

# **Safety and Comfort** Aspects of Personnel Transport Vehicles (PTV) used in Underground Coal Mining

**Maintenance Technology Institute (MTI)  
Monash University**

## **Presentation Outline**

- **Safety and comfort in current vehicles**
- **ACARP Project C14037**
- **Kestrel retrofit project**
- **New concept vehicles**
- **Conclusions**

## Safety and Comfort in Current Generation of PTV's



- **The personal injuries related to personnel carriers in the Australian underground mining industry are considered to be unacceptably high.**
  - Back injuries
  - Neck injuries
  - Ankle injuries
- **The level of safety provided is also not considered adequate**
  - Predominantly side facing seating
  - No or poor restraint against sudden deceleration
  - Rigid and heavy vehicle structures
- **The level of comfort provided is poor**
  - Poor cabin ergonomics – layouts, seats
  - Seats with no suspension
  - Very rigid vehicle suspension
  - Open cabin – no AC, coal dust

## MTI Involvement



- **Industry group consisting of four underground coal mines approached MTI to review the current situation and develop a proposal for improvements**
- **MTI, Monash University Accident Research Centre and Monash University Art and Design developed a proposal for ACARP funding**
- **Kestrel Mine Management took immediate action and proposed a fast-track program to retrofit their fleet of nine Driftrunners**
- **ACARP project C14037 has been completed**
  - Specifications
  - New concept designs
- **A new ACARP proposal has been submitted to complete the engineering design of a new concept design**

# ACARP Project C14037



## The roll of project C14037 was:

- a) To deliver a formal set of vehicle specifications that would lead to:
  - A decrease in the incidence rate and severity of loss time injuries (LTI's) as well as restricted work injuries (RWI's)
  - Positive changes to the safety culture of personnel
  - Industry-wide standardisation of personnel carriers in underground mines
- b) To create the basis for a new concept underground mining personnel carrier.

# Redesign Guidelines and Specifications



## The key features responsible for vehicle related injuries include:

- Poor ergonomic consideration to layout and seating
- Too stiff vehicle and seating suspension
- Lack of personal restraint in the event of a vehicle impact or rapid deceleration

## The specifications developed address many current short-comings in terms of safety and comfort, with particular emphasis on:

- Cabin layout
- Seating
- Effective Personnel Restraint
- Suspension Characteristics
- Multi-functionality

# Kestrel Coal Retrofit Project



- Kestrel wanted a fast-track program to retrofit their Driftrunner fleet
- Project started in Nov 2004 and first vehicle completed in March 2005
- The objectives were to improve **Safety** and **Comfort**
- The work comprised:
  - Layout design – 11 personnel foreword/rear facing seats
  - Suspension seats
  - Restraint system
    - lap/sash with a 4N retractor
    - stainless steel aircraft buckle
    - Enlarged tongue
  - Chassis modifications and testing
    - lowered chassis rails
    - Improved rear axle location with trailing links
    - Fitted progressive rate suspension springs



# Kestrel Coal Driftrunner Retrofit Project (Cont.)



## Before Retrofit



# Kestrel Coal Driftrunner Retrofit Project (Cont.)

## After Retrofit



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# Redesign Guidelines and Specifications

## Rear Cabin Layout

The main function of the mine car seat is to provide stable body support in a posture that is:

- Comfortable over the duration of the journey
- Appropriate for the transportation of fully kitted mine personnel

Typical characteristics of rear cabin seating of current PTV are:

- Troop carrier type layout
- Poor posture
- Lack of personnel restraint system
- Insufficient headroom



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- Poor comfort
  - Inadequate of safety

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## Redesign Guidelines and Specifications (Cont)



### Critical requirements for PTV:

- Flexibility
- Personnel carrying capacity – 10 acceptable 12 preferred
- Seating orientation – forward/rear facing
- Appropriate level of safety and comfort
- User-friendly restraint system
- Reduction in transmitted road vibration
- Strength and protection requirements

### Dimensional Constraints:

- Total vehicle height: 1800-2000 mm
- Vehicle width: 2000-2150 mm
- Rear cabin length: 3200 mm (max)
- Ground clearance: 300-400 mm
- Exit step: 300 mm (max)

