The main achievements of the CHILD project

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CHILD

Contract G3RD-CT-2002-00791

Duration: (49 months) : September 2002 – September 2006
Funding: Partially funded by the European Commission
Programme : Standard, Measurements & Testing

Partners: 14, from seven European countries
Coordinator: RENAULT S.A - Françoise CASSAN
How was CHILD born?

- 1989: International Task Force on Child Restraint, initiated by Claude Tarrière from RENAULT – 13 pioneers from all over the world, working on a voluntary basis, without any financial subsidiary.

- 1996: CREST was the successor of the ITFCRS. It was partly funded by the European Commission under the SMMT programme of the 4th PCRD. It opened the way to a better knowledge in the field of children protection.

- 2002: CHILD takes the advantage of the CREST experience. It is a continuation, but with many new development items that were not in CREST. CHILD is now completed, but there is still a lot to do to improve the safety of children in cars.

ITF-CRS
CHILD organisation

Real world situation study

Experimentation & modelling

Co-ordination & dissemination

Consolidation & analysis

WP1

WP2

WP3

WP4
WP 1 Accidentology
Main contributions of WP1

WP1 has made a contribution to the scientific objectives of CHILD through the provision of real-world crash investigations.

These in-depth cases provide a better understanding of the crash events including:
• the injury causes and outcomes for restrained children
• the child restraint systems used
• the child kinematics
CHILD accident database

- Contains 669 accident cases
  - 264 CHILD cases
  - 405 CREST cases
- Effectively and efficiently managed
- Analysis conducted, dissemination through publications.

The results of analysis of the accident data base are presented during this conference in two other CHILD communications:

- “CHILD : Analysis of CHILD data related to frontal impacts”, Alan Kirk et al…

- “CHILD : Analysis of CREST and CHILD data related to side impacts”, Philippe Lesire et al…
USE and MISUSE

WP1 has also provided a literature review, surveys of use and a testing programme to evaluate misuse.

They have all contributed to the understanding of the effects of misuse on the performance of child restraint systems.
Literature review

- Review of the knowledge of CRS use and misuse in Europe and the rest of the world
- Surveys undertaken in France and Spain
- Report of the situation in Germany, to complement literature report
- All these reports are available on the CHILD website:

  www.childincarsafety.com
Spanish & French misuse surveys

Aim of studies:

- To determine the level of use & misuse of CRS
- To know the attitudes of parents towards the use & misuse of CRS
- Additionally, to collect information to be used for the development of test procedures and the misuse evaluation programme

**MISUSE** of a child restraint system is defined as any incorrect fitting of the restraint in the vehicle (e.g. having the seat belt routed incorrectly) or incorrect positioning or restraining of the child within it (e.g. having the harness too loose).

**INAPPROPRIATE USE** is defined as the child being restrained in the wrong type of restraint for their size, age or weight. Inappropriate use can also include use of a CRS not corresponding to ECE R44.
Attitudes towards the use of CRS

(%) Reasons for not using the CRS

The child does not stay seated: 25.5%
We have one but the child does not want to use it: 20.9%
Short journey: 18.2%
No es el vehículo que utiliza habitualmente: 11.9%
Expensive: 5.5%
A question of space / not much room: 4.5%
Go in a hurry: 1.8%
The child is very big: 0.9%
others: 5.5%

BASE: 110 children that do not use CRS
Place where the CRS was purchased and misuse (%)

- Supermarket
- Accessories for vehicles shop
- Children’s shop
- 2nd hand
- Present
- Other

% of system that were misused

Place of sale
Conclusions

The proportion of children well protected while travelling in cars appears to be extremely low.
As an average value, 73% of children of the surveys were not using their CRS correctly.
A large proportion of CRS shows several misuse at the same time.

- Review did not provide information on the effect of misuse on the performance of CRS,
  - An additional task was agreed partly through the CHILD project, involving non CHILD partners,
  - A comprehensive testing programme to evaluate the effects of misuse was set up.

