a, 4110b (see FIGS. 44C & 44D) formed therein. The first and second SIP devices 4102a, 4102b are positioned within respective cavities 4110 of the first and second upright side members 4106, 4108 when in a retracted configuration. As shown, when in the retracted configuration, occupant facing surfaces 4112a, 4112b of the torso SIP devices 4102a, 4102b may be substantially flush with an adjacent interior surface of the first and second upright side members 4106, 4108 or another adjacent portion of the seat shell 4104. In the extended configuration, the first and second torso SIP devices 4102a, 4102b are removed from their cavities 4110a, 4110b and are positioned adjacent to the occupant surface of the seat shell 4104.

[0663] A torso SIP device 4102a, 4102b may be rotated about an axis between the retracted configuration and the extended configuration. In the illustrated, non-limiting embodiment, the first and second torso SIP devices 4102a, 4102b are configured to rotate about a generally horizontally oriented axis at a bottom of the cavity 4110a, 4110b. Accordingly, the first torso SIP device 4102a may be positioned directly beneath the cavity 4110a formed in the first upright side member 4106 when in the extended configuration. Similarly, the second torso SIP device 4102b may be positioned directly beneath the cavity 4110b formed in the second upright side member 4108 when in the extended configuration. In the extended configuration, the occupant facing surface 4112a, 4112b of each respective torso SIP device 4102a, 4102b may be located adjacent to, and in some embodiments in direct contact with an adjacent surface of the seat shell 4104. However, it should be understood that embodiments where the torso SIP devices 4102a, 4102b are rotatable an axis having a different orientation, such as a vertically oriented axis for example, between a retracted and extended configuration are also within the scope of the disclosure. In an embodiment, a portion of a torso SIP device 4102a, 4102b may

be affixed to the child seat 4101 to limit the allowable movement of the torso SIP device 4102a, 4102b to transformation between the retracted and extended configurations.

[0664] Another embodiment of a child seat 4200 having at least one torso SIP device transformable between a retracted configuration and an extended configuration is illustrated in FIGS. 45A-45D. Similar to the previously described embodiment, a first torso SIP device 4202a may be associated with a first portion of the seat shell 4204, such as a first upright side member 4208 of an upright portion 4206 of the seat shell 4204, and a second torso SIP device 4202b may be associated with a second portion of the seat shell, such as a second upright side member 4210 of the upright portion 4206. In an embodiment, each of the first and second upright side members 4208, 4210 has a recess or cavity formed therein (not shown). At least a portion of the first and second torso SIP devices 4202a, 4202b are received within the respective cavities of the first and second upright side members 4208, 4210 in a retracted configuration (FIGS. 45A and 45B). As shown, when in the retracted configuration, an occupant facing surface 4212a, 4212b of the torso SIP devices 4202a, 4202b may be substantially flush with an adjacent interior surface of the seat shell 4204, such as an occupant facing surface of the seat side members 4220, 4222 of a seat portion 4224 of the seat shell 4104 for example. In the extended configuration, the first and second torso SIP devices 4202a, 4202b protrude from their cavities to reduce the available space within the interior of the seat shell 4204.

[0665] In an embodiment, the torso SIP devices 4202a, 4202b are translatable along an axis, such as a horizontally oriented axis for example, between the retracted configuration (FIGS. 45A and 45B) and the extended configuration (FIGS. 45C and 45D). Further, in the illustrated, non-limiting embodiment, respective upper surfaces 4230a, 4230b of the first and second torso SIP devices 4202a, 4202b are configured to form an armrest for an occupant of the child seat 4200. The torso SIP devices 4202a, 4202b may form an armrest when a torso SIP device 4202a, 4202b is in at least one, and in some embodiments in both, the retracted configuration, and the extended configuration.

[0666] In other embodiments, a similarly retractable torso SIP device may have another configuration including size and shape. For example, in the non-limiting embodiment of FIG. 46, a retractable torso SIP device 4302 of a child seat 4300 has a circular or oval configuration.

[0667] Another child seat 4400 having at least one torso SIP device transformable between a retracted configuration and an extended configuration is illustrated in FIGS. 47A-47D. Similar to the previous embodiments, a first torso SIP device 4402a may be associated with a first portion of a seat shell 4404 of the child seat 4400, such as a first upright side member

4408 of an upright portion 4406 of the seat shell 4404. Alternatively, or in addition, a second torso SIP device 4402b may be associated with a second portion of the seat shell, such as a second upright side member 4410 of the upright portion 4406. In the illustrated, non-limiting embodiment, the first and second torso SIP devices 4402a, 4402b are connected to the back 4412 of the seat shell 4104, at a location near the first upright side member 4408 and the second upright side member 4410, respectively.

[0668] Each of the first and second torso SIP devices 4402a, 4402b may be receivable within a corresponding cavity (not shown) formed in the seat shell 4104 via an opening 4414 in the upright support surface 4416 of the back 4412 (proximate a junction between the seat back 4412 and a seat support surface 4418). When in the retracted configuration and arranged within a cavity, the torso SIP devices 4402a, 4402b may be flush with, the adjacent upright support surface 4416, or alternatively, an adjacent seat support surface 4418. When in the extended configuration, as shown in FIGS. 47C and 47D, the first and second torso SIP devices 4402a, 4402b protrude from their cavities to reduce the available space within the interior of the seat shell 4404. The torso SIP devices 4402a, 4402b in the extended configuration are disposed between an occupant's torso and/or leg and the adjacent upright side member 4408, 4410 and/or seat side member 4420, 4422. The torso SIP devices 4402a, 4402b may be translatable, rotatable, or some combination of translatable and rotatable between the retracted configuration and the extended configuration.

[0669] A child seat 4500 having at least one similar torso SIP according to another embodiment is illustrated in FIGS. 48A-48D. Similar to the previous embodiment, a first torso SIP device 4502a may be associated with a first portion of the seat shell 4504 and a second torso SIP device 4502b may be associated with a second portion of the seat shell 4504. In the illustrated, non-limiting embodiment, the first and second torso SIP devices 4502a, 4502b are connected to a seat portion 4506 of the seat shell 4504, such as at a location near a first upright side member 4508 and a second upright side member 4510 of an upright portion 4512 of the seat shell 4504, respectively. The first and second torso SIP devices 4502a, 4502b are movable relative to openings 4514a, 4514b formed in the seat support surface 4516 between a retracted configuration and an extended configuration. In the retracted configuration (FIGS 48A and 48B), the torso SIP devices 4502a, 4502b are fully arranged within a corresponding cavity (not shown), such as located beneath the seat support surface 4516. In the extended configuration (FIGS. 48C and 48D), the first and second torso SIP devices 4502a, 4502b protrude generally vertically upwardly through the openings 4514 formed in seat support surface 4516 to reduce the available space within the interior of the seat shell 4504. The torso SIP devices 4502a,

4502b may be translatable, rotatable, or some combination thereof between the retracted configuration and the extended configuration.

[0670] With reference now to FIGS. 86A-86F, another embodiment of a child seat 8200 including a torso SIP device 8202 transformable between a plurality of configurations is illustrated. In each of the plurality of configurations, at least a portion of the torso SIP device 8202 remains at a fixed location relative to the child seat 8200 as will be described in more detail below. As shown, the torso SIP device 8202 includes a plurality of sections 8204a, 8204b, 8204c, 8204d connected together via one or more connector members 8206. Although four sections 8204a, 8204b, 8204c, 8204d are illustrated in the FIGS., it should be understood that embodiments having any number of sections, such as two sections, three sections, or more than four sections are also within the scope of the disclosure. Each of the plurality of sections 8204a, 8204b, 8204c, 8204d of the torso SIP device 8202 may be substantially identical; however, embodiments where one or more of the sections 8204a, 8204b, 8204c, 8204d has a different configuration are also contemplated herein. Further, in the illustrated, non-limiting embodiment, a single connector member 8206 is coupled to each of the plurality of sections 8204a, 8204b, 8204c, 8204d. For example, a connector member 8206 may be coupled to a surface of each of the plurality of sections 8204a, 8204b, 8204c, 8204d facing an adjacent side member 8208 of the child seat 8200. In other embodiments, a connector member 8206 may be coupled to only a portion of the plurality of sections 8204a, 8204b, 8204c, 8204d, such as to two adjacent sections of the plurality of sections for example.

[0671] When coupled by the at least one connector member 8206, the plurality of sections 8204a, 8204b, 8204c, 8204d are movable relative to one another to control a configuration of the torso SIP device 8202. The sections 8204a, 8204b, 8204c, 8204d may be movable to control a width and a height of the torso SIP device 8202. At least one of the plurality of sections 8204a, 8204b, 8204c, 8204d of the torso SIP device is mounted at a position in alignment with a hip of an occupant. The total number of the plurality of sections 8204a, 8204b, 8204c, 8204d arranged at this position is adjustable to control a width of the torso SIP device 8202. In a first or minimum thickness mode (FIG. 86A), only a single section 8204a is arranged at the position in alignment with an occupant's hip. However, in a second mode, more than one section, such as a first and second section 8204a, 8204b (FIG. 86B), may be arranged at this position. To transform between modes, one or more adjacent sections of the plurality of sections 8204a, 8204b, 8204c, 8204d may be folded, translated, or otherwise manipulated into overlapping arrangement with the first section 8204a along an axis extending between the opposing sides of the child seat 8200 at the position in alignment with an

occupant's hip. In further modes, additional sections may be arranged in overlapping arrangement and alignment with the other sections and the hip of an occupant. For example, a mode including three stacked sections 8204a, 8204b, 8204c is shown in FIG. 86C and a mode including four stacked sections 8204a, 8204b, 8204c, 8204d is shown in FIG. 86D. Stacking respective sections 8204a, 8204b, 8204c, 8204d of the torso SIP device 8202 allows a user to adjust the width of the torso SIP device 8202 based on the size of the occupant within the child seat 8200. Although the torso SIP device 8202 is illustrated as being arranged at a first side member 8208 of the child seat 8200, it should be appreciated that in other embodiments, the torso SIP device 8202 may alternatively or additionally be arranged at the opposite side member (not shown) of the child seat 8200.

[0672] With reference now to FIGS. 87A-87E, another embodiment of a child seat 8300 having at least one torso SIP device is shown. In the illustrated, non-limiting embodiment, a torso SIP assembly 8302 including one or more torso SIP devices 8304a, 8304b mounted to a child seat 8300. As shown, the torso SIP assembly 8302 includes a first torso SIP device 8304a positionable near a torso of a child seated within the child seat 8300 and a second torso SIP device 8304b positionable at the same height or at a different height near a torso of the occupant of the child seat 8300. A connector body 3806 is connected to both the first torso SIP device 8304a and the second torso SIP device 8304b to form a single unit. As shown, the torso SIP assembly 8302 may be an insert removably connectable to the child seat 8300. Although the torso SIP devices 8304a, 8304b are illustrated and described as being part of a torso SIP assembly 8302, in other embodiments, the torso SIP devices 8304a, 8304b may be directly connectable to the child seat 8300.

[0673] In embodiments where the torso SIP assembly 8302 and/or the torso SIP devices 8304a, 8304b are separable from the child seat 8300, the child seat 8300 may include a connection assembly 8310 engageable with a portion of at least one torso SIP devices 8304a, 8304b or alternatively, with the connector 8306 of the torso SIP assembly 8302 to retain the torso SIP devices 8304a, 8304b in position about the child seat 8300. In an embodiment, the connection assembly 8310 may be operably to loosely retain the torso SIP assembly 8302 or torso SIP devices 8304a, 8304b in position about the child seat 8300. The phrase "loosely retain" as used herein is intended to include embodiments where the torso SIP assembly 8302 or torso SIP devices 8304a, 8304b are attached to the child seat 8300, however, the torso SIP assembly 8302 or torso SIP devices 8304a, 8304b have some degree of movement while attached thereto. In the illustrated, non-limiting embodiment, the connection assembly 8310 includes a tether 8314 mounted to the child seat 8300 via a pin 8312. As shown, the pin 8312

is arranged at an upright surface 8322 of the back portion 8320 of the child seat 8300. However, embodiments where the pin 8312 is arranged at another suitable location that does not affect the occupant of the child seat are also contemplated herein. Rotation of the pin 8312 may lock the pin 8312 into engagement with the child seat 8300, thereby restricting separation of the tether 8314 coupled to the pin 8312 from the child seat 8300.

[0674] In other embodiments, such as shown in FIGS. 88A-88D, the connection assembly 8310 may rigidly mount the torso SIP assembly 8302 or torso SIP devices 8304a, 8304b to the child seat 8300. In such embodiments, the connection assembly 8310 may include a pin 8330 movable between a first position and a second position. The pin 8330 may include a feature or alternatively, may be operably coupled to another component, represented at 8332, that is movable into engagement with a torso SIP device 8304a, 8304b or the connector 8306 to restrict separation and/or movement thereof relative to the child seat 8300. For example, the feature or component 8332 may be receivable within or configured to engage a corresponding groove or recess 8334 formed in a torso SIP device 8304a, 8304b or the connector 8306. When the pin 8330 is in a first position, as shown in FIG. 88A and 88C, the feature or component 8332 is separated or disengaged from a torso SIP device 8304a, 8304b or the connector 8306, and when the pin 8330 is in the second position, as shown in FIG. 88B and 88D, the feature or component 8332 may be coupled to the torso SIP device 8304a, 8304b or the connector 8306. In the non-limiting embodiment of FIGS. 88A and 88B, the pin 8330 is illustrated as rotating about an axis between the first position and the second position. In another embodiment, as shown in FIGS. 88C and 88D, the pin 8330 may be configured to translate within a slot between the first position and the second position. Although the various connection mechanisms 8310 are illustrated and described herein with respect to a torso SIP device 8304a, 8304b, it should be understood that such a connection assembly 8310 may be applied to any SIP device disclosed herein, such as a head SIP device, a shoulder SIP device, and/or an external SIP device (to be described in more detail below) formed from a structurally modifiable body.

[0675] The transformable torso SIP devices illustrated and described in FIGS. 38A-48D are illustrated and described herein as rigid or semi-rigid bodies. However, in other embodiments, a transformable torso SIP device may be formed from a structurally modifiable body. With reference now to FIGS. 49A-49E, a child seat 4600 having at least one configurable or transformable torso SIP device formed from a flexible body is illustrated. As shown, a first torso SIP device 4602a may be associated with a first portion of a seat shell 4604 of the child seat 4600 and a second torso SIP device 4602b may be associated with a second portion of the seat shell 4604. In the illustrated, non-limiting embodiment, the first and second torso SIP

devices 4602a, 4602b are connected to a first upright side member 4608 and a second upright side member 4610, respectively, of an upright portion 4606 of the seat shell 4604. The first and second torso devices 4602a, 4602b may be positioned proximate to an interface with an adjacent first side seat member 4614 and second side seat member 4616 of a seat portion 4612 of the seat shell 4604. A portion of the first and second torso SIP devices 4602a, 4602b may but need not be receivable within a cavity formed in a corresponding portion of the seat shell 4604.

[0676] In the illustrated, non-limiting embodiment, the first and second torso SIP devices 4602a, 4602b are formed from structurally modifiable bodies, such as inflatable bladders or air bags. In a retracted configuration, the structurally modifiable bodies may be deflated, and therefore are generally flush with the interior of the seat shell 4604, such as shown in FIGS. 49A and 49B. In a deployed configuration, the structurally modifiable bodies 4602a, 4602b may be filled with a fluid, such as air for example. As shown in FIGS. 49C-49E, the filled structurally modifiable bodies 4602a, 4602b protrude inwardly from the interior surface of the first and second upright side members 4608, 4610, respectively. Further, when filled, the structurally modifiable bodies 4602a, 4602b may be elastically deformable to absorb energy applied thereto during a crash event.

[0677] With reference to FIGS. 89A-89D, another embodiment of a child seat 8400 having a first and second torso SIP device 8402a, 8402b formed from structurally modifiable bodies, such as inflatable bladders or air bags is illustrated. Similar to the previous embodiments, the structurally modifiable bodies 8402a, 8402b may be filled with a fluid, such as air for example, to transform between a retracted and a deployed configuration. As shown, a control 8404a, 8404b, such as a valve for example, operable to control a flow of air into and/or out of a structurally modifiable body may be associated with at least one of the torso SIP devices 8402a, 8402b. Although separate valves 8404a, 8404b are illustrated as being associated with each respective torso SIP device 8402a, 8402b in the FIGS., embodiments where a single valve is operable to control a fluid flow into a plurality of SIP devices 8402a, 8402b are also contemplated herein. The valves 8404a, 8404b may be adjusted, for example rotated in a first direction to provide a flow of air into a corresponding torso SIP device 8402a, 8402b, and the valves 8404a, 8404b may be further adjusted, such as rotated in a second direction to remove air from a corresponding torso SIP device 8402a, 8402b.

[0678] The valves 8404a, 8404b may be arranged at respective surfaces 8406a, 8406b of the torso SIP devices 8402a, 8402b that are not intended to contact an occupant of the child seat 8400. In the illustrated, non-limiting embodiment, the valves 8404a, 8404b are arranged



at a forward-facing surfaces 8406a, 8406b of the torso SIP devices 8402a, 8402b. However, embodiments where a valves 8404a, 8404b is at another suitable location accessible by an operator are also contemplated herein. Further, because the valves 8404a, 8404b are arranged at the body of each respective torso SIP device 8402a, 8402b, the valves 8404a, 8404b are movable with the torso SIP devices 8402a, 8402b between the retracted and deployed positions. Although a control 8404a, 8404b in the form of a valve is illustrated and described herein with respect to torso SIP devices 8402a, 8402b, it should be understood that such a control may be applied to any SIP device disclosed herein, such as a head SIP device, a shoulder SIP device, and/or an external SIP device (to be described in more detail below) formed from a structurally modifiable body.

