60 years of child safety - Challenges today

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SAFER seminar on Child Occupant Protection: Latest knowledge and future opportunities
Gothenburg, Sweden

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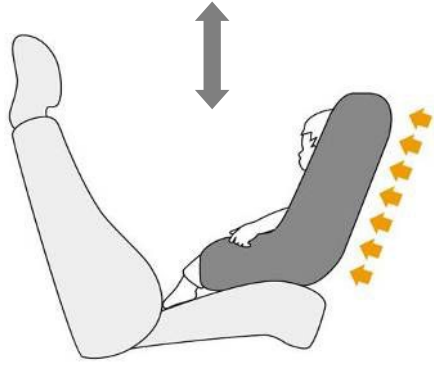
VOLVO

The first child seat prototype for protection

by Bertil Aldman

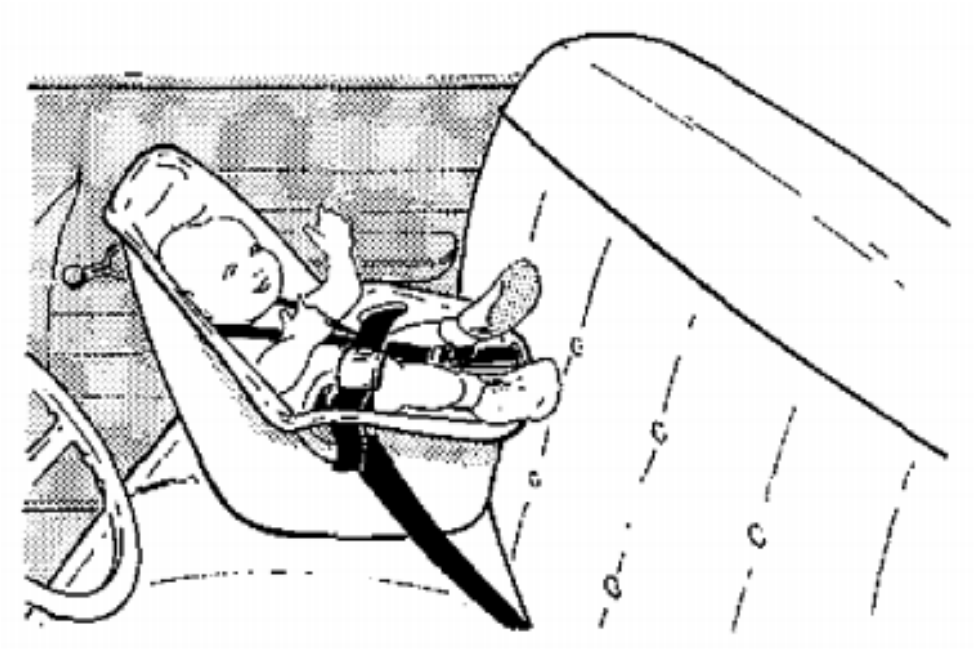
Crash test 1964 in a Volvo PV444



Ref. Aldman, Stapp, 1964

Infant seat

The GM Infant Safety Carrier
(Feles, SAE-700042, 1970)



GM Love seat
(Radovich, Stapp, SAE-831655, 1983)

Available child seats in Sweden 1974

Production seat by Klippan,1967

Production seat by Hylte, 1968

Production seat by Volvo, 1972

"*Although convinced about the **very good protection abilities**, most non-Swedish researchers regarded the rearward facing seats as an **unrealistic solution to the problem***"
(*Thomas Turbell, 1974*)

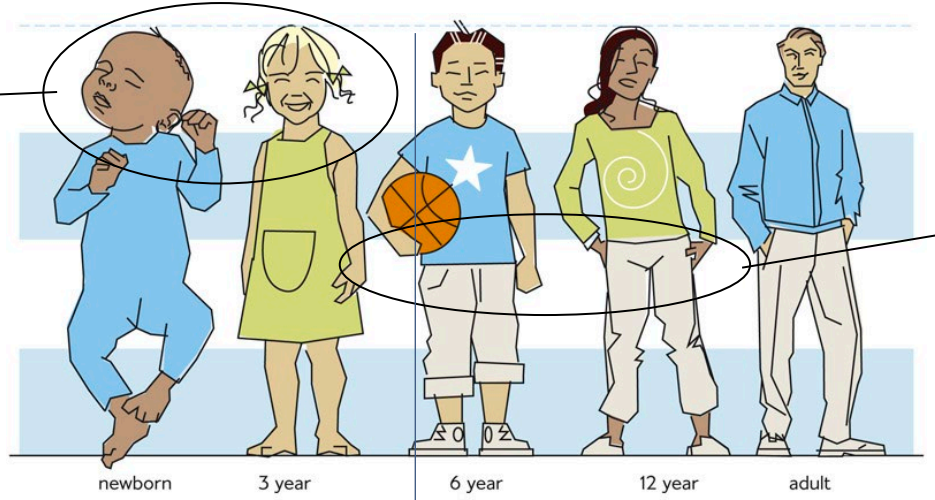
Ref. Turbell, VTI report 36A, VTI.se, 1974

