

# CRASH ENERGY & CHICKEN FINGERS

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CODE: TZDSC

EMS \_\_\_\_\_

Engineers \_\_\_\_\_

## WHO'S IN THE ROOM?

Law Enforcement \_\_\_\_\_ CPST \_\_\_\_\_

# Laws of Thermodynamics



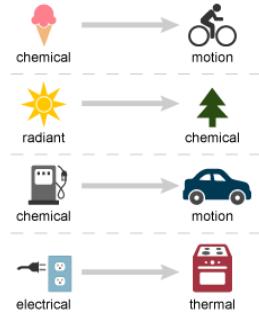
- Energy can not be created or destroyed, only transferred or transformed
- $F = ma$
- For every action, there is an equal and opposite reaction

The more you convert/transfer energy, the more disordered it becomes

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## Energy transformations



Source: National Energy Education Development Project (public domain)

# First Law:

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- A moving vehicle has turned a dormant energy into momentum and that energy will need to be redirected to prevent it from giving us big owies in a crash
- *"If this energy is so dangerous, why don't we feel it?"*
  - Everything in the vehicle has the same/similar energy; our brains have been fooled



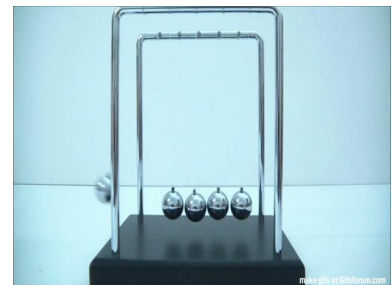
## Second Law:

- The force required to keep a thing in place is related to how quickly the vehicle stops (acceleration) and the weight of the thing (mass)
  - Acceleration = change in speed, positive or negative



## Third Law:

- Things will keep bouncing around until we find a safe way to divert that energy elsewhere, preferably by slowing them down (make the change in speed last longer) or preventing the energy from getting there
  - Seat belts, crumple zones, airbags, car seats and their magical parts
- Energy is lazy and easily distractible



## An Example

- Vehicle travelling at 30 mph, collision with a bridge...30 → 0 mph in 0.03 seconds
- Child Passenger: 6 y/o, 50 lbs
- Impact Force is traditionally measured in Newtons (N)
  - One Newton is the force required to move 1 kg by 1 m/s each second in the direction of applied force
  - Considering force of gravity, holding one of these would feel like 1N:



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## Dude, is he still talking about math stuff?

30 mph = 13.41 meters/second (Travelling Speed)

50 lbs = 22.68 kg (Child)

Time to zero: .03

$$F = M \times A$$

• Force = Child \* Travelling Speed / time it takes to get to zero

•  $F = 22.68 * (13.41 / 0.03) = 10,196 \text{ N}$  (feels like 1.04 tons)

– (...so basically like the force of 20,392 chicken fingers)

• There's more: Deceleration force = g's

– Child is experiencing about 46g's of force before impact (belted)

– Unbelted =  $Child * (13.41 / 0.006) = 50,981 \text{ N}, 229 \text{ g's}$

• Slow down...deceleration in 0.1 sec = 3,041 N, 14 g's



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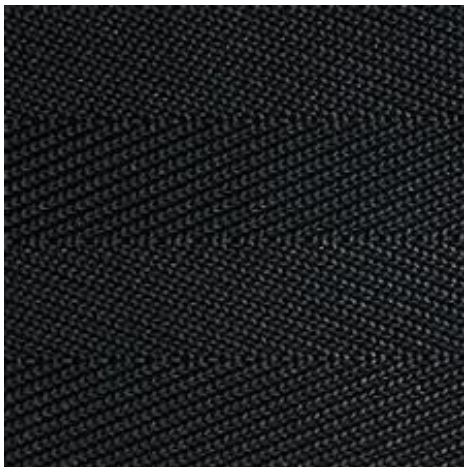
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## Why Safety Belts/Car Seats Matter

- Keep people in the vehicle
- Contact the strongest parts of the body
- Spread forces over a wide area of the body
- Protect the head, brain, and spinal cord
- Help the body to slow or "ride down" the crash forces