[0679] With reference now again to FIG. 1, alternatively, or in addition to a head SIP device 70, shoulder SIP device 72a, 72b, and/or torso SIP device, as illustrated and described herein, the child seat system 20 may also include one or more SIP devices 74 arranged at a lateral side of the back or upright portion 28, such as near a center thereof, and may protrude outwardly therefrom. Such an SIP device, also be referred to herein as an “external SIP device” may be arranged at a child seat, a support base, or both. Further, it should be understood that an external SIP device as illustrated and described herein may be integrated into a child seat as an alternative to, or in combination with one or more of a head SIP device, a shoulder SIP device, and a torso SIP device as previously described herein. An external SIP device may be operable to limit or control an interaction between an exterior of the child seat system and an adjacent part of a vehicle, such as a vehicle door for example.

[0680] With reference now to FIGS. 50A-52B, various examples of an external SIP device associated with a child seat system. The at least one external SIP device may be permanently or removably connected to a corresponding portion of the child seat system via any suitable connection mechanism. For example, an external SIP device may be chemically adhered to, fastened via one or more fasteners, or integrally formed with a portion of the child seat system. Accordingly, an external SIP device may be a single unitary body or may be formed via a plurality of components connectable to one another to form the external SIP device.

[0681] With reference to FIGS. 50A and 50B, an example of a child seat system 4700 including an external SIP device 4702 is illustrated. As shown, the child seat system includes a child seat 4704 positionable about a support base 4706. The child seat 4704 includes a seat shell 4708 having an upright portion 4710 and a seat portion 4712. The external SIP device 4702, such as a bumper for example, may be arranged at the support base 4706. In the

illustrated, non-limiting embodiment, the support base 4706 includes a base seat portion 4714 positioned generally adjacent to the seat portion 4712 of the child seat 4704 and a base back portion 4716 positioned generally adjacent to the upright portion 4710 of the child seat 4704. As shown, the external SIP device may be arranged at a lateral side 4720 of the base back portion 4716, such as near a center thereof, and may protrude outwardly therefrom, as shown in FIG. 50A. However, in other embodiments, such as shown in FIGS. 51A-51B, an external SIP device may alternatively or additionally be located at another portion of the support base.

[0682] The example of a child seat system 4800 illustrated in FIGS. 51A-51B is similar to that of FIGS. 50A-50B. However, in the illustrated, non-limiting embodiment, the external SIP device 4802 is located at a base seat portion 4810 of the support base 4806, adjacent to a seat portion 4808 of the child seat 4804. As shown, the external SIP device 4802 may be arranged at a lateral side 4812 of the base seat portion 4810 and may protrude outwardly therefrom, as shown in FIG. 51A. Although the external SIP device 4802 is illustrated as being arranged near an interface with the base back portion 4814, in other embodiments, the external SIP device 4802 may be arranged near a front 4811 of the base seat portion 4810.

[0683] Regardless of a position of an external SIP device 4702, 4802 about the support base 4706, 4806, a contour of the external SIP device 4702, 4802 may be generally complementary to the adjacent surface of the support base 4706, 4806 at that location. However, embodiments where the external SIP device 4702, 4802 has a different contour are also contemplated herein.

[0684] In the illustrated, non-limiting embodiments shown in FIGS. 50A-51B, the external SIP devices 4702 and 4802, may be pods or bumpers fixed in position about the support base and formed from a material having a desired hardness. With reference now to FIGS. 99 and 100, in other embodiments, an external SIP device mounted to the support base is formed from a substantially rigid member. FIG. 99 illustrates a child seat system including a child seat 8900 positionable about a support base 8902. The child seat 8900 includes a seat shell 8904 having an upright portion 8906 and a seat portion 8908. The support base 8902 includes a base seat portion 8910 positioned generally adjacent to the seat portion 8908 of the child seat 8900 and a base back portion 8912 positioned generally adjacent to the upright portion 8906 of the child seat 8900. An external SIP device 8920 in the form of a bar is mounted to the support base 8902, such as at a lateral side of the support base 8902 for example. In the illustrated, non-limiting embodiment, a first end 8922 of the external SIP device 8920 is connected to the base seat portion 8910 and a second opposite end 8924 of the external SIP device 8920 is connected to the base back portion 8912. The external SIP device 8920 may

have a generally linear contour, or in some embodiments may have an arcuate contour, such as a convex contour extending away from the support base 8902 for example.

[0685] The example of a child seat system illustrated in FIG. 100 is similar to that of FIG. 99. However, in the illustrated, non-limiting embodiment of FIG. 100, both ends 9004, 9006 of an external SIP device 9002 are connected to the same portion of the support base 9000. For example, both the first end 9004 and the second end 9006 of the external SIP device 9002 may be arranged at a base seat portion 9010 of the support base 9000. Alternatively, the first end 9004 and the second end 9006 of the external SIP device 9002 may be arranged at a base back portion 9012 of the support base 9000.

[0686] The external SIP devices 8920, 9002 described herein may protrude generally perpendicularly from the lateral side of the support base 8902, 9000. In other embodiments, the external SIP devices 8920, 9002 may extend generally vertically from the support base 8902, 9000. In such embodiments, as shown in FIG. 100, the external SIP device 9002 overlaps a portion of the child seat 9020 positioned vertically above the interface between the ends 9004, 9006 of the external SIP device 9002 and the support base 9000.

[0687] Further, the external SIP devices 8920, 9002 may be permanently or removably coupled to the support base 8902, 9000. In embodiments where the external SIP device 8920, 9002 is removable, the external SIP device 8920, 9002 may be connectable to the support base 8902, 9000 via any suitable coupling mechanism (not shown). In the illustrated, non-limiting embodiments, the external SIP devices 8920, 9002 are detachably connectable to the support base 8902, 9000, at both a first lateral side and a second, opposite lateral side thereof. In such embodiments, the position of the external SIP devices 8920, 9002 relative to the support base 8902, 9000 may be selected based on the orientation and/or location of the child seat system 20 relative to a vehicle door. Further, the external SIP devices 8920, 9002 may be attached to the support base 8902, 9000, with a tether (not shown) even when the external SIP devices 8920, 9002 are not affixed at the first side or second side of the support base 8902, 9000. It should be appreciated that any of the SIP devices disclosed herein, including head SIP devices, shoulder SIP devices, and torso SIP devices may be tethered to a portion of a corresponding child seat, such as a child seat or a support base, when the SIP device is removably connectable to the child seat system.

[0688] Another example of an external SIP device is illustrated in FIG. 101. Similar to the embodiment shown in FIG. 99, the support base 9100 includes a base seat portion 9104 and a base back portion 9106 and in the illustrated, non-limiting embodiment the external SIP devices 9102a, 9102b disposed at opposite sides of the support base 9100 are rigid bars having

both respective first ends 9110a, 9110b and second ends 9112a, 9112b connected to the support base 9100. Although the first ends 9110 are illustrated as being connected to the base seat portion 9104 and the second ends 9112 are illustrated as being connected to the base back portion 9106, embodiments where both ends 9110, 9112 are connected at the base seat portion 9104 or the base back portion 9106 are also contemplated herein. The external SIP devices 9102a, 9102b may have any suitable contour, and in an embodiment, include a contour complementary to the lateral side of the support base 9100. In an embodiment, the external SIP devices 9102a, 9102b each include respective clips 9114 for securing the vehicle belt relative to the support base 9100. Although a support base 9100 having two similar external SIP devices 9102a, 9102b is illustrated, it should be appreciated that in other embodiments, the support base 9100 may have a single external SIP device movable between opposing lateral sides of the support base 9100 based on the orientation and location of the support base 9100.

[0689] In an embodiment, the external SIP devices 9102a, 9102b are movably mounted to the support base 9100 of a child seat system. The external SIP devices 9102a, 9102b may be transformable between respective stowed or retracted configurations, and respective deployed or extended configurations. The external SIP devices 9102a, 9102b may be positioned to absorb energy applied to the child seat during a side impact crash event when in the deployed configurations and may not be positioned to absorb energy when in the stowed configurations. In FIG. 101, the external SIP device 9102a is illustrated in the stowed configuration and the external SIP device 9102b is illustrated in the extended configuration.

[0690] When in the stowed configuration, a substantial entirety of the body of the stowed external SIP device 9102a, and/or 9102b may be arranged directly adjacent to the side of the support base 9100 (see external SIP device 9102a in FIG. 101). In an embodiment, the external SIP devices 9102a, 9102b are arranged within a corresponding recess (not shown) formed at the lateral side of the support base 9100 when in the stowed configuration. In respective extended configurations, the body of the external SIP devices 9102a, 9102b are generally offset from the surface of the support base 9100. As shown in FIG. 101, in the extended configuration the external SIP device 9102b protrudes laterally outwardly from the support base 9100 to form a brace. The external SIP devices 9102a, 9102b may be rotatable between the stowed and extended configurations. In an embodiment, the external SIP devices 9102a, 9102b remain coupled to the support base 9100 as the external SIP devices 9102a, 9102b are transformed between the stowed and extended configurations. However, embodiments where the external SIP devices 9102a, 9102b are separated from the support base 9100 during this transformation are also contemplated herein.

[0691] Another example of an external SIP device transformable between a stowed configuration and an extended configuration is illustrated in FIGS. 102A and 102B. The illustrated child seat system includes a support base 9200 configured to receive a child seat (not shown). The support base 9200 includes a base seat portion 9202 and a base back portion 9204. An external SIP device 9210 may be movably mounted to the support base 9200, such as adjacent to the base back portion 9204 thereof. In an embodiment, the external SIP device 9210 is arranged at a forward-facing surface 9206 of the base back portion 9204 rather than a lateral side thereof. The external SIP device 9210 may include a rigid member, such as bar formed into a U-shape for example. In an embodiment, the external SIP device 9210 is pivotable about an axis relative to the support base 9200 between the stowed configuration (FIG. 102A) and the extended configuration (FIG. 102B). In the stowed configuration, the external SIP device 9210 may be positioned adjacent to the forward-facing surface 9206 of the base back portion 9204, and in some embodiments, may be receivable within a groove 9212 formed therein. In the extended configuration, a portion of the external SIP device 9210 extends beyond a lateral side of the support base 9200. In FIG. 102B, the external SIP device 9210 is illustrated in a rotated position arranged at the right of the support base 9200. However, it should be understood that in other embodiments, the external SIP device 9210 may alternatively or additionally be rotatable about an axis such that a portion of the external SIP device 9210 extends beyond the left lateral side of the support base 9200. Further, in other embodiments, the external SIP device 9210 may be separable from the support base 9200 and reconnectable thereto in the desired position.

[0692] In a similar embodiment, illustrated in FIGS. 106A-106B, a support base 9600 configured to receive a child seat (not shown) includes a base seat portion 9602 and a base back portion 9604, and a belt lock-off mechanism 9606 operable to secure a vehicle belt 9601 to the support base 9600. In an embodiment, the belt lock-off mechanism 9606 has a base 9608 and a plurality of arms 9610a, 9610b extending outwardly from the distal end of the base 9608 to form a general T-shape. The belt lock-off mechanism 9606 including these arms 9610a, 9610b may act as an external SIP device. The belt lock-off mechanism 9606 is movably mounted to the support base 9600, such as adjacent to the base back portion 9604 thereof. In an embodiment, the belt lock-off mechanism 9606 is arranged at a forward-facing surface 9612 of the base back portion 9604 rather than a lateral side thereof.

[0693] The belt lock off mechanism 9606 is rotatable about an axis between a first, open position (FIG. 106A) in which a gap 9614 for receiving the vehicle belt 9601 is formed between the forward-facing surface 9612 and the belt lock off mechanism 9606 and a second,

closed position (FIG. 106B) in which the belt lock-off mechanism 9606 is positioned adjacent to the forward-facing surface 9612 and applies a tension to the vehicle belt 9601. With the belt lock-off mechanism 9606 in the closed position, the end of a respective arm 9610a, 9610b may be positioned adjacent to a vehicle door such that in the event of a side impact crash, the door will contact the arm 9610a, 9610b before contacting the remainder of the child seat system.

[0694] In the non-limiting embodiments illustrated in FIGS. 103-105, an external SIP device is arranged at a lateral side of a support base and is movable relative thereto between the stowed and extended configurations. With reference to the support base 9300 of FIG. 103, the external SIP device 9302 includes a rigid member 9304. The distal end 9306 of the rigid member 9304 positioned closest to a vehicle door may include a planar surface to maximize engagement with the vehicle door and absorption of energy therefrom in the event of a side impact crash. The body 9304 of the external SIP device 9302 may be receivable within an opening 9308 formed at a bottom or an interior of the support base 9300 such that a portion of the body 9304 protrudes from a side of the support base 9300 in both the stowed and deployed configurations. In an embodiment, the portion of the external SIP device 9302 extending from the side of the support base 9300 has a generally curved contour. However, embodiments with a different contour are also contemplated herein. The external SIP device 9302 may be configured to slide or translate within the opening between the stowed and deployed configurations. Accordingly, the amount of the body 9304 arranged of the external SIP device 9302 at a respective side of the support base 9300 when in the deployed configuration is greater than the amount of the body 9304 arranged at the respective side of the support base 9300 when in the stowed configuration.

[0695] In the non-limiting embodiment illustrated in FIG. 103, the external SIP device 9302 is movable to a deployed configuration at only one side of the support base 9300. In such embodiments, a second external SIP device (not shown) may be positioned for deployment adjacent to an opposite side of the support base 9300. However, in other embodiments, the external SIP device 9300 may be movable between a stowed configuration, a first deployed configuration, and a second deployed configuration. In such embodiments, the same external SIP device 9300 may be used regardless of which side the support base 9300 is positioned adjacent to a vehicle door. Further, in such embodiments, opposing sides of the body 9304 may have similar configurations and each end may have a planar surface, like surface 9306 described above, for contacting a vehicle door during a crash event.

[0696] The support base 9400 of FIG. 104 is similar to the support base of FIG. 103. As shown, an external SIP device 9402a, 9402b associated therewith includes a rigid member

9404 having a distal end 9406 including a planar surface to maximize engagement with the vehicle door. Each external SIP device 9402a, 9402b may be pivotally mounted to the support base 9400 and configured to rotate about an axis between the stowed configuration (9402b) and deployed configurations (9402a). In an embodiment, the respective axes of the external SIP devices 9402a, 9402b are oriented generally parallel to a longitudinal axis of the support base 9400. As shown by external SIP device 9402a, when in the deployed configuration, the external SIP devices 9402a, 9402b protrude in one or more directions from a lateral side of the support base 9400. In an embodiment, when in the stowed configuration, as shown by external SIP device 9402b, the external SIP devices 9402a, 9402b are each receivable within a corresponding groove or recess 9408a, 9408b formed in the support base 9400. In the illustrated, non-limiting embodiment, the external SIP devices 9402a, 9402b are arranged at the base seat portion 9410 thereof and the groove 9408a, 9408b are formed at an upper surface 9412 of the base seat portion 9410. However, it should be understood that embodiments where the external SIP devices 9402a, 9402b are arranged at another location about the support base 9400, such as at the base back portion 9414 for example, are also contemplated herein. When the external SIP device 9402a, 9402b is in the stowed configuration, the entirety of the external SIP device 9402a, 9402b may be arranged within the corresponding recess 9408a, 9408b, or alternatively, only a portion of the external SIP device 9402a, 9402b may be receivable therein.

[0697] In yet another embodiment illustrated in FIG. 105, at least one external SIP device 9502 mounted to a support base 9500 is translatable between a stowed configuration and a deployed configuration. As shown, the external SIP device 9502 may be arranged at a lateral side of the support base 9500. Although the external SIP device 9502 is illustrated as being positioned at the base back portion 9504, embodiments where the at least one external SIP device 9502 is alternatively or additionally mounted at the base seat portion 9506 are also contemplated herein. The external SIP device 9502 includes a plurality of body members 9508a, 9508b coupled together in an axially telescoping or translating manner. Accordingly, one or more of the plurality of body members 9508a, 9508b may be nested when the external SIP device 9502 is in a stowed configuration and the plurality of body members 9508a, 9508b may be coupled to and protrude one from another when the external SIP device 9502 is in the deployed configuration. In the deployed configuration, a distal end of the external SIP device 9502 may be positioned to contact the vehicle door.

[0698] In an embodiment, the external SIP device 9502 may be removably connectable to the support base 9500. In the illustrated, non-limiting embodiment, the support base 9500 includes a plurality of reliefs or mounting grooves for mounting the external SIP device 9502.

While the external SIP device is illustrated as being mounted to a relief (not shown) formed at a right lateral side of the support base 9500, the external SIP device may alternatively be mounted to the relief arranged at the left lateral side of the support base 9500 based on an orientation of the support base 9500 and its position relative to a vehicle door. Accordingly, in an embodiment, a position for the external SIP device is selected based on an orientation of the support base 9500 relative to a vehicle door.

[0699] With reference to FIGS. 131A-131C, another embodiment of an external SIP device movable between a plurality of positions is illustrated. A child seat system 11700 including a support base 11702 and a child seat 11704 connectable to the support base 11702 in a plurality of positions is illustrated. As shown, an external SIP device 11706 may form a foot arranged at the support base 11702. The foot may extend laterally beyond the lateral sides of the support base 11702 such that when the support base is installed on a vehicle seat, an end of the foot may abut or engage a vehicle door. In an embodiment, the external SIP device 11706 is movable between a first configuration (FIG. 131B), associated with a forward-facing installation of the child seat system 11700 and a second configuration (FIG. 131C) associated with a rearward-facing installation of the child seat system 11700. In the first configuration, the external SIP device 11706 may be arranged at a rear of the support base 11702, such as near an interface between a seat portion 11708 and an upright portion 11710 of the support base 11702. In the second configuration, the external SIP device 11706 may be arranged at a front 11712 of the support base 11702, such as near an opposite end of the seat portion 11708 thereof. One or more notches may be formed at the support base 11702, such as at the front 11712 or the back thereof, to properly position the foot 11706 at the respective forward and rearward positions. The external SIP device 11706 may be pivotally coupled to the support base 11702 for rotation between the first and second configurations. The configuration of the external SIP device 11706 may be adjusted manually, or alternatively, the external SIP device 11706 may transform automatically, such as with rotation of the child seat 11704 relative to the support base 11702 for example.