A presentation will be made tomorrow:
“MISUSE : how can the experience gained in the ad-hoc group of misuse be useful for the comprehension of real life crash consequences”, Manuela Cataldi et al
WP2: Experimentation & Modelling

- Dummy and sensor development
- Virtual dummy and human modelling
- Experimental accident reconstructions
- Virtual Accident Reconstructions
TNO developed and validated a new born dummy, the Q0

FTSS improved and updated the whole Q-Dummy family
Future of Q0

• **Improved research tool**
  – Protection of babies in cars
  – Shaken baby syndrome (UvA)

• **Use in regulation**
  – EEVC WG12-18: proposal of new dummies for ECE-R44

• **Use in consumer programmes**
  – NPACS: Q-dummies for frontal & lateral
Q-dummies Update Program

- Update program started 2003
- Based on CREST experience
- Improve dummy durability, retain current biofidelity
- Frontal impact evaluations
- Updated dummies evaluated by EEVC WG12 and 18 (introduction in ECE-R44)
- Q1.5 added to cover ECE-R44 mass groups

Improvements made:
- New head and neck
- New durable rubber shoulder
- Infra-red measurement system in chest
- Modified hip cups and elbow joint.
- Q0 dummy developed
Q-family fully equipped ...

... to contribute to child safety
Sensors development

• “Children are not small adults”

• Additional measurements on the dummies necessary

• Although abdominal injuries still occur, currently no possibilities to assess the abdominal loads within the Q-child-dummy family exist
  – 2 different principles were investigated within CHILD
• Every sensor is assigned to a small area on the abdomen’s surface
• The prototype works well but further improvements are necessary
• The effective local force can be calculated by using the measured pressure and the area
Pressure sensor

- Abdominal block with two holes
- Two gel filled bladders replace the normal abdomen
- The pressure inside the abdomen is measured
Enhanced method & tools for child thoracic and abdominal compliance assessment by clinical treatment observations

INRETS & Université FOURIER - Grenoble
Displacement & force acquisition

Video camera 1

Video recording

Video camera 2

3D analysis of hand motion

Force recording

Force/deflection plotting

Tracking of hands displacement and 3D reconstruction

Force measuring device

Deflection (mm)

Force (daN)
Virtual dummy & human modelling

- Numerical simulation improves the development in child safety
- Real dummy measurements of crash/sled tests are used for the validation of virtual dummy models

Proposed approach within CHILD

- Development of a detailed child neck model
- Coupling of the detailed neck FE model to a multibody model
- Definition of neck loading under accidental conditions
- Extraction of best injury parameter candidate

A presentation will be made this afternoon:
« Child neck finite element model development and validation against experimental data », Remy Willinger et al..
Experimental accident reconstructions
Experimental accident reconstructions

- 37 reconstructions were stored, 29 frontal and 7 side crashes,
- 58 were already available at the end of CREST,
- In CHILD, 62 cars were prepared, crashed and measured,
- The new sensors and dummies were investigated in different reconstructions,
- Cameras from different positions filmed the scene,
- Up to 50 measurement channels for one dummy.

The different dummies were used 193 times:
- Q0 (7), Q1 (13), Q3 (48), Q6 (35)
- P3/4 (16), P1½ (17), P3 (11), P6 (27), P10 (14), other (5)

In CHILD, dummies have travelled about 60,000 km through Europe!
Virtual accident reconstruction

- A simplified numerical model of a group 0+ CRS was created to validate the Q0 model, by modelling a real CRS

- A series of frontal and lateral sled tests were performed to obtain more data for the validation of the LS-Dyna dummy model within a CRS environment

- Frontal and side impact configurations were finally used for the validation
Virtual accident reconstruction