## Not the Spider-Man Kind



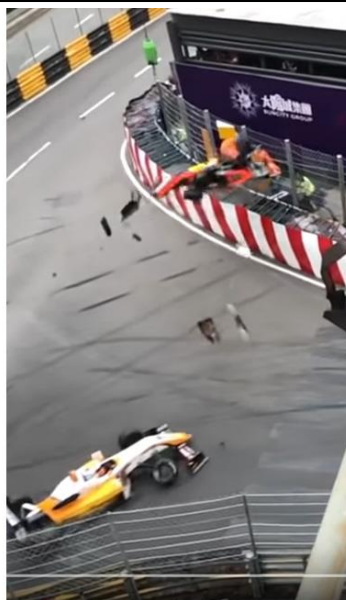
# I have a suggestion...



## Th

- So

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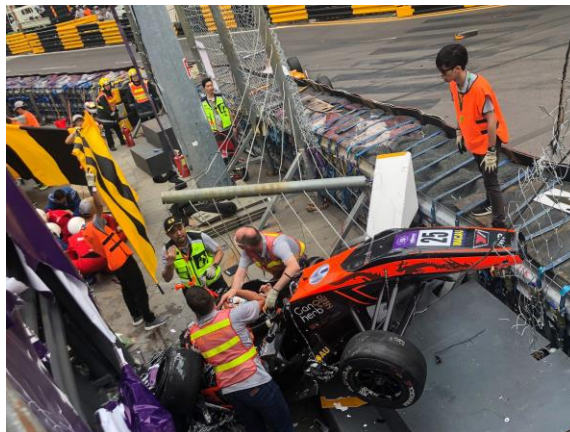


# A Closer Look



Analysis: The factors that saved Floersch's life (motorsport.com)

# A Closer Look



## The Case for Slowing Down

$$54.89 \text{ kg} * (76.44 \text{ m/s} / 0.05) = 83,920 \text{ N (156 g)}$$

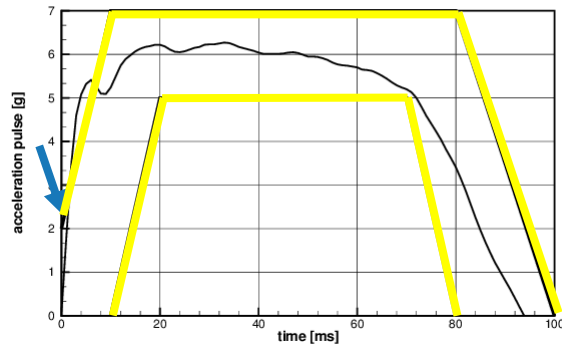


$$54.89 \text{ kg} * (64.82 \text{ m/s} / 0.1) = 35,580 \text{ N (66 g)}$$

# EMS



# Crash Pulse Corridor : Cars



# Passenger Car vs. Ambulance

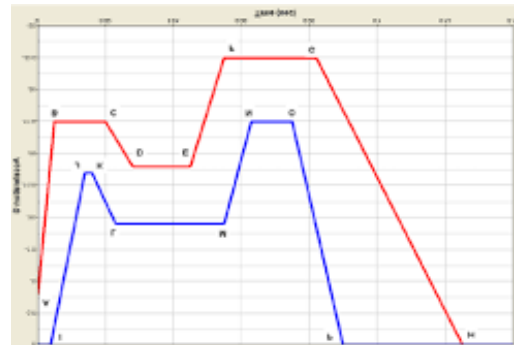
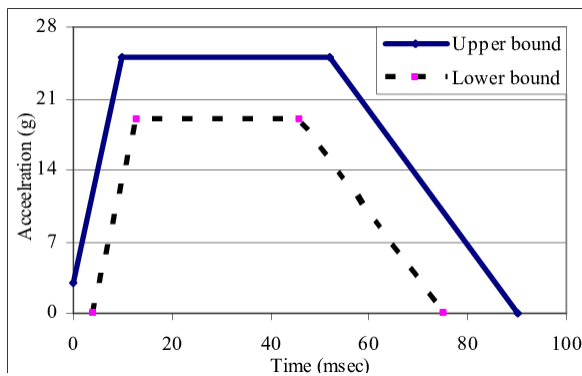