[0700] The child seat system may have a maximum width at a location of at least one side impact protection (SIP) device arranged at an exterior thereof. With reference to FIGS. 50A-51B, FIGS. 98A -106B and further reference to FIGS. 126A and 126C discussed below, in an embodiment, the child seat system has a maximum width at a location of at least one SIP device mounted to an exterior surface of a support base. The at least one SIP device may be located at the base seat portion of the support base, at the base back portion of the support base, or alternatively, at both the base seat portion and the base back portion. In such embodiments,



a width of the child seat at the at least one SIP device is less than the width defined by the at least one SIP device. In embodiments where the at least one SIP device is transformable between a first position and a second position, the maximum width may be defined by the at least one SIP device when in the first, deployed position. However, in some embodiments, the width at the at least one SIP device when in a second, stowed position may still be greater than a width of the child seat at the at least one SIP device.

[0701] In other embodiments, an external SIP device may alternatively or additionally be mounted at one or more locations about an exterior of the child seat of the child seat system. With reference now to FIGS. 52A-56B, various embodiments including at least one external SIP device affixable to a child seat at or near a location of the child seat associated with a vehicle belt path are illustrated.

[0702] The non-limiting embodiment of FIGS. 52A and 52B includes child seat system 4900 including an external SIP device 4902 device. As shown, the child seat system includes a child seat 4904 positionable about a support base 4906. The child seat 4904 includes a seat shell 4908 having an upright portion 4910 and a seat portion 4912. The upright portion 4910 includes a back portion 4914, and a first upright side member 4916 and a second upright side member 4918 extending from opposing sides of the back portion 4914. In the non-limiting embodiment, an external SIP device 4902 is arranged at an exterior surface of the at least one of the first and second upright side members 4916, 4918. As shown, the external SIP device may be positioned near the bottom of the upright portion 4910, such as adjacent to an interface with the seat portion 4912 for example. The external SIP device 4902 may but need not have a contour complementary to the corresponding portion of the upright side member 4916, 4918. Further, the external SIP device 4902 may protrude outwardly beyond the surface of the adjacent surface of upright side member 4916, 4918. In the illustrated, non-limiting embodiment of FIGS, the child seat 4904 does not include openings that define part of a vehicle belt path.

[0703] In FIGS. 53A-53B, another embodiment of a child seat system 5000 having a child seat 5002 positionable about a support base 5004 is shown. Similar to the previous embodiments, the child seat 5002 includes a seat shell 5006 having an upright portion 5008 and a seat portion 5010. The seat portion 5010 includes a first seat side member 5012 and a second seat side member (not shown) extending from opposing sides of a seat support surface (not shown). An external SIP device 5020 is arranged at an exterior surface of at least one of the first and second seat side members 5012. In the illustrated, non-limiting embodiment, the external SIP device 5020 is arranged near an interface with the upright portion 5008 and

adjacent to, for example behind, a slot 5014 formed in a seat side member 5012 for receiving a lap portion of a vehicle belt. As shown, a body of the external SIP device 5020 protrudes laterally or outwardly from the seat side member 5012 such as in a direction oriented substantially perpendicular to the seat side member 5012. Although an external SIP device 5020 having a generally rectangular configuration is shown, it should be understood that other suitable configurations are also within the scope of the disclosure.

[0704] With reference now to FIG. 112, the illustrated, non-limiting child seat system 10000 includes a child seat 10002 positionable about a support base 10004. Similar to the previous embodiments, the child seat 10002 includes a seat shell 10006 having an upright portion 10008 and a seat portion 10010. The seat portion 10010 includes a first seat side member (not shown) and a second seat side member 10012 extending from opposing sides of a seat support surface (not shown). In the illustrated, non-limiting embodiment, a cupholder 10014 is arranged at each seat side member 10012, such as near a front 10016 of the child seat 10002 for example. As shown, the cupholder 10014 may be movable between an extended configuration and a retracted configuration (shown); however, in other embodiments, the cupholder 10014 may be fixedly mounted to the child seat 10002.

[0705] At least one external SIP device is arranged at an exterior surface of at least one of the first and second seat side members 10012. In an embodiment, an external SIP device 10020 is arranged at each respective seat side member 10012, at a location forward of the cupholder 10014. Alternatively, or in addition, an external SIP device may be vertically aligned with the cupholder 10014. For example, an external SIP device 10022 may be positioned above the cupholder 10014, such as between the cupholder 10014 and an upper edge 10024 of the seat side member 10012 and/or an external SIP device 10026 may be positioned beneath the cupholder 10014, such as between the cupholder 10014 and a bottom 10029 of the seat portion 10010 for example. In the illustrated, non-limiting embodiment, the child seat 10002 additionally includes an external SIP device 10028 arranged near an interface between the upright portion 10008 and a seat portion 10010. As shown, the external SIP device 10028 may be positioned adjacent to, for example beneath, an opening 10030 that defines a portion of a vehicle belt path, such as formed in an adjacent upright side member 10032 of the upright portion 10008.

[0706] Each of the illustrated external SIP devices 10020, 10022, 10026, 10028 may protrude laterally or outwardly from the first or second seat side member 10012 in a direction oriented substantially orthogonal to the respective seat side member 10012. Although an external SIP devices 10020, 10022, 10026, 10028 having generally rectangular configurations

are shown, it should be understood that other suitable configurations, such as configurations complementary to the contour of the child seat 10002 at a respective location for example, are also within the scope of the disclosure.

[0707] In some embodiments, an external SIP device is located near or directly adjacent to an opening that forms part of a vehicle belt path when the child seat system is mounted in a forward-facing configuration. With reference to FIGS. 54A-54B, another embodiment of a child seat system 5100 is illustrated. As shown, the child seat system 5100 includes a child seat 5102 positionable about a support base 5104. A seat shell 5106 of the child seat 5102 includes an upright portion 5108 and a seat portion 5110. The upright portion 5108 includes a back portion 5112, and a first upright side member 5114 and a second upright side member (not shown) extending from opposing sides of the back portion 5112. Each upright side member 5114 includes an opening 5116 formed therein that may form part of a belt path for receiving a vehicle belt about the child seat 5102.

[0708] Similar to the previous embodiments, an external SIP device 5120 is arranged at an exterior surface of at least one of the first and second upright side members 5114. In the illustrated, non-limiting embodiment, the external SIP device 5120 is arranged vertically above the opening 5116. The external SIP device 5120 may protrude from and be oriented generally parallel to the adjacent upright side member 5114. As shown, the external SIP device 5120 may extend from near a front edge 5118 of the upright side member 5114 toward the back portion 5112. In such embodiments, the external SIP device 5120 may extend over the entire length of the upright side member 5114, or alternatively, over only a portion thereof. However, in other embodiments, the external SIP device 5120 may be arranged locally above the opening 5116.

[0709] Another embodiment of a child seat system 5200 including a child seat 5202 and a support base 5204 is illustrated in FIGS. 55A-55E. Similar to the previous embodiment, a seat shell 5206 of the child seat 5202 includes an upright portion 5208 and a seat portion 5210. The upright portion 5208 includes a back portion 5212, and a first upright side member 5214 and a second upright side member 5216 extending from opposing sides of the back portion 5212. Each upright side member 5214, 5216 includes an opening 5218 formed therein that may form part of a belt path for receiving a vehicle belt about the child seat 5202.

[0710] At least one external SIP device is affixed to an exterior surface of the upright portion. In the illustrated, non-limiting embodiment, a first external SIP device 5220a is positioned at an exterior surface of the first upright side member 5214 and a second external SIP device 5220b is positioned at an exterior surface of the second upright side member 5216. As shown, the first and second external SIP devices 5220a, 5220b are located directly behind

the opening 5218, such as between the opening 5218 and the back portion 5212 of the child seat 5202. The first and second external SIP devices 5220a, 5220b may but need not extend above the opening 5218. Although the external SIP devices 5220a, 5220b are illustrated as being positioned solely at the upright side members 5214, 5216, with a back surface 5222 substantially flush with a back edge 5224 of the upright side member 5216 (see FIG. 55E), embodiments where the external SIP devices 5220a, 5220b additionally extend about the back portion 5212 are also within the scope of the disclosure. At such a position, the external SIP devices 5220a, 5220b may be remote from the vehicle belt path, such as from both the lap portion and the shoulder portion of a vehicle belt for example. The external SIP devices 5220a, 5220b protrude laterally or outwardly from the upright side member 5214, 5216 such as in a direction oriented substantially perpendicular to the upright side member 5214, 5216. The external SIP device 5220a, 5220b may extend laterally beyond the outermost surface of the upright side member 5214, 5216.

[0711] In the illustrated, non-limiting embodiments, the external SIP devices 5220a, 5220b positioned near the opening 5218 are illustrated as having a generally rectangular or polygonal shape. As shown, the shape may vary over a cross-section of the external SIP device 5220a, 5220b taken in one or more planes, such as a vertical plane and/or a horizontal plane. However, the illustrated embodiments are intended as an example only and an external SIP device 5220a, 5220b having a uniform shape or any other suitable shape that does not extend interfere with the vehicle belt path opening 5218 is contemplated herein. For example, in the non-limiting embodiment of a child seat system 5300 illustrated in FIGS. 56A and 56B, a child seat 5302 having an external SIP device 5320 mounted to the upright portion 5308 of a seat shell 5306 adjacent to an opening 5318 that forms part of a vehicle belt path is illustrated. However, as shown, a surface 5322 of an external SIP device 5320a, 5320b positioned closest to the opening 5318 may be curved. Such curvature of the surface 5322 may be sized and positioned to allow a user's hand to reach through the adjacent opening 5318 during installation of the vehicle belt; additionally, or alternatively, the curvature may be sized and positioned to avoid contacting a vehicle belt. Although the curvature of the surface 5322 is illustrated as being complementary to the contour of the adjacent opening 5318, such as a convex curvature for example, in other embodiments, the external SIP device 5320 may have a curvature that is different than the adjacent opening 5318, such as a convex curvature for example.

[0712] Although not shown, it should be appreciated that one or more additional external SIP devices may be arranged at the child seat and/or support base of the child safety system disclosed in each of the embodiments of FIGS. 50A-56B. In some embodiments, each

child seat and/or support base includes another external SIP device disposed at an opposite side of the child safety system and having a configuration substantially identical to the external SIP devices illustrated and described herein.

[0713] An external SIP device, such as device 4902, 5020, 5120, 5220, 5320, located at an exterior surface of a child seat may assist with absorbing impact between a child seat and a vehicle door during a side impact crash event. In an embodiment, such an external SIP device may be operable to transfer a load applied thereto, such as during a crash event for example, into the structure of the child seat, such as the back portion of the seat shell for example. This transfer of load may induce rotation of the child seat. Rotation of the child seat may better distribute the load applied to the occupant, thereby reducing the likelihood of a head injury. An external SIP device may also reduce the chest deflection of an occupant of the child seat system during a crash event.

[0714] In embodiments where an external SIP device is arranged near an opening in the back portion that forms part of a vehicle belt path when the child seat system is in a forward-facing configuration, such as shown in FIGS. 55A-56B for example, the external SIP device 5220a, 5220b, 5320 may be operable to engage or retain a portion of the vehicle belt, such as the shoulder portion for example, at a desired position relative to the child seat. With reference to FIG. 57, an exemplary embodiment of an external SIP device 5402 arranged adjacent to an opening 5404 formed in an upright support member 5406 of a child seat 5400 is illustrated. In an embodiment, the external SIP device 5402 includes a guide portion 5408 in the form of a slot. As shown, the slot 5408 may extend inwardly from an outermost end 5410 of the external SIP device 5402. A width of the slot 5408 may be equal to or greater than a width of a corresponding portion of the vehicle belt 5412, such as a shoulder portion 5414 of the vehicle belt 5412. The slot 5408 may be formed at a non-parallel angle to a back surface 5416 of the external SIP device 5402. As shown, the slot 5408 may slope vertically downwardly toward a front of the external SIP device 5402. However, a slot having any configuration suitable to properly position a portion of a vehicle belt 5412 receivable therein is contemplated herein. The slot 5408 may be arranged to direct the vehicle belt toward the opening, and therefore may be considered to form a portion of the belt path.

[0715] In an embodiment, the slot 5408 is configured to apply a clamping force to the vehicle belt to hold the vehicle belt in a desired position. For example, a width of the slot 5408, measured between a back and front of the external SIP device, may vary over the length of the slot 5408, whereby a portion of the slot proximate the back of the slot 5408 may be lesser in width so as to hold the vehicle belt in position. FIG. 58 illustrates an external SIP device 5502

according to another embodiment. Similar to the previous embodiment, the external SIP device 5502 is arranged adjacent to an opening 5504 formed in an upright support member 5506 of a child seat 5500. A guide portion 5509 of the external SIP device 5502 includes a guide member 5510 affixed to a portion of the external SIP device 5502, such as an upper surface 5508 thereof for example. In an embodiment, the guide member 5510 is a resilient clip biased into engagement with the adjacent surface 5508 of the external SIP device 5502. A clearance may be defined between a surface of the guide member 5510 and the adjacent surface 5508 of the external SIP device 5502 and a portion of a vehicle belt 5512, such as a shoulder portion 5514 for example may be receivable therein. The bias of the guide member 5510 towards the surface 5508 may restrict unintended movement of the vehicle belt 5512 relative to the external SIP device 5502 in at least one direction.

[0716] In other embodiments, such as shown in FIG. 59, an external SIP device 5602 includes a guide portion 5609 in the form of a guide member 5610, such as similar to guide member 5510. The guide member 5610 may be rotatable relative to an external SIP device 5602 to selectively restrict movement of a vehicle belt 5612 relative to the external SIP device 5602. For example, the guide member 5610 may be rotatable between a first, unlocked position and a second, locked position. In the first, unlocked position, the vehicle belt 12 is free to move relative to the guide member 5610, and in the second, locked position, the vehicle belt 12 is locked within by the guide member 5610 relative to the guide portion 5609 and the external SIP device 5602.

[0717] As shown, the clip 5610 may be mounted to an upper surface 5608 of the external SIP device 5602. However, embodiment where such a clip 5610 is movably mounted at an adjacent portion of the seat shell of the child seat 5600, such as at the upright support member 5606 near the opening 5604 for receiving the vehicle belt 5612 for example, are also contemplated herein.

[0718] With reference now to FIG. 60, another embodiment of a child seat 5700 having an external SIP device 5702 arranged adjacent to an opening 5704 formed in an upright support member 5706 of the child seat 5700 is illustrated. As shown, the external SIP device 5702 may be movably mounted to the child seat 5700, such as to the upright support member 5706. In the illustrated, non-limiting embodiment, the external SIP device 5702 is rotatable about an axis relative to the child seat 5700 to selectively engage and restrict movement of a portion of the vehicle belt 5712, such as a shoulder portion 5714 for example, relative thereto. In an embodiment, the external SIP device may include a camming surface such that as the external SIP device 5702 rotates in a first direction, a force applied to the vehicle belt 5712 by the

external SIP device 5702 increases. It should be appreciated that each of the external SIP devices 5402, 5502, 5602, 5702 described in FIGS. 57-60 engageable with a vehicle belt is similarly operable to transfer a load applied thereto, such as via engagement with a vehicle door during a crash event, into the structure of the child seat, and in some embodiments, to cause rotation of the child seat relative to a vehicle seat.

[0719] With reference now to FIGS. 145A-145E, an example of a child seat system 12700 including a plurality of external SIP devices according to another embodiment is illustrated. The child seat system 12700 includes a support base 12701 and a child seat mountable to the support base 12701. In the illustrated, non-limiting embodiment, the child seat is movable, for example rotatable, relative to the support base 12701 when connected thereto. The child seat 12702 may be rotatable relative to the support base 12701 between a plurality of configurations. For example, the child seat 12702 may be rotatable between a first rotational configuration (FIGS. 145A-145C), such as a configuration in which the child seat 12702 is in a facing-forward position, and a second rotational configuration (FIG. 145D), such as a configuration in which the child seat 12702 is in a rearward-facing position. However, it should be appreciated that embodiments where the child seat 12702 is positionable in one or more additional configurations, such as at third configuration (FIG. 145E) between the first rotational configuration and a second rotational configuration are also within the scope of the disclosure.

[0720] As shown, the child seat 12702 has a seat shell 12704 defining a seat portion 12706 and an upright portion 12708 of the child seat. The upright portion 12708 includes an upright support surface 12710, a first upright support member 12712 arranged at a first side of the upright support surface 12710 and a second upright support member 12714 arranged at a second opposite side of the upright support surface 12710. A belt path opening 12716a, 12716b may be formed in each upright support member 12712, 12714 that defines a portion of a vehicle belt path relative to the child seat 12702. The belt path openings 12716a, 12716b may be configured to receive a vehicle seatbelt (not shown) to secure the child seat 12702 to a vehicle seat, such as when the child seat 12702 is in a forward-facing high-back configuration.