World-first belt-positioning booster, also a Swedish invention

Ref. Norin et al. SAE paper no. 790320, 1979

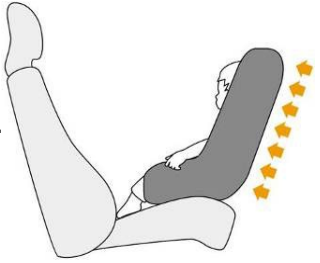
Real-world protection for the child

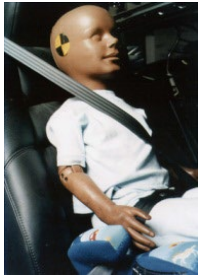
Head is heavy
and neck is weak



Pelvis is under
development
and legs are shorter

Rearward facing child seat
to distribute the loads over
the head and torso



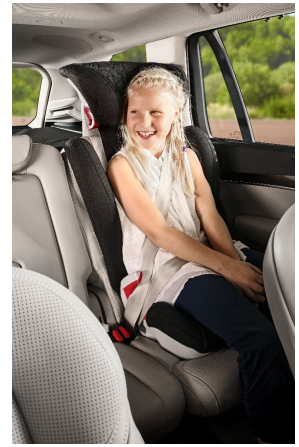


Belt-positioning booster
to adapt the child into the vehicle
protection systems

Recommendation based on the protection needs of the child

Rearward facing child seats

up to at least 4 years old



Booster seat

Booster cushion

Integrated booster

Belt-positioning boosters

up to stature 140 cm and at least 10 years old

Protection principles of a rearward facing child seat, frontal impact

The head and body are restrained together in a good balance.

- Minor loads through the neck.
- Well-protected head.

Frontal impact

Ref. Jakobsson et al., Prot. of Children in Cars Conf, Munich, 2013

Protection principles of a rearward facing child seat, frontal impact

Forward facing:

The head is restrained by the neck only.

- High loads through the neck.
- Risk for head impacts.

Frontal impact

The head and body are restrained together in a good balance.

- Minor loads through the neck.
- Well-protected head.

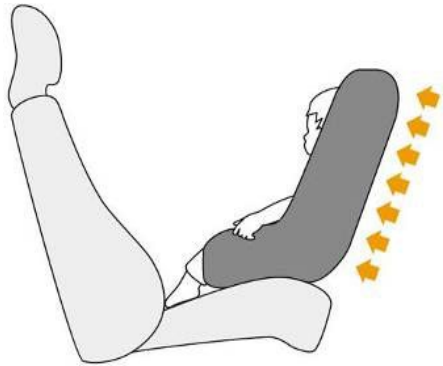
Frontal impact

Ref. Jakobsson et al., Prot. of Children in Cars Conf, Munich, 2013

Rearward facing – the safest way

Reduced injury risks, specifically in frontal and side impacts

- Swedish real-world data
- US real-world data



More robust and forgiving in misuse situations

- Less sensitive to slack in harness and attachments
- Since the introduction in 1960s, very few fatalities using rearward facing child seats in Sweden

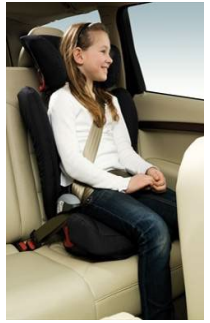
Ref. Jakobsson, Prot. of Children in Cars Conf, Munich, 2017

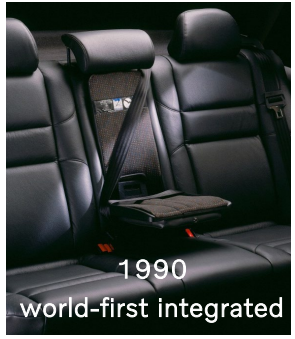
Development of **rearward facing child seats**
- changes in design, protection principles remain

1964
World-first child safety seat prototype

2000
World-first rearward facing child seat with ISOFIX

Development of **boosters**





What's the role of the booster?