Image Credit: Dan Sjoquist, Serenity Safety Products

# Crash Forces at Work in the Ambulance

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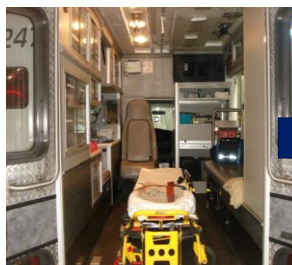
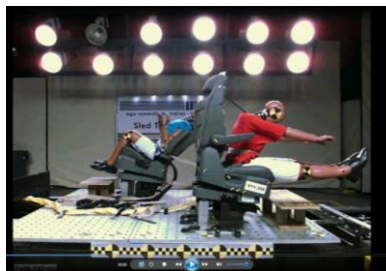


Photo Credits: NIOSH, CDC

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## WHEN AMBULANCES CRASH EMS Provider & Patient Safety

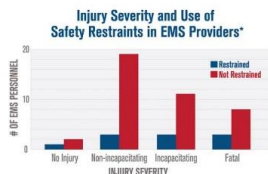
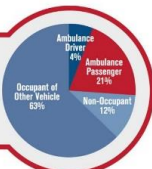
DATA COLLECTED BETWEEN 1992-2011



**4,500**  
vehicle traffic crashes involving  
an ambulance per year  
ESTIMATED ANNUAL AVERAGE

**34%**  
resulted in  
injuries

**33**  
people killed  
per year



**84%**  
OF EMS PROVIDERS  
IN THE PATIENT COMPARTMENT  
**WERE NOT RESTRAINED**

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**ONLY 33%**  
OF PATIENTS  
**WERE SECURED\***

WITH SHOULDER AND LAP RESTRAINTS

**44%** of patients were  
ejected from the cot  
in serious crashes\*

**61%**  
restrained with lateral  
belts only\*

**38%**  
shoulder  
harnesses  
were  
available  
but were  
not used\*

\* IN SERIOUS CRASHES  
INVESTIGATED BY  
NHTSA



**SIT DOWN & BUCKLE UP!**  
Secure Your Patients. They Rely on You!

This safety message brought to  
you by NHTSA's Office of EMS.



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## Resources for EMS

- Automotive Safety Program – Riley Children’s: <https://preventinjury.medicine.iu.edu/>
- NASEMSO Safe Transport of Children Committee
- EMSC: <https://emscmn.org/resources/ems/>

# CPS QUICK FACTS

## AAP Recommendation - Best Practices

- Infants and toddlers should ride rear-facing until they exhaust the height or weight limit of their seat
- Children then transition to a forward-facing seat with 5-point harness and use that seat until they exhaust the height or weight limit
- School-aged children should then use a belt-positioning booster until they fit the vehicle seat belt properly
- Children under 13 should always sit in the back seat
- Chicken fingers permitted based on good behavior, sauces optional\*

\*AAP does not currently have a stance on chicken fingers in automobiles

## Proper Use Makes A Difference



## General Use and Best Practice

### • Harnessing

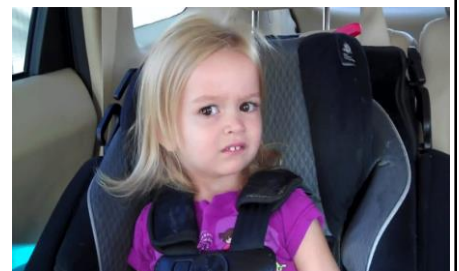
- Harness should be snug so there is no loose webbing at the shoulders (“pinch test”) and straps are snug against hips
- Retainer clip should be positioned on the child’s chest in line with arm pits
- Rear-facing: straps should go over child’s shoulder so they enter the car seat shell at or below shoulder level
- Forward-facing: straps at or above shoulders
- No clothing with thick insulation