[0721] As shown, a first external SIP device 12720a is mountable to the first upright support member 12712 near the belt path opening 12716a formed therein, and a second external SIP device 12720b is mountable to the second upright support member 12714, such as near the belt path opening 12716b formed therein. Various views of an exemplary first external SIP device 12720a are illustrated in more detail in FIGS. 146A-146C. It should be understood that the second external SIP device 12720b may be substantially identical to, but a mirror image of

the first external SIP device 12720a. As shown, the external SIP device 12720a includes a substantially hollow body 12722 having a front wall 12724 and a rear wall 12726. In the illustrated, non-limiting embodiment, the rear wall 12726 is connected to the front wall 12724 at a first end 12728 of the body 12722. The rear wall 12726 may have an arcuate contour such that a distance between the front wall and the rear wall 12726 gradually increases from the first end of the body 12722 towards a second, opposite end of the body 12730. In an embodiment, the front wall 12724 is contoured such that the distance between front wall 12724 and the rear wall 12726 varies over a height of the external SIP device 12720a. In the illustrated, non-limiting embodiment, the front wall has an arcuate configuration, such as a convex curvature. Accordingly, the distance between the front and rear walls 12724, 12726 as shown in FIG. 146C may be at a maximum near a top 12729 of the external SIP device 12720a and may be at a minimum near a bottom of the external SIP device 12720a. In the illustrated, non-limiting embodiment, the front wall 12724 is connected to the rear wall 12728 at the bottom 12731 of the external SIP device 12720a.

[0722] A sidewall 12732 may extend between and connect the front wall 12724 and the rear wall 12726 between the first end 12728 and the second end 12730 of the body 12722, such as near the top 12729 of the external SIP device 12720a. However, in some embodiments, the at least one sidewall 12732 is integrally formed with the front wall 12724. The external SIP device 12720a may have a unitary body such that the plurality of walls 12724, 12728, 12732 of the body 12722 are integrally formed. It should be understood that the shape of the external SIP device 12720a illustrated and described herein is intended as an example only.

[0723] When the external SIP device 12720a is mounted to the child seat 12702, the first end 12728 of the body 12722 is spaced from the child seat 12702 and the second end 12730 is arranged in direct contact therewith. When mounted, the rear wall 12726 may be substantially flush with an exterior surface of the upright portion 12708 such that the rear wall of the external SIP device extends continuously therefrom. For example, as shown in FIG. 145A and 145C, the second end 12730 of the body 12722 is affixed to a side of the back 12713 of the upright portion 12708 such that the rear wall 12726 is flush with the back 12713 and extends continuously outward therefrom. Further, the contour of the rear wall 12726 over its height may mirror the corresponding contour of the back 12713 of the child seat 12702 directly adjacent to its mounting location. Forming the external SIP devices 12720a, 12720b with such a contoured back wall 12726 may prevent interference with the support base 12701 or with a vehicle seat as the child seat 12702 is rotated relative to the support base 12701.



[0724] In some embodiments, the contour of the rear wall 12726 corresponds to or is complementary to a contour of an adjacent surface, such as a forward-facing surface for example, of an industry standard vehicle seat. This contour may be complementary to the vehicle seat in a horizontal direction and/or a vertical direction. In embodiments where the vehicle seat is a free-standing seat, such as a captain's chair, the rear walls 12726 of the external SIP devices 12720a, 12720b may be complementary to the forward-facing surface of the vehicle seat near the two opposing edges thereof. In embodiments where the vehicle seat is a bench seat, the rear wall 12726 of at least one of the external SIP devices 12720a, 12720b, may be complementary to the forward-facing surface of the vehicle seat near an edge thereof positioned closest to a vehicle door.

[0725] Further, due to the positioning of the external SIP device 12720a about the child seat 12702, such as at an interface between an upright support member 12712 and a back 12713 of the upright portion 12708 and adjacent to a corresponding belt path opening 12716a for example, an axial length of at least a portion of the front wall 12724 (measured between the first end 12728 and second end 12730 of the body 12722) may vary over the height of the body 12722. This variation in length of the front wall 12724 may match a contour of the exterior of the upright support member 12712 at a location adjacent to the belt path opening 12716a. When an external SIP device 12720a, 12720b is positioned about the child seat 12702, as shown in FIG. 145B and FIG. 153 part of the front surface formed by the front wall 12724, such as the lower portion thereof, is curved or sloped away from the belt path opening 12716a, 12716b. This contour creates an enlarged area for a user to access the belt path opening 12716a, 12716b.

[0726] In an embodiment, a top portion of the front wall 12724, or the top portion of the front wall 12724 in combination with the sidewall 12732 may also be contoured, for example rounded or sloped. This contour and/or the position of the external SIP device 12720a, 12720b relative to the belt path opening 12716a, 12716b may facilitate proper positioning of the vehicle belt relative to the belt path opening 12716a, 12716b.

[0727] As shown, the exemplary external SIP device 12720a may include one or more mounting members for connecting the external SIP device 12720a to the child seat 12702. In the illustrated, non-limiting embodiment, the one or more mounting members may include at least one tuck tab 12740. As shown, the at least one tuck tab 12740 is an elongated rib 12742 that protrudes beyond the second end 12730 of the body 12722. The at least one tuck tab 12740 may additionally include a protrusion 12744 arranged at a distal end of the elongated rib 12742 engageable with a corresponding feature, such as a groove for example, formed in the child seat 12702. In the illustrated, non-limiting embodiment, the external SIP device 12720a,

12720b includes a two tuck tabs 12740, each being receivable within a corresponding opening (not shown) formed in the child seat 12702. Although the tuck tabs 12740 are both illustrated as extending from the rear wall 12726, embodiments where one or more tuck tabs 12740 are arranged at another location about the body 12722 are also contemplated herein. Further, although the tuck tabs are illustrated as being substantially identical, embodiments where tuck tabs 12740 have different dimensions to prevent installation of the external SIP device 12720a, 12720b in an improper orientation are also contemplated herein. When the external SIP device 12720a, 12720b is positioned about the child seat 12720 and the tuck tabs 12740 are arranged within a corresponding opening or recess, one or more fasteners 12748 may additionally be used to couple the external SIP device to the child seat 12702. The fasteners 12748 may be engageable with the body 12722 near a tuck tab or remotely therefrom.

[0728] Various views of an exemplary first external SIP device 12800 suitable for use as an external SIP device 12720a, 12720b of FIGS. 146A-146E according to another embodiment are illustrated in FIGS. 148A-148C. The external SIP device 12800 has a substantially hollow body 12802 including a front wall 12804 and an arcuate rear wall 12806. The body 12802 may have a configuration substantially identical to that described in the previous embodiment. However, the one or more mounting members of the external SIP device 12720a of FIGS. 148A-148C vary from that of the previous embodiment. As shown, the one or more mounting members of the external SIP device 12800 may include at least one tuck tab 12810. In the illustrated, non-limiting embodiment, the tuck tab 12810 extends from the front wall 12804. Similar to the previous embodiment, the tuck tab 12810 includes a protrusion 12812 engageable with a corresponding portion of the child seat 12702.

[0729] With reference to FIGS. 149A-149B, an example of a bracket 12820 positioned about the periphery of a belt path opening 12716a, 12716b formed in an upright support member 12712, 12714 of the child seat 12702 is illustrated. As shown, the bracket 12820 may include an engagement rib 12822 configured to engage the at least one tuck tab 12810 of the external SIP device 12800. In the illustrated, non-limiting embodiment, the rib 12822 is arranged at an inner surface 12824 of the bracket 12820 and extends into the belt path opening 12716a, 12716b. As shown in FIGS. 149B, when the external SIP device 12800 is mounted to the child seat 12702, the tuck tab 12810 may extend through a gap 12826 created between the rib 12822 and the adjacent inner surface 12824 of the bracket 12820 and the protrusion 12812 may engage a side surface of the rib 12822, thereby restricting translation of the external SIP device 12800 away from the bracket 12820.

[0730] The one or more mounting features may alternatively or additionally include at least one positioning feature 12840a, 12840b including an elongated body 12842 that protrudes beyond a second end 12808 of the body 12802 and that is receivable within at least one corresponding opening formed in the child seat 12702. In the illustrated, non-limiting embodiment, the external SIP device includes a first positioning feature 12840a and a second positioning feature 12840b. The first positioning feature 12840a and the second positioning feature 12840b may have different dimensions to prevent installation of the external SIP device 12800 in an improper orientation.

[0731] Alternatively, or in addition to the tuck tab 12810 and/or the positioning features 12840a, 12840b, the one or more mounting members of the external SIP device 12800 may alternatively or additionally include at least one connector 12850 receivable within an opening formed in the child seat 12702. An end of the connector 12850 extends from the body 12802 and has an opening 12852 formed therein. When the external SIP device 12800 is positioned adjacent to a child seat such as child seat 12702 for example, a fastener (not shown) may be receivable within the opening 12852 to mount the external SIP device 12800 to the child seat.

[0732] With reference to FIG. 150, yet another embodiment of an external SIP device having one or more mounting members is illustrated. Exclusive of the mounting members, the external SIP device 12900 may be substantially identical to the body of the external SIP devices 12720a, 12720b and 12800. In the illustrated, non-limiting embodiment, the external SIP device 12900 includes a plurality of connectors 12902, each having a body with an opening 12904 formed therein for receiving a fastener. In an embodiment, a fastener 12906 may alternatively or additionally be receivable within an opening formed at or proximate to a front wall of the external SIP device 12900. The fastener 12906 may be extendable through a bracket 12910 arranged about a periphery of a belt path opening 12912 formed in an upright side member 12914 of a child seat 12901.

[0733] Another embodiment of an external SIP device 8602 mounted to a child seat 8600 is illustrated in FIGS. 96A-96B. As shown, the external SIP device 8602 may be mounted to the child seat 8600 at a location near an opening 8604 formed in an upright support member 8606 of the child seat 8600. However, embodiments where the external SIP device 8602 is mounted to another location about the child seat 8600 or even the support base are also contemplated herein. The opening 8604 formed in the upright support member 8606 may be part of the vehicle belt path and is configured to receive a vehicle seatbelt (not shown) to secure the child seat 8600 to a vehicle seat, such as when the child seat is in a forward-facing high-back configuration. In an embodiment, the size of the body 8610 of the external SIP device

8602 is larger than the opening 8604 formed in the upright support member 8606. As shown, the body 8610 may have a generally trapezoidal shape such that a width of the body 8610 is smallest near a location, such as an end 8612 where the body 8610 is coupled to the child seat 8600 and increases in a direction away from the coupling with the child seat 8600, such as toward a distal end 8614 for example. However, any suitable shape is contemplated herein.

[0734] The external SIP device 8602 may be movable relative to the child seat 8600 to selectively access the opening 8604 associated with the vehicle belt path. As shown, the external SIP device 8602 is rotatable between a first position in which the external SIP device 8602 is aligned with and configured to overlap at least a portion of the opening 8604 (see FIG. 96A) and a second position, where the external SIP device 8602 is spaced from the opening 8604. In the illustrated, non-limiting embodiment, the external SIP device 8602 covers the entire opening 8604 when in the first position such that the opening 8604 and the vehicle belt path is inaccessible, and the external SIP device 8602 is spaced from the opening 8604 such that the substantially entire opening 8604 is exposed and the vehicle belt path is accessible when in the second position. Because the opening 8604 may be used when the child seat 8600 is in a forward-facing configuration, the external SIP device 860 may be arranged in the first position when the child seat 8600 is in a rearward-facing configuration and may be arranged in the second position when the child seat 8600 is in the forward-facing configuration. Although only a single external SIP device 8602 is illustrated in FIGS. 96A-96B, it should be appreciated that an identical external SIP device may be arranged at the opposite side of the child seat 8600.

[0735] With reference to FIGS. 90-95, another embodiment of a child seat 8500 having a movable external SIP device 8502 is illustrated. Similar to the previous embodiment, the external SIP device 8502 is positioned generally adjacent to an opening 8504 formed in an upright support member 8506 of the child seat 8500. However, embodiments where the external SIP device 8502 is arranged at another position about a side of the child seat 8500 are also contemplated herein. The external SIP device 8502 is movable between a first position and a second position, the second position being spaced from the first position. Further, it should be appreciated that the external SIP device 8502 may be arranged at one or more intermediate positions along the path of movement defined between the first position and the second position. In such embodiments, a position of the external SIP device 8502 may be adjusted by a user to align the external SIP device 8502 with a vehicle door or to locate the external SIP device 8502 at a position closest to the vehicle door.

[0736] In the illustrated, non-limiting embodiment, the child seat 8500 includes a key plate 8510 having an elongated slot 8512 formed therein. As shown, the elongated slot 8512

extends longitudinally relative to the key plate 8510 and has a length less than the length of the key plate 8510. Although a substantially linear elongated slot is illustrated in FIGS. 92A-92B, embodiments where the elongated slot has another configuration, such as a curvilinear configuration for example, are also within the scope of the disclosure. As will be described in more detail below, the elongated slot 8512 defines the path of movement of the external SIP device relative to the child seat 8500. Although the key plate 8510 is shown as a separate component secured to either an interior or an exterior of the child seat 8500, it should be understood that in other embodiments, the key plate 8510 may be integrally formed with a portion of the child seat 8500, such as the upright support member 8506 of the child seat 8500 for example. The external SIP device 8502 is positioned adjacent to a first side 8514 of the key plate 8510, such as at the exterior of the child seat 8500 for example. Further, the external SIP device 8502 is movably coupled to the key plate 8510. In an embodiment, the external SIP device 8502 includes a keying member 8520 that extends through the elongated slot 8512. As shown, a locking nut 8522 may be arranged at an end of the keying member 8520 adjacent to the second, opposite side 8516 of the key plate 8510. The locking nut 8522 has one or more dimensions larger than the elongated slot 8512 to prevent movement of the external SIP device 8502 out of the plane defined by the first side 8514 of the key plate 8510. Accordingly, the interface between the locking nut 8522 and the elongated slot 8512 restricts separation of the external SIP device 8502 from the key plate 8510.

[0737] In an embodiment, the key plate 8510 includes at least one lock recess, and in some embodiments, a plurality of lock recesses 8524 formed at different locations at the second side 8516 of the key plate 8510. The lock recesses 8524 may be counterbores that extend through only a portion of a thickness of the key plate 8510. Although the illustrated key plate 8510 includes four lock recesses 8524 spaced over a length of the elongated slot 8512, embodiments having a single lock recess, two lock recesses, three lock recesses, or more than four lock recesses are also within the scope of the disclosure. In an embodiment, the plurality of lock recesses 8524 are substantially identical. Each of the plurality of lock recesses 8524 may have a contour complementary to the locking nut 8522. For example, the lock recess 8524 may be substantially identical in size and/or shape to the locking nut 8522 such that the locking nut 8522 is receivable within any of the plurality of lock recesses 8524. When arranged within a lock recess 8524, the locking nut 8522, and therefore the external SIP device 8502 coupled to the keying member 8520, is restricted from travel along the path of movement defined by the elongated slot 8512.

[0738] The external SIP device 8502 is movable, for example translatable or slidable, between a first position adjacent to a first end 8526 of the slot 8512, as shown in FIG. 92A and 92B, and a second position where the external SIP device 8502 is arranged adjacent the second, opposite end of the slot (FIG. 90). In the illustrated, non-limiting embodiment, the external SIP device 8502 is arranged at an exterior of the child seat 8500 as the external SIP device 8502 travels along the path of movement of the elongated slot 8512. With reference to FIG. 92B, in the first position, the locking nut 8522 is arranged within a first lock recess 8524a, and in the second position, the locking nut 8522 is arranged within a fourth lock recess 8524d. Further, in the illustrated, non-limiting embodiment, the external SIP device 8502 is positionable at a third position in which the locking nut 8522 is arranged within a second lock recess 8524b, and a fourth position in which the locking nut 8522 is positioned within a third lock recess 8524c. The second lock recess 8524b may be positioned adjacent to the first lock recess 8524a, and the third lock recess 8524c may be located between the second lock recess 8524b and the fourth lock recess 8524d.

[0739] An actuator 8530 may be operably coupled to the keying member 8520. In the illustrated, non-limiting embodiment, the actuator 8530 is threadably connected to the keying member 8520; however, any suitable direct or indirect connection is within the scope of the disclosure. The actuator 8530 includes a button 8532 exposed at a surface of the external SIP device 8502. The actuator 8530 is receivable within a corresponding slot 8534 (FIG. 95) of the external SIP device 8502 such that the button 8532 may be selectively depressed. In an embodiment, a biasing mechanism 8536 is arranged between a portion of the external SIP device 8502 and the actuator 8530, or between a surface of the child seat 8500, such as the upright support member 8506, and the actuator 8530. The biasing force of the biasing mechanism 8536 is operable to bias the actuator 8530 to a default or unactuated position. In the unactuated position, the button 8532 of the actuator 8530 may be flush with the adjacent surface of the external SIP device 8502, or alternatively, may be sunken relative to the surface of the external SIP device 8502.

[0740] When the actuator 8530 is operated, such as by applying a force to the button 8532 for example, the keying member 8520 is moved in a direction away from the key plate 8510 and the external SIP device 8502. Accordingly, the actuator 8530 is operable to separate the lock nut 8522 from a respective lock recess 8524. While the lock nut 8522 is disengaged from the plurality of lock recesses 8524, the external SIP device 8502 is freely movable along the path of movement defined by the elongated slot 8512. Upon reaching a desired position, the force is removed from the button 8532 and the actuator 8530 is biased by the biasing

mechanism 8536 back to its unactuated position. This movement of the actuator 8530 in response to the biasing force of the biasing mechanism 8536 causes a similar movement of the keying member 8520, causing the locking nut 8522 to reengage with a corresponding lock recess 8523 of the key plate 8510. In an embodiment, at least one of the locking nut 8522, the keying member 8520, the key plate 8510, and the external SIP device 8502 includes a feature, such as a contour for example, which prevents unintended rotation of the external SIP device 8502 when the locking nut 8522 is disengaged from the lock recesses 8524. It should be appreciated that the movable connection between the external SIP device 8502 and the child seat 8500 as described herein is intended as an example only.