- The use of PC Crash was useful to reconstruct the real world accident.
- As better the knowledge is about the accident, as better will be the reconstruction.
<table>
<thead>
<tr>
<th>ID</th>
<th>Model</th>
<th>Side</th>
<th>Dummy</th>
<th>50th percentile</th>
<th>10th percentile</th>
<th>Notes</th>
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<td>1176</td>
<td>IDADA ARTPO/E</td>
<td>left side</td>
<td>2</td>
<td>y11</td>
<td>0</td>
<td>no good dummy for that age</td>
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<tr>
<td>1177</td>
<td>IDADA R826/04R, ESPACE N</td>
<td>right side</td>
<td>5</td>
<td>y07</td>
<td>1</td>
<td>CONFIGURATION TOO DIFFICULT</td>
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<td>frontal</td>
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<td>y10</td>
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<td>y03</td>
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<td>booster</td>
</tr>
<tr>
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<td>LAB15260</td>
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<td>y09</td>
<td>2</td>
<td>no good dummy for that age</td>
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<td>LAB15260</td>
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<td>y01</td>
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<td>no good dummy for that age</td>
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<tr>
<td>1185</td>
<td>LAB15260</td>
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<td>3</td>
<td>y09</td>
<td>4</td>
<td>PNC FC G1</td>
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<tr>
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<td>LAB15260</td>
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<td>4</td>
<td>y11</td>
<td>3</td>
<td>no good dummy for that age</td>
</tr>
<tr>
<td>1187</td>
<td>LAB15260</td>
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<td>5</td>
<td>y05</td>
<td>3</td>
<td>PNC FC G1</td>
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<td>LAB15260</td>
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<td>y05</td>
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<td>opposite vehicle is truck - difficult to reproduce</td>
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<td>y05</td>
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<td>5</td>
<td>y05</td>
<td>0</td>
<td>opposite vehicle is truck - difficult to reproduce</td>
</tr>
<tr>
<td>1194</td>
<td>LAB15260</td>
<td>right side</td>
<td>5</td>
<td>y05</td>
<td>0</td>
<td>opposite vehicle is truck - difficult to reproduce</td>
</tr>
</tbody>
</table>

WP 3: validation & procedures
Example of accident case in db
Example of reconstruction in db

- Reconstruction database contains all information
- Connection to the accident database possible
Based on reconstruction experience,
It is difficult to assess the quality of a reconstruction, when compared with accident. Comparison of pictures is not sufficient to guarantee that the test severity was correct. Comparison of static deformations of cars from accident and reconstructions is necessary.

Static measurement
Deceleration curve
Score and its reliability
Shape for sled testing
Adjustment of pulse
Validation of crash data

Test is performed with given configuration.

The validation of crash data is based on:
- static deformations measurements,
- pictures of vehicles,
- deceleration curves,
- pictures of child dummies,
- curves,
- films, on board camera views
Injury criteria
Injury criteria

- **Objectives:** to propose test procedures using instrumented child dummies and to recommend limits for the injury criteria values

- **Difficulty:** no child biomechanical injury data available in literature, directly usable for Q-dummies

  **Need:** determine child injury limits

**Objectives:**

- To identify the physical parameters associated with various child injury mechanisms

- To determine the injury risk curves for the Q-family dummies:
  - In frontal and side impact,
  - For head, neck, thorax and abdomen
Methodology

The reconstructions from CHILD & CREST are validated by the group

Injuries paired with dummy measurements

Data scaled to a given age

Injury risk curves
Injury risk curves

Three methods used to construct the injury risk curves:

- Certainty method
- CTE (Consistant Threshold Estimate)
- Logistic regression
Frontal impact: head injury risk curves

AIS2+ Risk Curves - Head Resultant (a3ms) - Q dummies

AIS3+ Risk Curves - Head Resultant (a3ms) - Q dummies
Frontal impact: head injury risk curves
# Frontal impact: head injury risk thresholds

## ACCELERATION

<table>
<thead>
<tr>
<th>Injury risk</th>
<th>20%</th>
<th>50%</th>
</tr>
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<tbody>
<tr>
<td>AIS 2+</td>
<td>81g</td>
<td>90g</td>
</tr>
<tr>
<td>AIS 3+</td>
<td>88g</td>
<td>97g</td>
</tr>
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</table>

## HIC 36ms

<table>
<thead>
<tr>
<th>Injury risk</th>
<th>20%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS 2+</td>
<td>1050</td>
<td>1290</td>
</tr>
<tr>
<td>AIS 3+</td>
<td>1150</td>
<td>1460</td>
</tr>
</tbody>
</table>
For the side impact the sample size is not large enough to construct injury risk curves.