## General Use and Best Practices

### • Installation

- Typically only one belt system – either lower anchors/tether (LATCH) or seat belt
- Belt should hold seat tight enough (pre-crash) so seat won’t move more than 1” side-to-side or front-to-back
- Generally, car seat shouldn’t touch vehicle seat
- No aftermarket products interfering with install or harnessing
- Car seats should not be used after expiration date or after a crash



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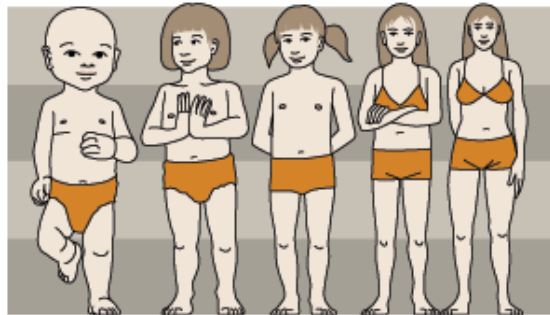
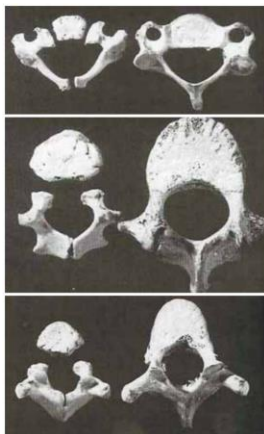
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## Gratuitous (Simulated) Violence

- Restrained vs. not restrained  
<https://www.youtube.com/watch?v=AjKeq2p8kRY>
- Side Impact  
<https://www.youtube.com/watch?v=TSvaZlaUL9k&list=PL19715AA92B39A54F&index=6&t=0s>
- RF Incorrect Belt Path  
<https://www.youtube.com/watch?v=e7zZ3m3eYII>
- Loose Installation with vehicle belt:  
<https://youtu.be/oucpYuDh55A>

## Unique Anatomical Challenges



# When The Real World and Test Lab Don't Match

- Seated out of position (belted/booster)
- Size of child may not be proportionate to test dummy
- Human response changes outcomes of crashes
- Crash testing standards are limited
  - FMVSS is limited (for good reason) and updates to standards are slow
  - Manufacturers exceed most requirements, but individual testing isn't necessarily apples to apples

CAR SEAT TECH<sub>NOLOGY</sub>

## New-ish Tech

*NOTE: Products shown are for discussion only and inclusion does not constitute product endorsement*

- Load Leg: [load leg crash test](#)



## New-ish Tech

*NOTE: Products shown are for discussion only and inclusion does not constitute product endorsement*

- Rebound Limiter





## New-ish Tech

*NOTE: Products shown are for discussion only and inclusion does not constitute product endorsement*

- Side Impact Management



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*Incoming! ...new FMVSS 213 side impact standards*

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## Stuff I used

- Texting and Driving in 1960: Terrible Maps
- Blues Brothers: <https://giphy.com/gifs/police-car-chase-RYjnzPS8u0jAs>
- Planes, Trains, and Automobiles: <https://trailers.getyarn.io/yarn-clip/af3f9711-7662-4476-9073-62012caca992/gif>
- Use the force: <https://tenor.com/view/use-the-force-darth-vader-light-saber-gif-14390717>
- Sloth: <https://giphy.com/gifs/artede-sloth-fautier-35A5gOA14la6v2eaFN>
- Sophia Floersch: <https://www.cnn.com/2020/05/31/motorsport/sophia-floersch-crash-le-mans-formula-3-laureus-cmd-spt-intl/index.html#:~:text=She'd%20collided%20with%20the, could%20survive%20such%20a%20crash.>
- Crash pulse cooridor: [https://www.researchgate.net/figure/Corridor-for-the-sled-acceleration-pulse-and-crash-pulse-as-recorded-for-one-of-the-tests\\_fig1\\_268276556](https://www.researchgate.net/figure/Corridor-for-the-sled-acceleration-pulse-and-crash-pulse-as-recorded-for-one-of-the-tests_fig1_268276556)

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### Texting and driving fatalities in 1960



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