[0741] In embodiments where the child seat of the child seat system is configured as an infant car seat, one or more SIP devices may be mounted at an exterior of the child seat. With reference now to FIG. 61A-61C, the illustrated child seat 5800 is an infant car seat including a handle 5802 rotatably affixed to a seat shell 5804 via one or more handle hubs 5806. In an embodiment, an external SIP device 5808 is affixed to and protrudes outwardly from an exterior surface of at least one handle hub 5806. The external SIP device 5808 may be rotatable with the handle hub 5806 about an axis relative to the seat shell 5804 of the child seat 5800.

[0742] Alternatively, or in addition, as shown in FIGS. 61B and 61C, an external SIP device 5810 may be arranged at an exterior of the child seat 5800, such as near a front end 5812 of a seat portion 5814 of the child seat 5800. As shown, the external SIP device 5810 may have a contour generally complementary to the adjacent portion of the child seat 5800 and protrudes outwardly, for example perpendicularly, away from the child seat 5800. At such a position, the external SIP device 5810 may be positioned between the seat shell 5804 and soft goods 5816 (see FIG. 61A) overlapping the seat shell 5804. In such embodiments, the external SIP device 5810 is sized and shaped so as not to interfere with rotation of the handle 5802 to a forward position adjacent to the front 5812 of the child seat 5800. An external SIP device 5808 and/or 5810 mounted at an exterior of an infant car seat, may be operable to increase the stiffness of the child seat and distribute a load applied to the child seat across the length of the child seat, away from the occupant.

[0743] In another embodiment, an infant car seat 10400 including a handle 10402 rotatably affixed to a seat shell 10404 via one or more handle hubs 10406a, 10406b is illustrated in FIGS. 116A-116D. As shown, at least one external SIP device 10408a, 10408b may be arranged at an exterior surface of the seat shell 10404, such as near a handle hub 10406a, 10406b for example. In the illustrated, non-limiting embodiment, the first external SIP device

10408a is positioned behind a first handle hub 10406a, such as between the handle hub 10406a and a rear 10410 of the child seat 10400 for example, and the second external SIP device 10408b is positioned at a similar location behind a second handle hub 10406b, between the handle hub 10406b and a rear 10410 of the child seat 10400. In an embodiment, the at least one external SIP device 10408a, 10408b is contoured to prevent interference with the handle 10402 as it rotates about an axis relative to the seat shell 10404 between a front position (not shown) and a rear position (shown in FIGS. 116C-116D). Although a notch or cutout 10412 is illustrated in FIGS. 116C-116D, it should be understood that any suitable configuration to prevent interference with the handle 10402 is contemplated herein.

[0744] With reference now to FIGS. 62A-64C, in some embodiments, an external SIP device may be transformable between a stowed or retracted configuration and a deployed or extended configuration. The non-limiting embodiment of a child seat system 5900 illustrated in FIGS. 64A-64B includes a child seat 5902 that may be mountable to a support base 5904. The child seat 5902 includes a seat shell 5906 having an upright portion 5908 and a seat portion 5910 as previously described herein. The upright portion 5908 may include a back 5912 and a first and second upright side member 5914, 5916 extending from the back 5912. At least one external SIP device is mounted to an exterior surface of the child seat 5902, such as at the upright portion 5908. In the illustrated, non-limiting embodiment, a first external SIP device 5920a is mounted near a first side 5922 of the back 5912 of the child seat 5902 and a second external SIP 5920b is mounted near a second, opposite side 5924 of the back 5912 of the child seat 5902. Although the external SIP devices 5920a, 5920b are shown as being mounted to the back 5912, in other embodiments, at least one of the external SIP device 5920a, 5920b may be mounted to a respective upright side member 5914, 5916.

[0745] The external SIP devices 5920a, 5920b may each be a bumper or other suitable member. In the illustrated, non-limiting embodiment, the external SIP devices 5920a, 5920b are movable, for example rotatable, between a stowed or retracted configuration and an extended or deployed configuration. In the retracted configuration, the external SIP devices 5920a, 5920b are arranged within corresponding cavities 5930a, 5930b formed in the seat shell 5906. In a retracted configuration (FIG. 62A), the external SIP devices 5920a, 5920b may be flush with an adjacent surface 5932 of the seat shell 5906. In the extended configuration (FIG. 62B), the external SIP devices 5920a, 5920b protrude outwardly from the seat shell 5906, such as beyond a most lateral surface of an adjacent upright side member 5914, 5916. The extended configuration may be substantially perpendicular to the retracted configuration. Although the external SIP devices 5920a, 5920b are illustrated as having a generally vertical orientation in



the stowed configuration and generally horizontal orientation in the extended configuration, it should be understood that such an external SIP device 5920a, 5920b arranged at another orientation or movable in another manner, such as about an axis extending across a width of the child seat 5902 is also contemplated herein.

[0746] A child seat system 6000 illustrated in FIGS. 63A-63C is similar to that of FIGS. 62A-62B. The child seat system 6000 includes a child seat 6002 mountable to a support base 6004. The child seat 6002 includes a seat shell 6006 having an upright portion 6008 and a seat portion 6010 as previously described herein. The upright portion 6008 may include a back 6012 and a first and second upright side member 6014, 6016 extending from the back 6012, respectively. At least one external SIP device 6020 is mounted to an exterior surface of the child seat 6002, such as at the upright portion 6008 for example.

[0747] In the illustrated, non-limiting embodiment, the child seat 6002 includes a single external SIP device 6020. As shown, the external SIP device includes a structural member 6022 mounted within a cavity 6024 formed at the back 6012 of the child seat 6002. Similar to the previous embodiment, the external SIP device 6020 is movable between a stowed or retracted configuration and at least one extended or deployed configuration. In the retracted configuration (FIG. 63A), the structural member 6022 of the external SIP device is wholly arranged within the cavity 6024. In such a configuration, the structural member 6022 may be flush with an adjacent surface 6032 of the child seat 6002. In an extended configuration, the structural member 6022 protrudes beyond a side 6026 or 6028 of the back 6012 of the child seat 6002.

[0748] In an embodiment, the external SIP device 6020 is movable between a first extended configuration (FIG. 63B) in which the structural member 6022 extends beyond a first side 6026 of the back 6012, and a second extended configuration (FIG. 63C) in which the structural member 6022 extends beyond a second, opposite side 6028 of the back 6012 (potentially depending on what side of the vehicle the child seat system 6000 is positioned). The structural member 6022 may be translatable between the retracted configuration and the extended configurations. In the extended configuration, the projection of the structural member 6022 extending beyond the side of the child seat 6002 is operable to absorb crash energy. Although an external SIP device 6020 having a single translatable element is illustrated and described herein, it should be appreciated that embodiments having a plurality of separate external SIP devices 6020, associated with a respective side of the child seat and translatable to a single extended configuration are also contemplated herein.

[0749] With reference to FIGS. 64A-64C, another child seat system 6100 is illustrated having a child seat 6102 mountable to a support base 6104. The child seat 6102 includes a seat shell 6106 having an upright portion 6108 and a seat portion 6110 as previously described herein. The upright portion 6108 may include a back 6112 and a first and second upright support member 6114, 6116 extending from the back 6112, respectively.

[0750] At least one external SIP device 6120 is mounted to an exterior surface of the child seat 6102, such as at the upright portion 6108. In the illustrated, non-limiting embodiment, the external SIP device 6120 is mounted to the back 6112 of the upright portion 6108, such as near a center thereof for example. Similar to the previous embodiment, the external SIP device 6020 includes a structural member 6122 movable between a stowed or retracted configuration and at least one extended or deployed configuration. In the illustrated non-limiting embodiment, the structural member 6122 is rotatable between the retracted configuration and an extended configuration. In the retracted configuration (FIG. 64A), the structural member 6122 is positioned in substantially overlapping arrangement with the back 6112 of the child seat 6102 and in some embodiments may have a generally vertical orientation. In an extended configuration (see FIGS. 64B and 64C), the structural member 6122 protrudes beyond one or both sides 6124, 6126 of the back 6112 of the child seat 6102 to absorb crash energy.

[0751] In an embodiment, the external SIP device 6120 is rotatable between a first extended configuration (FIG. 64B) in which the structural member 6122 extends beyond a first side 6124 of the back 6012, and a second extended configuration (FIG. 64C) in which the structural member 6122 extends beyond a second, opposite side 6126 of the back 6112 (potentially depending on what side of the vehicle the child seat system 6100 is positioned). Although an external SIP device 6120 having a single structural member 6122 movable between a plurality of extended configurations is illustrated and described herein, it should be appreciated that embodiments having a plurality of separate external SIP devices 6120, each being movable relative to an extended configuration adjacent to a respective side 6124, 6126 of the back 6112 of the child seat 6102 is also contemplated herein.

[0752] With reference now to FIGS. 113A-113C, another example of an external SIP device 10102 movable between a stowed or retracted position and an extended position is illustrated. As shown, the external SIP device 10102 is a cupholder movable relative to a child seat 10100 between an extended position (FIG. 113A) and a retracted position (FIG. 113B). In the illustrated, non-limiting embodiment, the cupholder 10102 is pivotable about an axis, such as a vertically oriented axis for example, between the extended and retracted positions.

However, in other embodiments, the cupholder 10102 may be pivotable about an axis having another orientation, such as a horizontally oriented axis for example.

[0753] A locking member 10104 may be associated with the cupholder 10102 and may be operable to selectively lock the cupholder 10102 in the extended position. The locking member 10104 may be transformable between a locked configuration and an unlocked configuration. In the unlocked configuration, the locking member 10104 is slidable within an interior of the child seat 10100 and in the locked configuration, the locking member 10104 is locked in position relative to the child seat 10100.

[0754] In an embodiment, an impact member 10106 is operably coupled to the cupholder 10102. Although the impact member 10106 is illustrated and described herein as a biasing mechanism such as a coil spring, it should be understood that in other embodiments, the impact member may be a cushion member, shock absorber, or other suitable mechanism configured to absorb energy applied thereto. As shown, the biasing mechanism 10106 is affixed to the locking member 10104 and may bias the locking member 10104 into engagement with the cupholder 10102. The locking member 10104 may be arranged at a position generally aligned with a movable portion of the cupholder 10102. Accordingly, the biasing mechanism 10106 may bias the cupholder 10102 toward the extended configuration. If the locking member 10104 is unlocked as the cupholder 10102 is rotated inwardly, the unlocked locking member 10104 will slide out of the path of rotation of the cupholder 10102 (see FIG. 113B). However, when the locking member 10104 is locked, the locking member 10104 remains fixed within the path of rotation of the cupholder 10102.

[0755] With reference to FIG. 113C, during a side impact event, a force may be applied to the cupholder 10102 causing the cupholder 10102 to pivot toward the retracted position. As the cupholder 10102 pivots, it engages the locking member 10104. Because the locking member 10104 is locked in position, the locking member 10104 will not translate laterally out of the path of rotation of the cupholder 10102. Rather, the force applied to the locking member 10104 compresses the biasing mechanism 10106. Once the force is removed, the biasing mechanism 10106 applies a reactionary force to the cupholder 10102. Accordingly, the cupholder 10102 and biasing mechanism 10106 absorb energy from the side impact event.

[0756] In another embodiment shown in FIG. 114A-114C, another example of a cupholder 10202 configured as an external SIP device movable between a stowed or retracted position and an extended position relative to a child seat 10200 is illustrated. In the illustrated, non-limiting embodiment, the cupholder 10202 is translatable along an axis between the extended and retracted positions. Similar to the previous embodiment, at least one locking

member 10204 is associated with the cupholder 10202. In the illustrated, non-limiting embodiment, a first locking member 10204a is aligned with a first side of the cupholder 10202 and a second locking member 10204b is aligned with a second side of the cupholder 10202. The at least one locking member 10204a, 10204b is transformable between a locked configuration and an unlocked configuration. In the unlocked configuration, each locking member 10204a, 10204b is slidable within an interior of the child seat 10200 and in the locked configuration, the locking member 10204a, 10204b is locked in position relative to the child seat 10200.

[0757] A biasing mechanism 10206a, 10206b is operably coupled to the cupholder 10202. As shown, a biasing mechanism 10206a, 10206b is affixed to each locking member 10204a, 10204b and is operable to bias the locking member 10204a, 10204b into engagement with the cupholder 10202. Each locking member 10204a, 10204b may be arranged at a position generally aligned with a movable portion of the cupholder 10202. Accordingly, a biasing mechanism 10206a, 10206b may bias the cupholder 10202 toward the extended configuration via the at least one locking member 10204a, 10204b. If the locking member 10204a, 10204b is unlocked as the cupholder 10202 is translated inwardly, the unlocked locking members 10204a, 10204b will slide outwardly (see FIG. 114B), out of the path of movement of the cupholder 10202. Accordingly, the biasing mechanisms 10206a, 10206b may not compress when the cupholder 10202 translates inwardly and the locking members 10204a, 10204b are unlocked. However, when a locking member 10204a, 10204b is locked, the locking member 10204a, 10204b will remain fixed within the path of the cupholder 10202.

[0758] During a side impact event, a force applied to the cupholder 10202 causes the cupholder 10202 to translate toward the retracted position. As the cupholder 10202 moves, it engages the locking members 10204a, 10204b. With the locking members 10204a, 10204b locked in position, the locking members 10204a, 10204b will not translate laterally out of the path of the cupholder 10202. Rather, the force applied to the locking members 10204a, 10204b compresses the respective biasing mechanisms 10206a, 10206b. Once the force is removed, the biasing mechanisms 10206a, 10206b apply a reactionary force to the cupholder 10202. Accordingly, the cupholder 10202 and biasing mechanisms 10206a, 10206b absorb energy from the side impact event.

[0759] In other embodiments, such as shown in FIG. 115, a sidewall of the child seat 10300 including a cupholder 10302, such as a seat side member 10306 of a seat portion 10304 of the child seat 10300 for example, may have an increased thickness. This increased thickness may be formed by increasing the thickness of the seat shell 10308 at the seat side member

10306, by increasing the thickness of the soft goods 10310 located adjacent to the seat side member 10306, or alternatively, by adding additional material or padding (not shown) at either the exterior of the seat side member 10306, or at an interior of the seat side member 10306, such as between the seat side member 10306 and the soft goods 10310 connected thereto.

[0760] In each of the embodiments of FIGS. 113A-114C, the external SIP device 10102, 10202, in the extended position, is movable or deformable to absorb energy during a crash event. Additional examples of SIP devices movable or deformable to absorb energy during a crash event, such as a side impact event for example are illustrated in FIGS. 125A-129.

[0761] In the illustrated, non-limiting embodiment shown in FIGS. 125A-125C, an SIP device 11102 is arranged at a portion of the child seat system, illustrated at 11100, such as a headrest, upright side member, seat side member, or the support base. Although the SIP device 11102 is illustrated as being mounted adjacent to an exterior surface 11104 of the portion 11100 of the child seat, embodiments where the SIP device 11102 is arranged at another position are also contemplated herein. As shown, the SIP device 11102 includes a rigid body 11106 movable between a first position (FIG. 125A, 125B) and a second position (FIG. 125C). The body 11106 includes a plurality of pins 11108 positioned to interact with a reaction member 11110. As shown, at least one pin 11108 is disposed on each side of the reaction member 11110 and the pins are arranged such that portion of the reaction member 11110 engaged with the pins 11108 has a curvature formed therein. This curvature restricts movement of the SIP device 11102 from the first position if a force applied thereto is less than a threshold. During a crash event, a force is exerted on the SIP device 11102, such as by the vehicle door for example. If the force exceeds the threshold associated with the reaction member 11110, the SIP device 11102 will move relative to portion 11100 of the child seat system and the reaction member 11110. Because the curvature of the reaction member 11110 is arranged at the pins 11108 of the SIP device 11102, as the SIP device 11102 and therefore the pins 11108 translate relative to the reaction member 11110, the reaction member 11110 is bent to move the curvature of the reaction member 11110 with the pins 11108. In the illustrated, non-limiting embodiment, when the SIP device 11102 is in the first position, the curvature is formed near a first end of the reaction member 11110 and when the SIP device is in the second position, the curvature is formed near a second, opposite end of the reaction member 11110. This straightening and bending of different sections of the reaction member 11110 generates a constant reaction force as the SIP device 11102 moves, thereby absorbing energy.

[0762] With reference to FIGS. 126A-126C, the exemplary child seat system 11200 includes a support base 11202 and a child seat 11204 mounted to the support base 11202. An SIP device 11206 may be mounted at one or more locations about the support base 11202 and/or the child seat 11204. As shown, the support base 11202 may include a base seat portion 11208 and a base upright portion 11210, and at least one SIP device 11206 may be arranged at the base seat portion 11208, the base upright portion 11210, or both. Similarly, the child seat 11204 may include a seat portion 11212 and an upright portion 11214, and at least one SIP device 11206 may be arranged at the seat portion 11212, the upright portion 11214, or both. In each of the illustrated, non-limiting embodiments, the one or more SIP devices 11206 are protrusions extending laterally from the child seat system. Further, the SIP devices 11206 are sacrificial and configured to deform or break off when a force is applied thereto, such as during a crash event. In an embodiment, protrusions may include one or more weakened regions to direct the transfer of force therethrough.