## Redesign Guidelines and Specifications (Cont)



**In view of the dimensional constraints, particularly the vehicle height, it was not possible to implement a complete ergonomic design.**

**Certain compromises had to be made keeping in mind sound ergonomic principles.**

**The approach in obtaining an acceptable solution was as follows:**

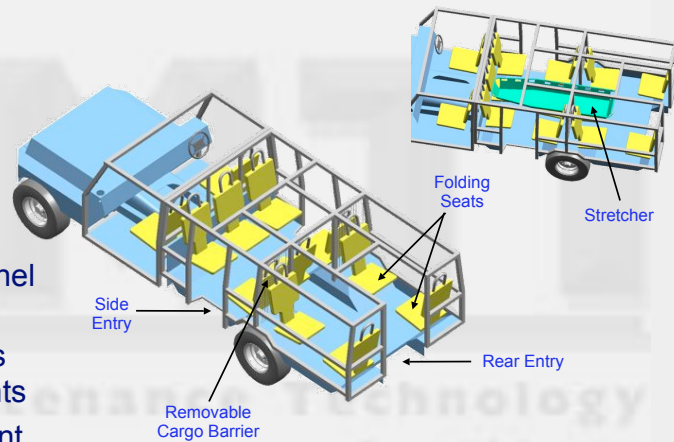
- Select/design a chassis that provided the greatest floor-to-roof height
- Design seating layout to maximise the use of available space
- Introduce forward/rear facing seats
- Install an effective restraint system
- Modify existing suspension to reduce whole body vibrations

## Redesign Guidelines and Specifications (Cont)



### 12 personnel capacity vehicle:

- Monocoque chassis
- Vehicle height: 2000 mm
- Seat-to-canopy height: 1060 mm
- Folding seats to maximise equipment carrying facilities
- Removable cargo barrier to enable simultaneous transportation of personnel and equipment
- Compliance with MDG No:1 guidelines for strength and protection requirements
- Provision for carrying a stretcher patient by folding centre seat
- Rear and side access to rear cabin



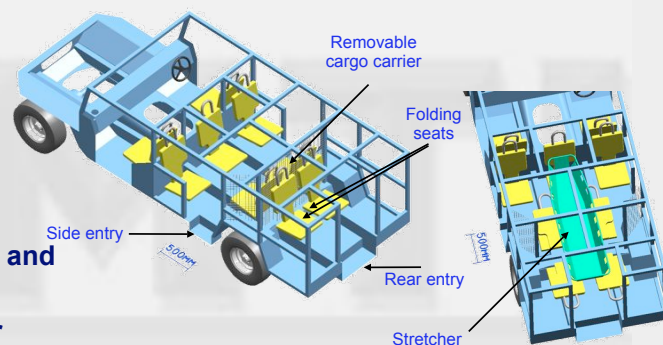
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## Redesign Guidelines and Specifications (Cont)



For access to mine areas with restricted height, a vehicle was designed with an overall height of 1800 mm featuring:

- 9 personnel carrying capacity
- Seat-to-canopy height 1005 mm
- Folding seats to maximise equipment carrying facilities
- Removable cargo barrier to enable simultaneous transportation of personnel and equipment
- Compliance with MDG No:1 guidelines for strength and protection requirements
- Provision for carrying a stretcher patient by folding centre seats
- Rear and side access to rear cabin
- Estimated ~2 tonne weight reduction of conventional rail chassis vehicle



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# New Concept Vehicles



- Several new concept vehicle designs were produced
- MTI in collaboration with:
  - Monash University Faculty of Art and Design
  - Accident Research Centre
  - PJB (OEM)
  - KADE Development (Maintenance)
- Methodology:
  - Used the “Redesign Guidelines and Specifications” previously developed
  - Allowed for: Safety, Comfort, Transport of auxiliary equipment,
  - Use as a work platform
  - Review by Industry Group including ACARP monitors
- Two final concepts have been proposed for further consideration