The booster is an adapter

Its role is to:

- **Boost**! - Raise the child into a good lap and shoulder belt position.
- Provide comfortable **cushion length.**
- **Lap belt guides** to help position the lap belt towards the pelvis, and to restrain the booster cushion.
- **Side support** for comfort and upright sitting posture
  - Could be provided by the booster.
  - It could just as well be an add-on comfort cover.

Integrated booster with an add-on comfort cover

Ref. Jakobsson et al., ESV Conf., Yokohama, 2023

Real-world data shows that booster-seated children are well protected in cars

- **High overall injury reducing effects**
- In **frontal impacts**, abdominal injuries are almost eliminated
- Children in **side-impacts** benefit from using boosters; both in near-side and far-side impacts
- **No differences seen between booster seat and booster cushion**; overall nor in side impact specifically

Refs. Jakobsson et al., ESV 3005, Durbin et al., JAMA 2003, Arbogast et al., Pediatrics 2009 and STAPP 2010

Child occupant protection is about real kids in real cars

The car + the child restraint + the user

Challenges today and in the future

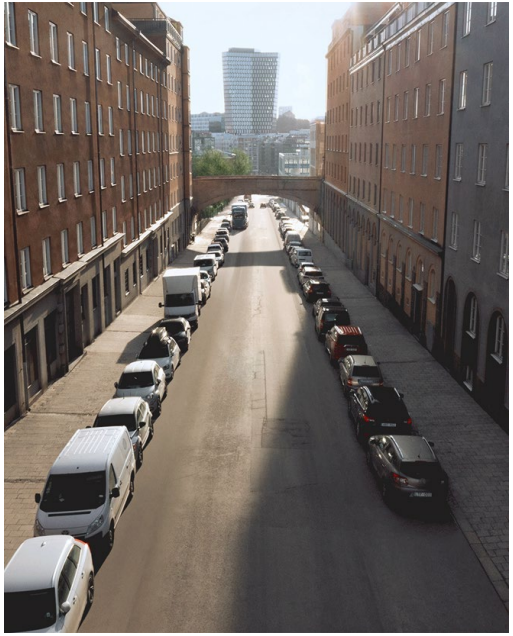
- Flexibility - car sharing, carpooling and ride hailing
- More streamlined cars driven by sustainability goals
- Increasing vehicle automation, e.g., autobrake, which may position the child more forward prior to the impact
- Influence of child restraint type-approval and consumer information tests for child restraints

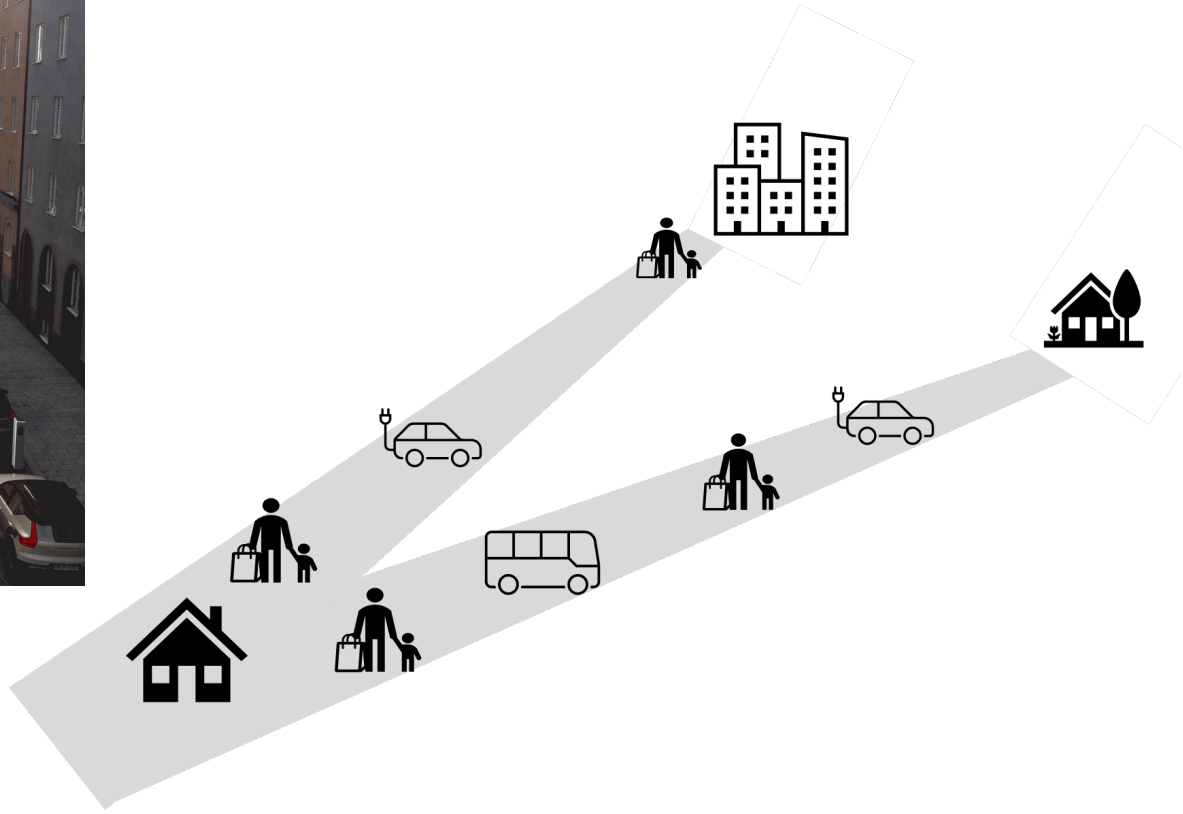
With the mindset of Vision Zero, we must target:

➢ High usage: focus user-friendly and simple design, always in accordance with the protection principles

➢ Low misuse: focus robust, forgiving and comfortable design + information

Changed cityscape and new forms of car ownership





The car + the child restraint + the user

Boosters

Difficult to fit booster seats in the car

Potential conflict with other passengers

Potential conflict with vehicle protection system

A booster cushion is a preferred booster for shared mobility

Ref. Jakobsson et al., ESV Conf., Yokohama, 2023

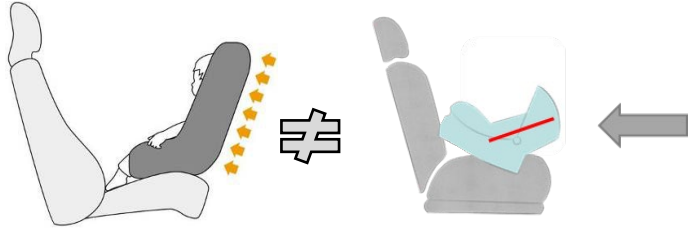
The car + the child restraint + the user

Rearward facing child seats

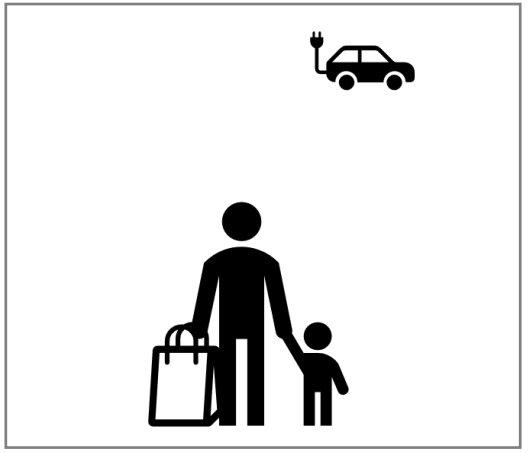
The optimal robust technical design for addressing misuse:

- Adheres to the protection principles
- The shell is the main load bearer
  - Addresses the whole-crash sequence perspective
  - In most crashes, the child is exposed to a forward movement (due to the car is travelling forward)

Applies only if positioned upright



How can we further promote and enable high usage?



How to find good solutions for shared mobility

Real world protection of children
- adhering to the protection principles

Stay in **rearward facing child seats** until large enough to use vehicle seatbelt together with a booster to adapt to the vehicle protection system.

As for adults, the **seatbelt** is the primary restraint for booster-seated children.

- The booster's main purpose is to **raise** the child in position
  - for good lap belt geometry, to help reduce risk of submarining in frontal impacts, and
  - for a more comfortable and safe mid-shoulder shoulder-belt position

Focus the essential protection principles and always consider the real-world context;
which includes **the car, the child restraint, and the user as one entity.**
This should be the foundation for all assessments, tests and communication.

Thank you!

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