[0763] With reference to FIGS. 127A-127C, an example of a sacrificial SIP device 11304 configured to deform or break off when a force is applied thereto is illustrated in more detail. In the illustrated, non-limiting embodiment, the exemplary SIP device 11304 is arranged at an exterior of the upright portion 11302 of a child seat 11300. As shown, the SIP device 11304 may include a generally cylindrically shaped body affixed at a first end to the child seat 11300. The body may be solid, or alternatively, may be at least partially hollow depending on the material of the body. In an embodiment, one or more weakened regions 11306 are formed in the body of the SIP device 11304. The weakened regions 11306 may be formed as grooves, slots, or any other suitable feature and may extend through only a portion or the entire thickness of the body. In an embodiment, the weakened regions are formed from a material having a reduced strength compared to the strength of the child seat. Alternatively, or in addition, the weakened regions may be formed by coupling two discrete components to one another. As shown, the weakened regions 11306 may be spaced about a periphery of the SIP device 11304 and adjacent weakened regions 11306 may be staggered relative to one another and relative to the distal end of the body. The weakened regions 11306 may facilitate the structural collapse of the SIP device 11304 when an impact force is applied to the distal end thereof. The body of the SIP device 11304 may be configured to bend and deform at each weakened region 11306. A distance between a surface of the child seat and the distal end of the SIP device 11304 after collapse is less than the distance between the child seat and the distal end of the SIP device 11304 before an impact force is applied thereto. The collapse of the SIP device 11304 absorbs energy from the impact applied thereto, thereby limiting the force transmitted to the child seat.

[0764] Another example of a sacrificial SIP device configured to deform or break off when a force is applied thereto is illustrated in more detail in FIG. 128A-128B. In the illustrated, non-limiting embodiment, an exemplary SIP device 11402 is arranged at an exterior of the child seat 11400. The SIP device 11402 may include a rigid body 11404 and at least one crushable structure 11406 mounted between the rigid body 11404 and the child seat 11400. The crushable structure 11406 may but need not be generally conical in shape. Further, the crushable structure 11406 may be formed from a material configured to depress, collapse, or crush when a force is applied thereto such that the crushable structure 11406 absorbs energy as it deforms. Although the crushable structures 11406 shown in FIG. 128B are formed from a bendable wire coiled into a conical shape, it should be understood that a crushable structure 11406 formed from any suitable material and having any shape is within the scope of the disclosure. The one or more crushable structures 11406 may be designed such that the displacement or deformation thereof plateaus beneath the threshold associated with injury of a child positioned within the child seat 11400.

[0765] FIG. 129 illustrates a plurality of head SIP devices 11502a, 11502b movable relative to the child seat 11500 to absorb energy during a crash event. As shown, one or more ramped surfaces 11504a, 11504b may be arranged at an interior surface 11506a, 11506b of one or more upright side members 1508, 11510 of the child seat 11500. Each head SIP device 11502a, 11502b may include one or more complementary ramped surfaces 11520a, 11520b arranged at an exterior surface of a headrest 11512 of the child seat 11500 adjacent to the interior surface 11506a, 11506b of the upright side members 11508, 11510. During normal use of the child seat 11500, the ramped surfaces 11520a, 11520b of a respective head SIP device 11502a, 11502b are not aligned with the adjacent ramped surfaces 11504a, 11504b of the upright side members 11508, 11510. However, when an impact force is applied to an upright side member 11508, 11510 of the child seat 11500, the ramped surfaces 11504a, 11504b thereof align with and engage the ramped surfaces 11520a, 11520b of the headrest 11512. As a result of the orientation of the ramped surfaces 11504a, 11504b, 11520a, 11520b, this engagement causes the upright side member 11508, 11510 to translate in a relative to the headrest 11512. In the illustrated, non-limiting embodiment, engagement between the ramped surfaces 11504a, 11504b, 11520a, 11520b is configured to drive the upright side member 11508, 11510 in a direction perpendicular to the direction of the impact force, thereby absorbing energy from the impact. Although the head SIP device 11502a, 11502b is illustrated and described relative to a headrest of the child seat, it should be understood that a similar SIP device may be arranged at another suitable location about the child seat.

[0766] In an embodiment, an SIP device may be mounted at a portion of the vehicle as an alternative to, or in addition to an SIP device mounted to the child seat system. With reference to FIG. 130, a child seat system 11600 is illustrated positioned on a vehicle seat of a vehicle 11601. As shown, an SIP device 11602 may be connectable to an interior surface of the vehicle adjacent to the child seat system 11600, such as to the vehicle door 11604 configured to contact or abut the child seat system 11600. The SIP device 11602 may be an airbag or a pod formed from any suitable energy absorbing materials or mechanisms. In an embodiment, the SIP device 11602 includes one or more components for mounting to any suitable portion of the vehicle 11601 including but not limited to a vehicle door 11604, a vehicle window 11608, a pillar 11614, the floor 11610, a door jamb, or the roof 11612. In an embodiment, the SIP device 11602 is tethered to the child seat system 11600 via a cable or other connection member 11620 such that the SIP device 11602 cannot be detached therefrom. It should be understood that the SIP device 11602 may be arranged adjacent to and configured to contact any suitable portion of the child seat system 11600 and may have a contour as described in any of the other embodiments disclosed herein.

[0767] Although only a portion of the various SIP devices illustrated and described herein are explicitly described as being transformable or configurable between a first configuration and a second configuration or a first position and a second position, it should be understood that any SIP device disclosed herein may be movable in such a manner. In an embodiment, one or more of the head SIP devices, shoulder SIP devices, torso SIP devices, and/or external SIP devices are transformable manually. For example, a user may apply a force to the SIP device, such as external SIP devices 5920a, 5920b, 6020, and 6120, to physically move the external SIP device to a desired position or configuration. This manual transformation may be performed either prior to or after installing an occupant within the child seat.

[0768] In other embodiments, transformation of one or more of the head SIP devices, shoulder SIP devices, torso SIP devices, and/or external SIP devices may occur automatically prior to or upon positioning of an occupant within a child seat. In such embodiments the child seat may include one or more sensors or mechanisms operable to detect the presence of a child and adjust or transform the SIP devices accordingly.

[0769] For example, with reference to FIGS. 97A-98B, a child seat may include an actuation mechanism operable to transform one or more SIP devices from a first configuration to a second configuration based on a configuration of the child seat. In the non-limiting embodiment of FIG. 97, an actuation mechanism 8702 is operable to transform an SIP device, such as an external SIP device 8704 for example, between a first configuration and a second



configuration based on the direction in which the child seat 8700 is mounted, such as relative to a support base 8706. For example, when the child seat 8700 is in a first, rearward-facing position (see FIG. 97B), the external SIP device 8704 may be in the first configuration. In the first configuration, the external SIP device 8704 may be retracted, or alternatively, may be at a first position along a path of movement of the external SIP device 8704. The first position along the path of movement may block or interfere with an opening (not shown) formed in the seat shell 8708 of the child seat 8700 associated with a vehicle belt path. When the child seat 8700 is in a second, forward-facing position, as shown in FIG. 97A, the external SIP device 8704 may be in the second configuration. In the second configuration, the external SIP device 8704 may be extended, or alternatively, may be arranged at a second position along a path of movement of the external SIP device 8704. In the second position along the path of movement, the external SIP device 8704 may be spaced from the opening so as not to interfere with a vehicle belt path of the child seat 8700. It should be understood that embodiments where the external SIP device 8704 is extended when the child seat 8700 is in a rearward-facing configuration, and stowed when the child seat is in the forward-facing configuration are also contemplated herein.

[0770] In the illustrated, non-limiting embodiment, the child seat 8700 and/or the support base 8706 includes an engagement member 8710 that is movable up and down as the child seat 8700 rotates relative to the support base 8706. This engagement member 8710 may be operably coupled to the external SIP device 8704 such that movement of the engagement member 8710 causes the external SIP device 8704 to transform between the first configuration and the second configuration. Although the external SIP device 8704 is illustrated and described herein as being arranged at the child seat 8700, embodiments where an external SIP device arranged at the support base 8706 is movable between a retracted and a deployed configuration in response to rotation of the child seat 8700 are also contemplated herein.

[0771] With reference to FIGS. 98A-98B, an actuation mechanism (not shown) is configured to operate different SIP devices based on the configuration of the child seat 8800 relative to a support base 8802. In the non-limiting embodiment, the support base 8802 includes a first external SIP device 8804 arranged at a first position and a second external SIP device 8806 arranged at a second position. For example, the first external SIP device 8804 may be arranged at a seat portion 8808 of the support base 8802 and the second external SIP device 8806 may be arranged at the back portion 8810 of the support base 8802. The first external SIP device 8804 and the second external SIP device 8806 may have similar configurations, or alternatively, may have different configurations. As shown, the first external SIP device 8804

may be extended and the second external SIP device 8806 may be retracted when the child seat 8800 is in the first rearward-facing configuration. Similarly, when the child seat 8800 is in the second, forward-facing configuration, the first external SIP device 8804 may be retracted and the second external SIP device 8806 may be extended.

[0772] In an embodiment, the actuation mechanism includes at least one an engagement member arranged at the child seat 8800 and associable with at least one external SIP device 8804, 8806. Different engagement members may be associated with respective external SIP devices 8804, 8806, or the same engagement member may be associated with multiple SIP devices 8804, 8806. The engagement between an engagement member and an external SIP device 8804, 8806 may cause the external SIP device 8804, 8806 to transform to the extended or deployed configuration. In other embodiments, an external SIP device 8804, 8806 may be biased to the extended configuration, such as by a biasing mechanism for example. In such embodiments, the engagement between the engagement member and an external SIP device 8804, 8806 may oppose the biasing force acting on the external SIP device 8804, 8806, thereby transforming the external SIP device 8804, 8806 to a retracted configuration.

[0773] In some embodiments, an SIP device, such as an external SIP device for example, is transformable between an extended position and a retracted position to provide clearance during rotation of the child seat between a forward-facing and a rearward-facing configuration. In the illustrated, non-limiting embodiment of a child seat system 9700 shown in FIGS. 107A-107B, a child seat 9702 is rotatably mounted to a support base 9704. As shown, the child seat 9702 includes a first external SIP device 9706a arranged at a first side of an upright portion 9708 of the child seat 9702 and a second external SIP device 9706b arranged at a second, opposite side of the upright portion 9708. As shown, the external SIP devices 9706a, 9706b are extended when the child seat 9702 is in both the forward-facing configuration (FIG. 107A) and the rearward-facing configuration (FIG. 107B). However, the external SIP devices 9706a, 9706b are movable to a retracted position to avoid interference during rotation of the child seat 9702 between the forward-facing and rearward-facing configurations.

[0774] Movement of the external SIP devices 9706a, 9706b to the retracted position may occur automatically by an actuation mechanism 9710 in response to rotation of the child seat 9702. The actuation mechanism 9710 includes at least one engagement link 9712 connected at a first end to a corresponding external SIP device 9706a, 9706b. An opposite end of the at least one engagement link 9712 may be movably coupled to a stationary cam ring 9714. The cam ring 9714 may have one or more raised areas 9716 and the engagement link

9712 may be located at the raised areas when the child seat 9702 is in at least one of the forward-facing and rearward-facing configurations. The raised areas 9716 drive vertical movement of the engagement link 9712, thereby causing the external SIP devices 9706a, 9706b operably coupled to the at least one engagement link 9712 to transform from a retracted position to a deployed position. Once the engagement links 9712 are rotated away from the raised areas 9716, the downward movement of the engagement links 9712 causes the external SIP devices 9706a, 9706b to transform to the retracted configuration. It should be appreciated that the actuation mechanism 9710 illustrated and described herein is intended as an example only and that an actuation mechanism 9710 having any suitable configuration to selectively retract an SIP device 9706a, 9706b during rotation of the child seat 9702 is contemplated herein. Further, although two external SIP devices 9706a, 9706b are illustrated, it should be appreciated that such an actuation mechanism may be used with a plurality of SIP devices arranged at different positions about the child seat 9702.

[0775] In yet another embodiment, illustrated in FIG. 108, an external SIP device 9802 mounted at an exterior of a child seat 9800 may be moved from an extended position to a retracted position automatically via engagement with a support base 9804 on which the child seat 9800 is mounted. As shown, the external SIP device is pivotally mounted within and protrudes from a cavity 9806 formed at a side of the child seat 9800. As the child seat 9800 rotates relative to the support base 9804, the support base 9804 will engage and apply a force to the external SIP device 9802 causing the external SIP device 9802 to rotate about its pivot axis in a first direction. This rotation opposes a biasing force of a biasing mechanism 9808 operably coupled to the external SIP device 9802. The external SIP device 9802 remains retracted within the cavity 9806 while the external SIP device 9802 is located adjacent to the support base 9804.

[0776] Once the portion of the child seat 9800 including the external SIP device 9802 is rotated away from the support base 9804, the force opposing the biasing mechanism 9808 is removed. As a result, the biasing mechanism 9808 biases the external SIP device 9802 back to the extended position. In an embodiment, the external SIP device 9802 is positionable in both a first retracted position and a second retracted position depending on the direction of rotation of the child seat 9800 relative to the support base 9804. In such embodiments, the cavity 9806 may be configured to receive the external SIP device 9802 when rotated in not only a first direction, but also in a second opposite direction. In such embodiments, a second biasing mechanism 9810 may be operably coupled to the external SIP device 9802 to bias the external SIP device 9802 back to the extended position from rotation in the second direction.

[0777] When a child seat system is mounted on a vehicle seat, it may be desirable to engage or extend only the portion of the SIP devices positioned adjacent to the vehicle door, and not the SIP devices located at an opposite side of the child seat system. With reference now to FIGS. 109A-111, a child seat system 9900 including a system for controlling a configuration of the SIP devices based on a position of the child seat system is illustrated. As shown, the child seat system 9900 includes a child seat 9902 rotatably mounted to a support base 9904. At least one SIP device 9906a is associated with the child seat 9902 in a forward-facing configuration and at least one SIP device 9906b is associated with the child seat 9902 in a rearward-facing configuration. The child seat 9902 additionally includes a first engagement member 9908 and a second engagement member 9909 operably coupled to the at least one SIP device 9906a associated with the child seat 9902 in a forward-facing configuration and a third engagement member 9910 and a fourth engagement member 9911, distinct from the first and second engagement members 9908, 9909, and operably coupled to the at least one SIP device 9906b associated with the child seat 9902 in a rearward-facing configuration. The first and second engagement members 9908, 9909 may be arranged at the same surface of the child seat 9902, such as a rear of the child seat 9902 for example, and are separated from one another by a distance. Similarly, the third and fourth engagement members 9910, 9911 may be arranged at the same surface of the child seat 9902, such as a front of the child seat 9902 for example, and are separated from one another by a distance.

[0778] The support base 9904 of the child seat system 9900 includes an actuator 9912 engageable with one of the first engagement member 9908, the second engagement member 9909, the third engagement member 9910, and the fourth engagement member 9911 to selectively extend the corresponding SIP devices 9906a, 9906b. As shown, the actuator 9912 of the support base 9904 may be arranged at a forward-facing surface 9916 of an upright portion 9914 of the support base 9904, and the engagement members 9908, 9909, 9910, and 9911 are located at a rear and front of the child seat 9902, respectively, at a surface positionable adjacent to the forward-facing surface 9916.

[0779] In an embodiment, the plurality of SIP devices 9906a, 9906b mounted to the child seat 9902 are biased into a retracted or stowed position. When the actuator 9912 engages either the first engagement member 9908 or the second engagement member 9909, a force is applied to the at least one SIP device 9906a associated with the child seat 9902 in the forward-facing configuration. This force opposes the bias acting thereon causing the at least one SIP device 9906a associated with the child seat 9902 in the forward-facing configuration to deploy. Similarly, when the actuator 9912 is engaged with the third engagement member 9910 or the

fourth engagement member 9911, a force is applied to the at least one SIP device 9906b associated with the child seat 9902 in the rearward-facing configuration. This force opposes the bias acting thereon causing the at least one SIP device 9906b associated with the child seat 9902 in the rearward-facing configuration to deploy. When none of the engagement members 9908, 9909, 9910, and 9911 are arranged in contact with the actuator 9912, such as when the child seat 9902 is rotating between the rearward-facing configuration and the forward-facing configuration for example (see FIGS. 110A-110B), the plurality of SIP devices 9906a, 9906b associated with each of the engagement members 9908, 9910 may be stowed.

[0780] The actuator 9912 may be arranged at different positions relative to the support base 9904 based on the location of the child seat system 9900 about a vehicle seat. For example, when the child seat 9902 is mounted to a vehicle seat at the driver side of the vehicle, the actuator 9912 may be in a first position, and when the child seat 9902 is mounted to a vehicle seat at the passenger side of the vehicle, the actuator 9912 may be in a second position. In the first position, the actuator 9912 may be engageable with the first engagement member 9908 and the third engagement member 9910, and in the second position, the actuator 9912 may be engageable with the second engagement member 9909 and the fourth engagement member 9911. Accordingly, the first engagement member 9908 and the third engagement member 9911 may be associated with operation of the SIP devices 9906a, 9906b when the child seat system 9900 is mounted at a driver side of a vehicle seat and the second engagement member 9909 and the fourth engagement member 9911 may be associated with operation of the SIP devices 9906a, 9906b when the child seat system 9900 is mounted at a passenger side of a vehicle seat. In some embodiments, the actuator 9912 may be positionable at a third position associated with the child seat 9902 being mounted to a vehicle seat centrally between the driver side and the passenger side of the vehicle.

[0781] In the illustrated, non-limiting embodiment, the actuator 9912 is movably mounted within a slot 9920 formed at the support base 9904, and the first position and the second position are disposed at opposite ends of the slot 9920 with the third position being arranged centrally between the first position and the second position. As shown in FIG. 111, a control feature 9922, such as a lever or dial for example, operably coupled to the actuator 9912 may also be arranged at the support base 9904. In the illustrated, non-limiting embodiment, the control feature 9922 is arranged at a different surface of the support base 9904 than the surface 9916 where the actuator 9912 is located. The control feature 9922 is movable to select a corresponding position of the actuator 9912 relative to the slot 9920 based on the position of the support base 9904 on a vehicle seat.