# Concept Vehicle Models



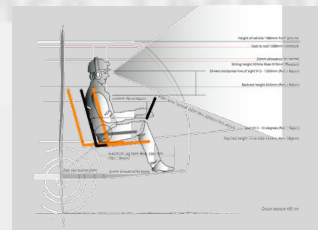
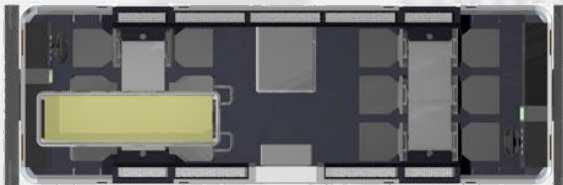
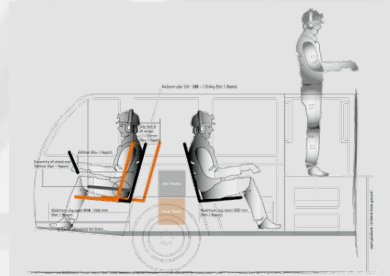


# Concept Vehicle: Final Model 1



## Bi-directional Vehicle

A purpose built vehicle to carry twelve mining personnel (including driver), accommodate a stretcher and a diverse amount of tools and ancillary equipment.



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# Concept Vehicle: Final Model 1 (Cont)



## Bi-directional Vehicle

### Main Features:

- Vehicle height: 1980 mm
- Excellent visibility and manoeuvrability
- Elevated safe raised central work platform and limited storage of equipment
- Modularity of design
- Ergonomic design providing a high level of passenger and driver comfort
- Effective restraint system
- Option of a sealed air conditioned cabin
- All wheel drive utilising hydraulic motors
- Reduced emission levels (DPM)

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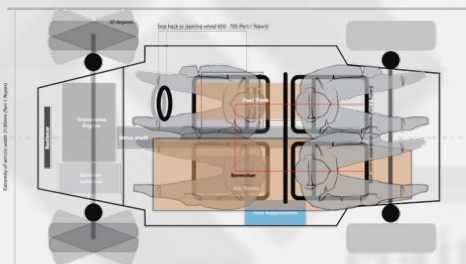


# Concept Vehicle: Final Model 2

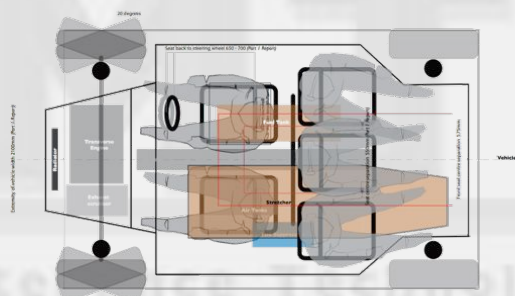


## Short-Wheel Base Personnel Carrier

The objective of this design is to create a conceptual package for a purpose built vehicle capable of carrying 4-5 mining personnel (including driver), accommodate a stretcher and ancillary equipment.



**Four man Version**



**Five man Version**

The principle repercussions of making the four-man vehicle into a five man capacity is an increase in overall length (including wheelbase) and the width of the vehicle will grow to the maximum permissible dimension (i.e. 2100mm).



# Concept Vehicle: Final Model 2 (Cont)



## Short-Wheel Base Personnel Carrier



**Moulded Side and rear Doors**



**Bumpers**



## Concept Vehicle: Final Model 2 (Cont)



### Short-Wheel Base Personnel Carrier

#### Features:

- Vehicle height: 1800 mm
- Ergonomic design
- Side and rear access
- Common components – bumpers, wheel arch panels, front and rear doors
- Forward curving bonnet for safe front sightlines
- Monocoque construction
- Use of moulded components to reduce vehicle weight

## Summary and Conclusions



- The current situation of PTV safety and comfort aspects were discussed
- Poor ergonomics in cabin layouts and seating is a major aspect that need to be improved to provide adequate safety and comfort for the users.
- In addition, there is potential to improve the engineering in relation to: weight, power, emission, etc.
- The Kestrel project has very successfully retrofitted a current vehicle model to improve ergonomics, safety and comfort
- In the current environment the industry deserves a new generation of vehicles that provide higher levels **Safety** and **Comfort** with improved engineering
- The proposed Concept vehicles demonstrates the potential to achieve these objective.