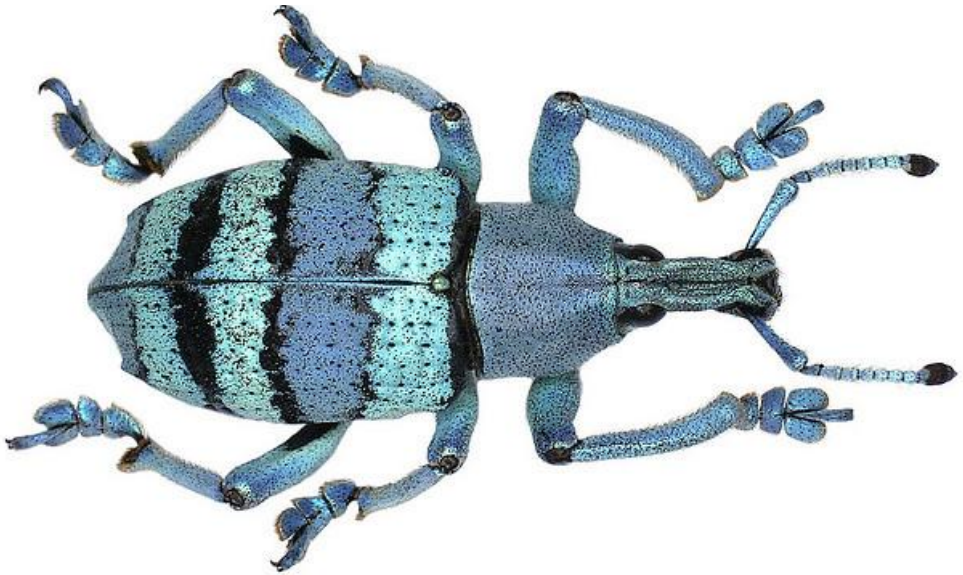
ULTRALIGHT AND ULTRASAFE EFFICIENT ELECTRIC VEHICLE



Eupholus amalulu Porion (Papua New Guinea; photo by Udo Schmidt)
Source: www.flickr.com/photos/coleoptera-us/2961189865/in/gallery-66925960@N08-72157627831065844/

Collaborative Project

Call Identifier: H2020-GV-2014

Topic: GV-5-2014 (RIA). Electric Two-Wheelers and New Ultra-Light Vehicle Concepts

Grant agreement no.: 653926

Start date (official): 1st June 2015

Duration: 4 years

WEEVIL: type of **beetle** from the Curculionoidea superfamily. Recognized by their distinctive long snout and geniculate antennae on the sides

Main goal

Development of a new L category 3-wheeler that is safe, quiet, clean and energy efficient, as well as attractive to the public

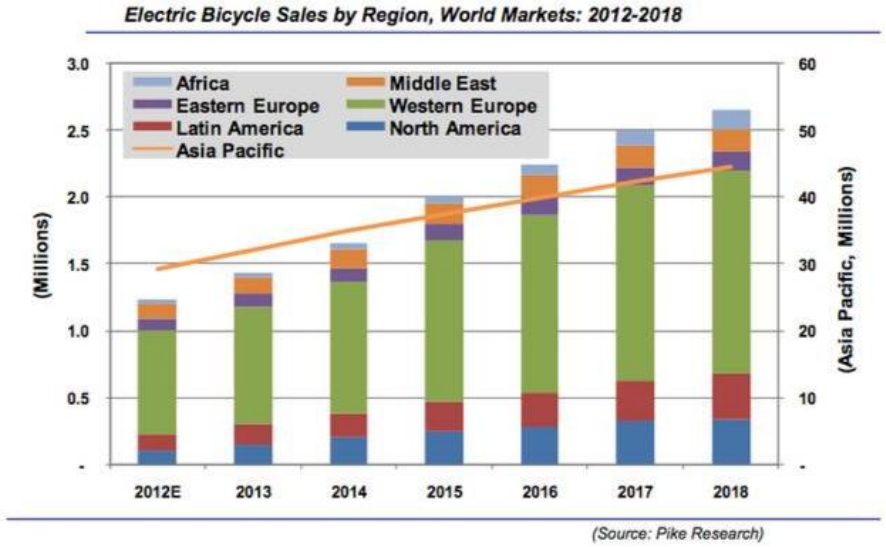
Three important innovative attributes

1. **Radical increase of safety** by incorporating a **composite structure** that can absorb three times more energy than typical metallic crash structures.
   - The composite structure will be manufactured with a **new process** for an affordable introduction of these materials into L-vehicles
2. **Wheel width varying mechanism** in order to allow adaptation to different speeds: **wider at high speeds** for stability, **narrower at low speeds for space optimization and parking**. The vehicle needs less than one third of the space required for a conventional car to be parked.
3. **New integrated drive-train**, as well as new solutions on system integration such as **modular/interchangeable battery packs**.