[0782] During installation of the support base 9904 upon a vehicle seat, the operator will select a corresponding position of the actuator 9912 using the control feature 9922. This selection will position the actuator for engagement with either the engagement members 9908, 9910 associated with the driver side or the engagement members 9909, 9911 associated with the passenger side of a vehicle seat. The operator will then rotate the child seat 9902 into a desired position relative to the support base 9904, such as based on the age and/or size of the child being received within the child seat 9902. This rotation of the child seat 9902 will move one of the plurality of engagement members 9908, 9909, 9910, 9911 into contact with the actuator 9912 causing the corresponding SIP devices 9906a, 9906b associated with the respective engagement member 9908, 9909, 9910, 9911 and positioned closest to the vehicle door to deploy. Although the engagement members 9908, 9909, 9910, 9911 are illustrated and described with respect to external SIP devices, it should be understood that multiple SIP devices arranged at any suitable location about the child seat 9902 may be associated with a respective engagement member.

[0783] In other embodiments, transformation of one or more of the head SIP devices, shoulder SIP devices, torso SIP devices, and/or external SIP devices may occur automatically in response to application of an external force to the child seat. Such a force may be applied by deployment of external airbags, such as airbags of a vehicle within which the child seat system is mounted. Alternatively, such a force may be applied via contact between a portion of the child seat system and an adjacent surface, such as a vehicle door for example.

[0784] With reference to FIGS. 117A – 118B, an example of a child seat system 10500 including an SIP device that is transformable in response to application of an external force is illustrated. The child seat system 10500 includes a child seat 10502 positioned about a support base 10504. The child seat 10502 includes a seat portion 10506 and an upright portion 10508, and at least one SIP device 10510 is illustrated protruding from an exterior surface of the upright portion 10508 of the child seat 10502. As shown, the SIP device 10510 may extend through an opening (not shown) formed in a seat shell 10512 of the child seat 10502 such that the SIP device 10510 is also arranged at an interior of the child seat 10502.

[0785] In the illustrated, non-limiting embodiment, the SIP device 10510 is movably mounted to the child seat 10502 via a linkage assembly 10520. As shown the linkage assembly 10520 includes a first link 10522 having a first end pivotally mounted to the child seat 10502 and a second link 10524 having a first end pivotally mounted to the child seat 10502. The second, opposite ends of the first link 10522 and second link 10524 are pivotally coupled to one another, and the SIP device 10510 may be attached to the linkage assembly 10520, such as

at the pivotal connection between the first and second links 10522, 10524 for example. When a force is applied to an exterior of the SIP device 10510, such as resulting from a side impact event, the SIP device translates inwardly with the movement being controlled by the corresponding pivotal movement of the first and second links 10522, 10524 of the linkage assembly 10520. It should be understood that any type of mechanism for controlling movement of the SIP device 10510 is contemplated herein, and that although the SIP device 10510 is arranged generally adjacent to a torso area of an occupant seated within the child seat 10502, such a linkage assembly 10520 may be implemented at any SIP device arranged at any suitable location about the child seat 1502.

[0786] With reference now to FIGS. 65A-67H, various embodiments of an actuation mechanism for transforming a SIP device are illustrated. Although the actuation mechanisms are illustrated and described herein as being operably coupled to at least one torso SIP device and/or at least one shoulder SIP device, it should be appreciated that an actuation mechanism may be suitable for use with any type of SIP device of the child seat system, at any position thereon. It should be appreciated that in any of the embodiments, one or more SIP devices may be at another location about the child seat, such as an opposite side of the child seat for example. Further, the same actuation mechanism, or alternatively, another actuation mechanism may be associated with the one or more SIP devices at the opposite side of the child seat.

[0787] In the non-limiting embodiment of a child seat 6200 as shown in FIGS. 65A-65D, a first torso SIP device 6202a is arranged adjacent to a first portion of the seat shell 6204, such as the first upright side member 6208 of an upright portion 6206 of the seat shell 6204, and a second torso SIP device 6202b is arranged adjacent to a second portion of the seat shell, such as a second upright side member 6210 of the upright portion 6206. However, embodiments where one or more of the torso SIP devices 6202a, 6202b are positioned adjacent a seat side member 6212, 6214 of a seat portion 6216 of the seat shell 6204 are also contemplated herein. Further, in the illustrated, non-limiting embodiment, a first shoulder SIP device 6220a is arranged adjacent to a portion of the seat shell 6204, such as the first upright side member 6208, and a second shoulder SIP device 6220b is arranged adjacent to another portion of the seat shell 6204, such as the second upright side member 6210.

[0788] At least one actuation mechanism 6230 associated with torso SIP device 6202a, 6202b and/or shoulder SIP devices 6220a, 6220b is operable to drive transformation of the at least one SIP device from a first configuration to a second configuration. As shown, the actuation mechanism 6230 includes an actuator or button 6232. In an embodiment, the actuator 6232 is arranged at an exterior surface 6234 of the child seat 6200. The actuator 6232 need not

be located directly adjacent to or in alignment with a SIP device operably coupled thereto, such as torso SIP device 6202a, 6202b or shoulder SIP device 6220a, 6220b. The actuator 6232 is operatively coupled to one or more SIP devices 6202a, 6202b, 6220a, 6220b via a linkage such as linkage 6236. Various linkages are illustrated in the FIGS. and may be suitable for use with the actuator 6232. In an embodiment, the linkage 6236a connecting the actuator 6232 to a torso SIP device 6202a is a rigid linkage. Another linkage 6236b illustrated as extending between the actuator 6232 and a shoulder SIP device 6220a is a flexible linkage, such as a cable or other tension member for example. In embodiments where an actuator 6232 is operably coupled to a plurality of SIP devices 6202a, 6202b, 6220a, 6220b, a separate linkage may be used to couple the actuator 6232 to each SIP device. In such embodiments, the plurality of linkages 6236a, 6236b associated with an actuator 6232 may be the same type of linkage or may be different (as shown).

[0789] An actuation mechanism 6230 as described herein is operable to selectively deploy or transform at least one SIP device, such as one or more head, shoulder, torso, or external SIP devices from a retracted configuration to an extended configuration in response to application of a force to the actuator 6232. For example, a force may be applied to the actuator 6232 during a crash event. This force is transmitted from the actuator 6232 to the torso SIP device 6202a via a corresponding linkage 6236a. Simultaneously, the force may be transmitted from the actuator 6232 to another SIP device, such as a shoulder SIP device 6220a via a corresponding linkage 6236b. Accordingly, such an actuation mechanism 6230 is operable to instantaneously transform one or more SIP devices associated with a child seat system to an extended configuration during a side impact collision.

[0790] The actuation mechanism 6230 may include a biasing mechanism (not shown) arranged between the actuator 6232 and the seat shell 6204. A biasing force of the biasing mechanism may be operable to bias the actuation mechanism 6230, via the actuator 6332, to a non-actuated configuration. In such embodiments, upon removal of the force from the actuator 6332, the biasing force of the biasing mechanism will bias the actuator 6332 back to a non-actuated position. This movement of the actuator 6232 may similarly transmit a force to an operatively coupled SIP device via the linkage 6236a, 6236b causing the SIP device to return to the retracted configuration.

[0791] With reference now to FIGS. 66A-66H, the illustrated child seat of FIGS 66A-66B may be substantially identical to the child seat previously described in FIGS. 65A-65D. As shown, a first torso SIP device 6302a is arranged adjacent to the first upright side member 6308 of an upright portion 6306 of the seat shell 6304, and a second torso SIP device 6302b



may be arranged adjacent to a second portion of the seat shell 6304, such as a second upright side member 6310 of the upright portion 6306. Further, in the illustrated, non-limiting embodiment, a first shoulder SIP device 6320a is arranged adjacent to a portion of the seat shell 6304, such as the first upright side member 6308, and a second shoulder SIP device 6320b is arranged adjacent to another portion of the seat shell 6304, such as the second upright side member 6310.

[0792] Another embodiment of an actuation mechanism for transforming a SIP device from a retracted configuration to an extended configuration is illustrated in these FIGS. 66A-66H. As shown, an actuation mechanism 6330 associated with the child seat 6300 includes an actuator 6332 operably coupled to at least one of the plurality of SIP devices of the child seat 6300, such as SIP devices 6302a, 6302b, 6320a, 6320b. In an embodiment, a biasing mechanism, such as a coil spring for example, may be operably coupled to one or more SIP device. For example, as shown, a first biasing mechanism 6334a is associated with a first torso SIP device 6302a and a second biasing mechanism 6334b may be associated with a first shoulder SIP device 6320a. Such biasing mechanisms 6334a and 6334b may be arranged between a body of the corresponding SIP device, such as torso SIP device 6302a and/or shoulder SIP device 6320a for example, and an adjacent surface of the child seat, such as the seat shell 6304. A biasing force of the biasing mechanism 6334a, 6334b is operable to bias a respective SIP device 6302a, 6320a into an extended configuration such that the SIP device 6302a, 6320a protrudes towards an occupant in the child seat 6300.

[0793] One or more catches 6336 may be used to retain each SIP device in a retracted configuration, against the biasing force of the biasing mechanism 6334. The actuator 6332 is operably coupled to the catch 6336 opposing the biasing mechanism 6334. In an embodiment, the actuator 6332 is operable to directly engage the catch, or a portion of the SIP device. However, in other embodiments, the actuator 6332 may be operably coupled to the catch 6336 via a linkage, such as a rigid linkage or a flexible linkage as previously described. In response to a crash, such as a side impact event, a force is applied to the actuator 6332. The resulting movement of the actuator 6332 transmits a force to the one or more catches 6336 opposing the biasing force of the biasing mechanism 6334 to hold a corresponding SIP device in the retracted configuration. This force causes the catch 6336 to disengage from the biasing mechanism 6334. Once the catch 6336 is released, the biasing force of the biasing mechanism 6334 biases the SIP device, such as 6302a, or 6320a for example, to the extended configuration. Accordingly, in the illustrated, non-limiting embodiment, transformation of an SIP device to an extended

configuration is driven directly by a biasing mechanism 6334 and indirectly by the actuator 6332.

[0794] With reference to FIGS. 67A-67H, another embodiment of an actuation mechanism operable to selectively transform a SIP device from a first, retracted configuration to a second, extended configuration is illustrated. The child seat 6400 illustrated may be similar to the previous embodiments. A SIP device, such as a torso SIP device 6402 for example, may be arranged adjacent to the first upright side member 6408 of an upright portion 6406 of the seat shell 6404. Further, in the illustrated, non-limiting embodiment, a second SIP device, such as a shoulder SIP device 6410 is arranged adjacent to a portion of the seat shell 6404, such as the first upright side member 6408.

[0795] An actuation mechanism 6430 associated with at least one SIP device, such as a torso SIP device 6402 or shoulder SIP device 6410 is operable to drive transformation of the SIP device from a first configuration to a second configuration. The actuation mechanism 6430 includes an actuator 6432 and a connection mechanism 6434 extending between the actuator 6432 and a corresponding SIP device 6402, 6410. In the illustrated, non-limiting embodiment, a headrest 6412 of the child seat 6400 is configured as the actuator 6432. As will be described in more detail below, movement of the headrest 6412 relative to the seat shell 6404 may be operable to extend or retract a corresponding SIP device 6402, 6410 of the child seat 6400.

[0796] An example of a connection mechanism 6434 is illustrated in more detail in FIGS. 67C, 67D, 67G, 67H. As shown, a track 6436 may be formed in the headrest 6412, and a lever 6438 associated with the seat shell 6404 may be operably coupled to the track 6436. Further, the lever 6438 may be operably coupled to an SIP device, such as the shoulder SIP device 6410 for example, via a flexible or rigid linkage 6440a. The lever 6438 may be operably coupled to the torso SIP device 6402 via another linkage 6440b. In the illustrated, non-limiting embodiment, the lever 6438 is pivotally mounted to the seat shell 6404 and a pin 6442 protruding from the lever 6438 is slidably receivable within the track 6436. When at least one SIP device, such as the shoulder SIP device 6410 and/or the torso SIP device 6402 for example, is in a retracted configured, the lever 6438 may be in a first position (see FIGS. 67C and 67D).

[0797] As the headrest 6412 is moved, for example translated relative to the seat shell 6404, the pin 6442 of the lever 6438 moves within the track 6436 of the headrest 6412. As shown, the track 6436 has a non-linear configuration such that as headrest 6412 moves, engagement of the pin 6442 with a bend or angle formed in the track 6436 causes the lever 6438 to rotate about its axis to a second position (see FIGS. 67G and 67H). As the lever 6438 rotates to this second position, a force is transmitted to the shoulder SIP device 6410 via the

linkage 6440a and to the torso SIP device 6402 via linkage 6440b, thereby causing the shoulder SIP device 6410 and the torso SIP device 6402 to transform from a retracted configuration to an extended configuration. In the illustrated, non-limiting embodiment, movement of the headrest 6412 in a downward direction, toward the seat portion of the seat shell 6404 transforms a corresponding SIP device 6402, 6410 to the extended configuration. However, embodiments where movement of the headrest 6412 in another direction, such as away from the seat portion of the seat shell 6404 for example is operable to transform a corresponding SIP device 6402, 6410 to the extended configuration is also contemplated herein. It should be appreciated that the connection mechanism 6434 illustrated and described herein is intended as an example only and that any suitable device operable to convert motion of the headrest into a corresponding movement of a SIP device coupled thereto is within the scope of the disclosure.

[0798] Although not shown in FIGS. 67A-67H, it should be appreciated that the child seat 6400 may include one or more additional devices, such as another torso SIP device and shoulder SIP device for example. In some embodiments, the child seat 6400 includes another torso SIP device and another shoulder SIP device disposed at an opposite side of the child safety system and having a configuration substantially identical to the torso and shoulder SIP devices 6402, 6410 illustrated and described herein.

[0799] In another embodiment, illustrated in FIGS. 118A-118B, another embodiment of an actuation mechanism operable to deploy an SIP device is illustrated. In the illustrated, non-limiting embodiment, the child seat 10600 has a seat portion 10602 and an upright portion 10604. The upright portion 10604 includes an upright support surface 10606 and a first and second upright side member 10608, 10610 extending from opposing sides of the upright support surface 10606. As shown, a first torso SIP device 10612a may be pivotally mounted near a center of the upright support surface 10606 and extend toward the first upright side member 10608, and a second torso SIP device 10612b may be pivotally mounted proximate a center of the upright support surface 10606 and extend toward the second upright side member 10610. Although the first and second torso SIP devices 10612a, 10612b are illustrated as being coaxial, embodiments where the first and second torso SIP device 10612a, 10612b are rotatable about different axes are also contemplated herein.

[0800] At least one actuation mechanism 10620 associated with one or more of the torso SIP devices 10612a, 10612b is operable to drive transformation of the at least one torso SIP device 10612a, 10612b from a first configuration (FIGS. 119A-119B) to a second configuration (FIGS. 120A-120B). In the illustrated, non-limiting embodiment, the child seat 10600 includes a first actuation mechanism 10620a associated with the first torso SIP device

10612a and a second actuation mechanism 10620b associated with the second torso SIP device 10612b. Each actuation mechanism 10620a, 10620b includes an actuator or button 10622a, 10622b operably coupled to a respective torso SIP device 10612a, 10612b. However, embodiments where a single actuation mechanism is operably coupled to the plurality of torso SIP devices 10612a, 10612b are also contemplated herein. In an embodiment, each actuator 10622a, 10622b is arranged at an exterior surface of the child seat 10600. The actuators 10622a, 10622b may but need not be located directly adjacent to or in alignment with the torso SIP device 10612a, 10612b operably coupled thereto.

[0801] As shown, each actuator 10622a, 10622b may be slidably connected to the child seat 10600 adjacent to a respective torso SIP device 10612a, 10612b. Accordingly, when a force is applied to the actuator, such as during a side impact event for example, the actuator 10622a, 10622b may translate inwardly from an unactuated position to an actuated position. Further, each actuator 10622a, 10622b may include an angled engagement surface 10624a, 10624b configured to contact a portion of the respective torso SIP device 10612a, 10612b. The slope of this surface 10624a, 10624b as the actuator 10622a, 10622b translates inwardly is configured to drive rotation of the torso SIP device 10612a, 10612b about its pivot axis into the interior of the child seat 10600, from a stowed position to a deployed position. This rotation of the torso SIP device 10612a, 10612b may rotate the occupant of the child seat 10600. In an embodiment, a biasing mechanism (not shown) may be operably coupled to each actuator 10622a, 10622b to bias the actuator 10622a, 10622b toward the unactuated position. Alternatively, or in addition, a biasing mechanism (not shown) may be operably coupled to each torso SIP device 10612a, 10612b to bias the torso SIP device 10612a, 10612b to the stowed position.

[0802] In another embodiment illustrated in FIG. 121A and 121B, an illustrated torso SIP device 10702 is a soft goods panel arranged at an interior of the child seat 10700, such as in contact with an occupant thereof. Although only a single torso SIP device 10702 is illustrated, it should be appreciated that embodiments including additional SIP devices are also within the scope of the disclosure. An actuation mechanism 10704 is associated with the torso SIP device 10702 and is operable to drive transformation of the torso SIP device 10702 from a first configuration (FIGS. 121A) to a second configuration (FIGS. 121B). In the first configuration, the soft goods panel may not have a linear configuration and/or a tension may not be applied to thereto. Similar to the previous embodiment, the actuation mechanism 10704 includes an actuator 10706 operably coupled to the torso SIP device 10702. In the illustrated, non-limiting embodiment, a portion of the torso SIP device 10702 is connected to the actuator

10706. The torso SIP device 10702 may be fixedly connected, or in some embodiments, may be pivotally connected to the actuator 10706.

[0803] The actuator 10706 may be slidably connected to the child seat 10700 adjacent to the torso SIP device 10702. When a force is applied to the actuator 10706, such as during a side impact event for example, the actuator 10706 is configured to translate relative to the child seat 10700. This movement of the actuator 10706 applies a tension to the torso SIP device 10702, pulling the soft goods panel taut. This transformation of the torso SIP device 10702 may rotate the occupant of the child seat 10700.