Acceleration threshold observed between INJURED & NON INJURED:

<table>
<thead>
<tr>
<th>Acc 3ms</th>
<th>0 – 50g</th>
<th>50 – 89g</th>
<th>≥99g</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS</td>
<td>0</td>
<td>1 - 5</td>
<td>≥5</td>
</tr>
</tbody>
</table>
Conclusions - head

• Relatively large sample size in frontal impact for AIS2+ and AIS3+ but not enough AIS4+ data sample for comparison with US legislation (5% of AIS 4+)

• Sample size in side impact small, nevertheless observation of an acceleration threshold between INJURED & NON INJURED is encouraging the continuation of side impact reconstructions

• Both in frontal and side reconstructions, head impact is the most frequent injury mechanism: to be considered to use the given criteria
Data analysis: neck shearing force Fx

Distribution by dummy age

<table>
<thead>
<tr>
<th>AIS</th>
<th>Fx</th>
</tr>
</thead>
<tbody>
<tr>
<td>No neck injury</td>
<td>&lt; 730N</td>
</tr>
<tr>
<td>AIS 5+</td>
<td>&gt; 1000N</td>
</tr>
</tbody>
</table>
Neck flexion moment My

Distribution by dummy age

<table>
<thead>
<tr>
<th>AIS</th>
<th>My</th>
</tr>
</thead>
<tbody>
<tr>
<td>No neck injury</td>
<td>&lt;13Nm</td>
</tr>
<tr>
<td>AIS 5+</td>
<td>/</td>
</tr>
</tbody>
</table>
Injury risk curve - chest

AIS 3+ Injury risk curve for the chest; chest deflection considered for Q6

- Sample should be improved in terms of number of values
- Specific response of the Q dummies to thoracic strap solicitations have to be thoroughly analyzed and improved using biomechanical data (geometry and stiffness)
- Afterwards V*C should be considered as a more pertinent criterion
Abdominal injury criteria

Injury risk curves were determined, based on:

- APTS data,
- MFS data

- Number of analyzed cases low to allow significant injury risk curves
- First step to assess abdominal criterion
- Specific response of the Q dummies to thoracic strap solicitations have to be improved using biomechanical data (geometry and stiffness)
- Both sensor systems show considerable potential for the prediction of the abdominal injury risk
Frontal Impact Test Procedure

- Representative of accidents in the CHILD database, which tends to be severe
- Representative of modern cars

Needs for further investigations:
• Interaction between children and advanced restraints in the rear
• Monitor average space allowed for head excursion
• Seat back strength in vehicles with seat belts integrated into seat back
Selected Side Test Procedure

With respect to harmonisation it is reasonable to propose a side impact test procedure, which is already in use (Harmonization if possible with ISO and NPACS).

As the CHILD proposal is meant to form as base for legislation and NPACS is a consumer test, there are good reasons to reduce the severity level, compared to NPACS.

Modified NPACS procedure:
- Intrusion velocity reduced by 20 %
  (corresponding to approx. 8 m/s)
- Worst-case conditions : Maximum intrusion close to dummy’s head

A presentation will be made tomorrow :
"Latest developments in side impact testing for CRS", Heiko Johannsen et al..
Website & Workshop

www.childincarsafety.com

30 & 31 May 2006, Berlin, Germany
The CHILD project had many objectives, all of which were met. However, for some of the objectives new information would enable them to be further validated.

The CHILD project brings together the expertise and technologies from the field of occupant safety with the focus on children. This work has involved a combination of traditional research methods together with the development of new expertise in areas such as the virtual environment.

For the further improvement of child occupant safety it remains necessary to extend this fundamental research activity. However, new, complimentary and specialised activities are also necessary. As a consequence, whilst the outcomes of CHILD are directly ready for use, there is a need for future research activities which focus on children, taking the outputs of the CHILD research project as the basis.
THANK YOU FOR ATTENTION!

Thanks to take care of us!!