[0804] While each of the various types of SIP devices illustrated and described herein may provide enhanced protection to an occupant of a child seat system, the benefits may be compounded by integrating a plurality of different types of SIP devices into a child seat system. The National Highway Transit Safety Administration (NHTSA) has several injury criteria, set forth in the Federal Motor Vehicle Safety Standard (FMVSS), associated with a child safety system during a crash event. These criteria include head injury criterion (HIC<sub>15</sub>) and chest deflection in one or both of a forward-facing configuration and a rearward-facing configuration. In some embodiments, each type of SIP device integrated into a child safety system may target a specific injury criterion or type of movement of the child safety system and/or the child occupant of the child safety system during a crash event. For example, a head SIP device may be designed to control head kinematics during a crash event, such as by rolling the occupant's head forward, an external SIP may redirect the load within the child safety seat away from the occupant, a shoulder SIP may reduce lateral translation of an occupant torso, and a torso SIP may reduce lateral translation of an occupant torso. However, because an occupant's head, shoulders, and torso are interconnected, the control provided by an SIP device at a given region of the occupant's body may further affect the movement of other portions of the occupant's body. For example, by directing movement of the occupant's head in a specific manner, a head SIP device may positively influence the torso kinematics of the occupant, making the shoulder SIP device and/or a torso SIP device more effective.

[0805] Accordingly, a child seat system may include a combination side impact protection (SIP) assembly including any combination of SIP devices described herein. A combination SIP assembly of a child seat system may include at least two SIP devices. For example, a child seat system 6800 having a combination SIP assembly including at least one head SIP device 6802 and at least one shoulder SIP device 6804 is illustrated in FIG. 71. A child seat system 6900 having a combination SIP assembly including at least one head SIP device 6902 and at least one torso SIP device 6904 is illustrated in FIG. 72. FIG. 73 shows a

child seat system 7000 having a combination SIP assembly including at least one head SIP device 7002 and at least one external SIP device 7004. A child seat system 7100 having a combination SIP assembly including at least one shoulder SIP device 7102 and at least one torso SIP device 7104 is illustrated in FIG. 74, and a child seat system 7200 having a combination SIP assembly including at least one shoulder SIP device 7202 and at least external SIP device 7204 is illustrated in FIG. 75. FIG. 76 illustrates a child seat system 7300 having a combination SIP assembly including at least one torso SIP device 7302 at least one external SIP device 7304.

[0806] Further in some embodiments, the combination SIP assembly of a child seat system include at least three SIP devices. For example, as shown in FIG. 77, a combination SIP assembly of a child seat system 7400 may include at least one head SIP device 7402, at least one shoulder SIP device 7404, and at least one torso SIP device 7406. Alternatively, a combination SIP assembly of a child seat system 7500, shown in FIG. 78, may include at least one head SIP device 7502, at least one shoulder SIP device 7504, and at least one external SIP device 7506. A child seat system 7600 having a combination SIP assembly including at least one head SIP device 7602, at least one torso SIP device 7604, and at least one external SIP device 7606 is illustrated in FIG. 79 and a child seat system 7700 having a combination SIP assembly including at least one shoulder SIP device 7702, at least one torso SIP device 7704, and at least one external SIP device 7406 is illustrated in FIG. 80. In an embodiment, as illustrated in FIG. 81, the child seat system 7800 includes a combination SIP assembly including at least one of each of a head SIP device 7802, a shoulder SIP device 7804, a torso SIP device 7806, and an external SIP device 7808.

[0807] It should be understood that the head SIP devices that are schematically shown in FIGS. 71-81 can be any of the previously described head SIP devices 70, 70a, 70b, 120, 120b, 202a, 202b, 302, 402, 502, 602, 702, 802, 902, 1002, 1102a, 1102b, 1204a, 1204b, 1304a, 1304b, 1404a, 1404b, 1504a, 1504b, 1604a, 1604b, 1704a, 1704b, 1804, 1804b, 1806a, 1806b, 1910a, 1910b, 1920a, 1920b, 2010a, 2010b, 2012a, 2012b, 2104a, 2104b, 2016a, 2106b, 2108a, 2108b, 2210a, 2210b, 2212a, 2212b, 2214a, 2214b, 2216a, 2216b, 2306a, 2306b, 2308a, 2308b, 2408a, 2408b, 2410a, 2410b, 2512a, 2512b, 2514a, 2514b, 2604a, 2604b, 2604c, 2704a, 2704b, 2804a, 2804b, 2904, 6504a, 6504b, 6506a, 6506b and 6602 and the like. Similarly, the shoulder SIP devices that are schematically shown can be any one or more of the previously described shoulder SIP devices 72a, 72b, 3012a, 3012b, 3100, 3202, 3300, 3402a, 3402b, 6220a, 6220b, 6320a, 6320b, 6402, 6715a, and 6712b and the like. The torso SIP devices that are schematically shown in FIGS. 71-81 can be any one or more of the previously described

torso SIP devices 3502a, 3502b, 3602a, 3602b, 3702a, 3702b, 3804a, 3804b, 3904a, 3904b, 3914a, 3914b, 4002a, 4002b, 4102a, 4102b, 4202a, 4202b, 4302, 4402a, 4402b, 4502a, 4502b, 4602a, 4602b, 6202a, 6202b, 6302a, 6302b and the like. Further, the external SIP devices that are schematically shown can be any one or more of the previously described external SIP devices 74, 4702, 4802, 4902, 5020, 5120, 5220a, 5220b, 5320, 5402, 5502, 5602, 5702, 5808, 5810, 5920a, 5920b, 6020, 6120, and 6410 and the like.

[0808] The term “about” is intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. As used herein, the term “substantially” and derivatives thereof, and words of similar import, when used to describe a size, shape, orientation, distance, spatial relationship, or other parameter includes the stated size, shape, orientation, distance, spatial relationship, or other parameter, and can also include a range up to 10% more and up to 10% less than the stated parameter, including 5% more and 5% less, including 3% more and 3% less, including 1% more and 1% less.

[0809] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, element components, and/or groups thereof.

[0810] While the present disclosure has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made, and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the claims.

## WHAT IS CLAIMED IS:

1. A child seat for installation on a vehicle seat, the child seat comprising:
  - a seat portion;
  - a back portion extending from the seat portion;
  - a headrest, the seat portion, the back portion, and the headrest in combination defining an interior of the child seat;
  - a combination side impact protection (SIP) assembly having at least two of:
    - a first SIP device arranged at the headrest;
    - a second SIP device arranged at an exterior of at least one of the seat portion and the back portion; and
    - a third SIP device arranged at an interior of at least one of the seat portion and the back portion.
2. The child seat according to claim 1, wherein the second SIP device is arranged at the back portion.
3. The child seat according to claim 1, wherein the second SIP device is arranged at the seat portion.
4. The child seat according to claim 1, wherein the second SIP device is engageable with a vehicle belt of the vehicle seat.
5. The child seat according to claim 1, wherein the child seat includes an opening associated with a vehicle belt path and the second SIP device is connected to the child seat proximate the opening.
6. The child seat according to claim 5, wherein the second SIP device is arranged behind the opening associated with the vehicle belt path.
7. The child seat according to claim 1, wherein the second SIP device is transformable relative to the child seat between a first configuration and a second configuration.
8. The child seat according to claim 1, wherein the third SIP device is arranged at the back portion.
9. The child seat according to claim 8, wherein the third SIP device is a shoulder SIP device.
10. The child seat according to claim 8, wherein the third SIP device is a torso SIP device.
11. The child seat according to claim 1, wherein the third SIP device is arranged at the seat portion.



12. The child seat according to claim 1, wherein the headrest is movable relative to the back portion and the third SIP device is movably coupled to the headrest.
13. The child seat according to claim 1, wherein at least one of the first SIP device, the second SIP device, and the third SIP device is transformable between a first configuration, in which the at least one of the first SIP device, the second SIP device, and the third SIP device does not protrude into the interior of the child seat, and a second configuration in which the at least one of the first SIP device, the second SIP device, and the third SIP device extends into the interior of the child seat.
14. The child seat according to claim 1, wherein the combination SIP assembly includes the first SIP device and the second SIP device.
15. The child seat according to claim 14, wherein the second SIP device is arranged at the back portion of the child seat.
16. The child seat according to claim 14, wherein the second SIP device is arranged at the seat portion of the child seat.
17. The child seat according to claim 14, wherein the combination SIP assembly further includes the third SIP device.
18. The child seat according to claim 17, wherein the third SIP device is arranged at the back portion of the child seat.
19. The child seat according to claim 17, wherein the third SIP device is arranged at the seat portion of the child seat.
20. The child seat according to claim 1, wherein the combination SIP assembly includes the first SIP device and the third SIP device.
21. The child seat according to claim 20, wherein the third SIP device is arranged at the back portion of the child seat.
22. The child seat according to claim 20, wherein the third SIP device is arranged at the seat portion of the child seat.
23. The child seat according to claim 20, wherein the combination SIP assembly further includes the second SIP device.
24. The child seat according to claim 23, wherein the second SIP device is arranged at the back portion of the child seat.
25. The child seat according to claim 23, wherein the second SIP device is arranged at the seat portion of the child seat.
26. The child seat according to claim 1, wherein the combination SIP assembly includes the second SIP device and the third SIP device.

27. The child seat according to claim 26, wherein the second SIP device is arranged at the seat portion of the child seat.
28. The child seat according to claim 26, wherein the second SIP device is arranged at the back portion of the child seat.
29. The child seat according to claim 26, wherein the third SIP device is arranged at the back portion of the child seat.
30. The child seat according to claim 26, wherein the third SIP device is arranged at the seat portion of the child seat.
31. The child seat according to claim 1, wherein the combination SIP assembly has the first SIP device, the second SIP device arranged at the back portion, and the third SIP device arranged at the back portion.
32. The child seat according to claim 31, wherein the combination SIP assembly further comprises a fourth SIP device arranged within the interior of the seat portion.
33. The child seat according to claim 1, wherein the first SIP device is one of a plurality of first SIP devices arranged at the headrest.
34. The child seat according to claim 33, wherein the plurality of first SIP devices are arranged at opposite sides of the headrest.
35. The child seat according to claim 33, wherein the plurality of first SIP devices are arranged at a same side of the headrest.
36. The child seat according to claim 1, wherein the second SIP device is one of a plurality of second SIP devices arranged at the exterior of at least one of the seat portion and the back portion.
37. The child seat according to claim 36, wherein the plurality of second SIP devices are arranged at the exterior of the back portion.
38. The child seat according to claim 1, wherein the third SIP device is one of a plurality of third SIP devices arranged at the interior of at least one of the seat portion and the back portion.
39. The child seat according to claim 38, wherein the plurality of third SIP devices are arranged at the interior of the back portion.
40. The child seat according to claim 38, wherein the plurality of third SIP devices are arranged at the interior of the seat portion.
41. The child seat according to claim 38, wherein at least one of the plurality of third SIP devices is arranged at the interior of the back portion and at least one of the plurality of third SIP devices is arranged at the interior of the seat portion.

42. The child seat of claim 1, wherein the child seat is receivable on a support base, the child seat being rotatable relative to the support base between a plurality of positions.
43. A child seat system positionable on a vehicle seat, the child seat system comprising:  
a child seat including a seat portion and a back portion extending from the seat portion; and  
at least one side impact protection (SIP) device positionable about the back portion, the at least one SIP device being aligned with a shoulder of an occupant of the child seat.
44. The child seat of claim 43, wherein the child seat further comprises a seat shell defining the seat portion and the back portion and the at least one SIP device is affixed to the seat shell.
45. The child seat of claim 43, wherein the child seat further comprises a headrest and the at least one SIP device is positioned at an interior surface of the back portion, adjacent to the headrest.
46. The child seat of claim 45, wherein the headrest is movable relative to the back portion between a raised position and a lowered position and the at least one SIP device is sized and positioned such that the headrest is freely movable relative to the back portion between the raised position and the lowered position.
47. The child seat of claim 43, wherein the child seat further comprises a headrest and the at least one SIP device is attached to the headrest.
48. The child seat of claim 47, wherein the headrest is movable relative to the back portion between a raised position and a lowered position and the at least one SIP device is movable with the headrest.
49. The child seat of claim 47, wherein the headrest includes a belt guide and the at least one SIP device is positioned adjacent to the belt guide.
50. The child seat of claim 47, wherein further comprising soft goods arranged about the headrest, the soft goods including at least one cutout arranged at a position adjacent to the at least one SIP device.
51. The child seat of claim 43, wherein the at least one SIP device has a body including a mounting surface positionable adjacent to the back portion, an occupant facing surface engageable by the occupant of the child seat, and a side portion extending between the mounting surface and the occupant facing surface, the side portion being contoured to facilitate movement of the occupant about the at least one SIP device.

52. The child seat of claim 51, further comprising a transition between the occupant facing surface and the side portion, the transition being shaped to facilitate forward movement of the occupant.
53. The child seat of claim 52, wherein the transition is rounded.
54. The child seat of claim 52, wherein the transition is sloped.
55. A child seat system positionable on a vehicle seat, the child seat system comprising:  
a child seat including a seat portion and a back portion extending from the seat portion, wherein the seat portion and the back portion define an interior of the child seat; and  
at least one side impact protection (SIP) device arranged within the interior of the child seat, the at least one SIP device being configured to contact a torso of an occupant of the child seat.
56. The child seat of claim 55, wherein the child seat further comprises a seat shell defining the seat portion and the back portion and the at least one SIP device is affixed to the seat shell.
57. The child seat of claim 55, wherein the at least one SIP device is positioned about the child seat such that an upper surface of the at least one SIP device forms an armrest for the occupant of the child seat.
58. The child seat of claim 52, wherein the at least one SIP device is arranged at the seat portion.
59. The child seat of claim 58, wherein the at least one SIP device defines a portion of a belt path for receiving a vehicle belt.
60. The child seat of claim 59, wherein the seat portion is configured as a booster and is removably couplable to the back portion.
61. The child seat of claim 59, wherein the at least one SIP device includes padding positioned directly adjacent to a hip of the occupant of the child seat.
62. The child seat of claim 52, wherein the at least one SIP device is arranged at the back portion.
63. The child seat of claim 52, wherein the at least one SIP device is transformable between a first configuration and a second configuration, the at least one SIP device being coupled to the child seat in both the first configuration and the second configuration.
64. The child seat of claim 63, wherein in the first configuration, the at least one SIP device is retracted and is not configured to restrict movement of the occupant within the child seat, and in the second configuration, the at least one SIP device extends into the interior of the child seat and is configured to contact the torso of the occupant.

65. The child seat of claim 63, wherein in the first configuration, the at least one SIP device is flush with an adjacent surface of the child seat, and in the second configuration, the at least one SIP device protrudes beyond the adjacent surface of the child seat into the interior.
66. The child seat of claim 63, wherein the at least one SIP device is translatable between the first configuration and the second configuration.
67. The child seat of claim 63, wherein the at least one SIP device is rotatable between the first configuration and the second configuration.
68. The child seat of claim 52, wherein the at least one SIP device has a rigid body.
69. The child seat of claim 52, wherein the at least one SIP device has a structurally modifiable body.
70. The child seat of claim 52, wherein the at least one SIP device has a wedge shape.
71. The child seat of claim 52, wherein the at least one SIP device is arranged at the seat portion at a position spaced from the back portion.
72. A child seat system positionable on a vehicle seat, the child seat system comprising:  
a child seat including a seat portion and a back portion extending from the seat portion, and an opening formed in the child seat defining a portion of a belt path for receiving a vehicle belt; and  
at least one side impact protection (SIP) device connected to an exterior of the child seat proximate the opening.
73. The child seat system of claim 72, wherein the at least one SIP device includes a guide portion operable to engage the vehicle belt, the guide portion being positioned to guide the vehicle belt along the belt path.
74. The child seat system of claim 73, wherein the guide portion is positioned to guide the vehicle belt toward the opening.
75. The child seat system of claim 73, wherein the guide portion is a slot formed in a body of the at least one SIP device, the vehicle belt being receivable within the slot.
76. The child seat system of claim 73, wherein the guide portion includes a guide member extending from the at least one SIP device, the vehicle belt being receivable between the guide member and the at least one SIP device.
77. The child seat system of claim 76, wherein the guide member is movable relative to the at least one SIP device between a first position, in which the vehicle belt is free to move relative to the guide portion, and a second position, in which the vehicle belt is locked within the guide portion.

78. The child seat system of claim 72, wherein the at least one SIP device is movably coupled to the child seat, the at least one SIP device being movable between a first position in which the vehicle belt is free to move relative to the at least one SIP device, and a second position, in which the vehicle belt is locked in engagement with the at least one SIP device.
79. The child seat system of claim 72, wherein the at least one SIP device is arranged at the back portion of the child seat.
80. The child seat system of claim 72, wherein the at least one SIP device is arranged near an interface between the back portion and the seat portion.
81. The child seat system of claim 72, wherein a rear surface of the at least one SIP device is flush with the exterior of the back portion.
82. The child seat system of claim 81, wherein the back portion of the child seat includes a back, a first upright side member arranged at a first side of the back, and a second upright side member arranged at a second side of the back, and a rear surface of the at least one SIP device is flush with the back.
83. The child seat system of claim 81, wherein the back portion of the child seat includes a back, a first upright side member arranged at a first side of the back, and a second upright side member arranged at a second side of the back, and a contour of the rear surface of the at least one SIP device corresponds to a contour of the back portion over a height of the at least one SIP device.
84. The child seat system of claim 72, wherein at least one SIP device is configured to rotate the child seat in response when a force is applied to the at least one SIP device.