L-category 3-wheelers and quadricycles

- Some advantages of the concept:
  - ✓ Compared to motorcycles: safety, comfort (the cabin is closed)
  - ✓ Compared to automobiles: easy to park, agility in narrow roads, total costs

- Increase of demand expected for next years (e.g. evolution of electric bikes in the past)

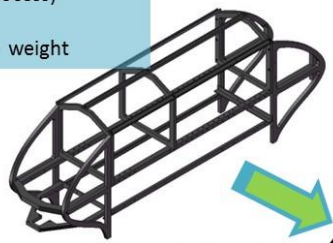


Concept

Safety:
- Composite-made structure with high SEA

Affordability:
- Low-cost composite structure (radically new high productivity manufacturing process)

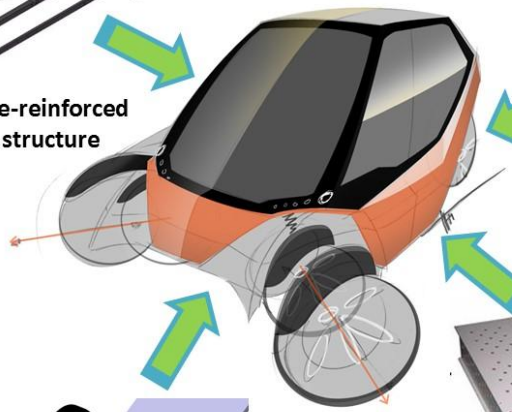
Efficiency:
- Reduced vehicle weight



Low-cost fibre-reinforced composite structure

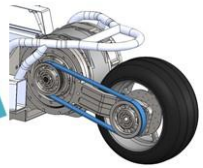
Comfort:
- Full encapsulation for environmental protection
- Comfortable seating space
- No tilting/balancing

Encapsulated 3-wheeler in tadpole configuration



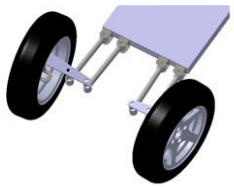
Efficiency:
- New drive train with improved efficiency over the whole operating range

Affordability:
- Magnet-free motor (no PM associated cost)



Efficient integrated drive-train

WEEVIL Goals:
- Urban vehicle
- Efficiency
- Safety
- Comfort
- Affordability



PINCER, Parking Cross-distance Adapter

Urban vehicle:
- Reduced footprint for tight roads/parking

Interchangeable battery pack

Efficiency:
- New battery management preventing degradation

Affordability:
- Battery pack interchangeability: batteries from range/manufacturer best fitting user needs/budget

Focus Groups

Locations: Milan, Rome and Frankfurt (cities with heavy daily commute)
Interviewed panel: men and women, aged 20 – 55, affluent, living in city suburbs and daily commuting

Commute and urban mobility in general are seen as a great source of daily stress. Germans prefer to avoid it by using efficient public transports. In Italy, where public transport is less efficient, people prefer to use private cars (Milan) or scooters (Rome)

Most appreciated features: parking capability in tight spaces and enhanced safety

Negative points: passenger tandem position was not seen as so comfortable (vehicle is anyhow seen for strict personal use)

Other: functionality versus sophisticated/unnecessary top equipment which might impact on price and battery life.

Other: range of interest, price point, reaction to draft designs

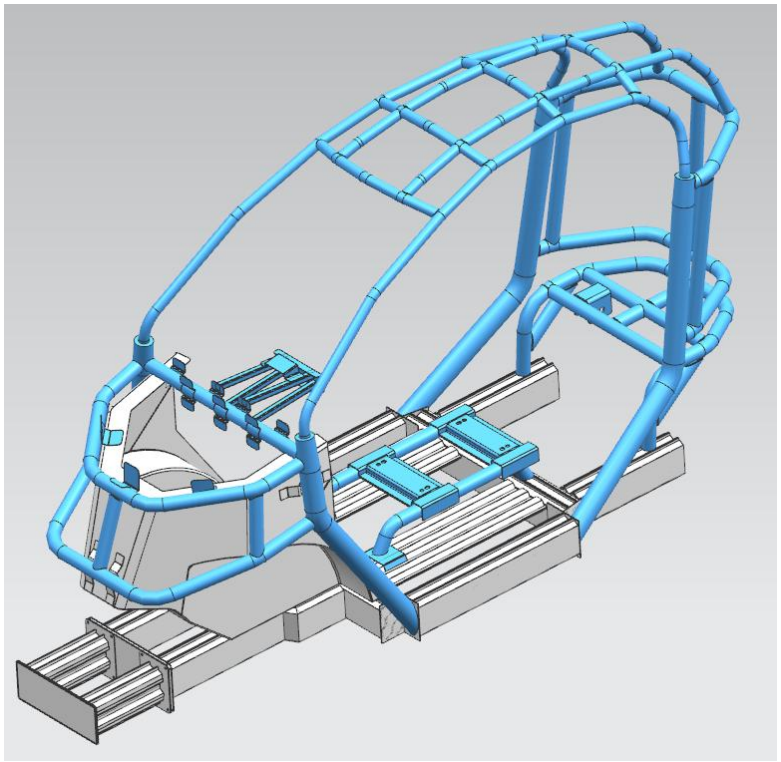
Design

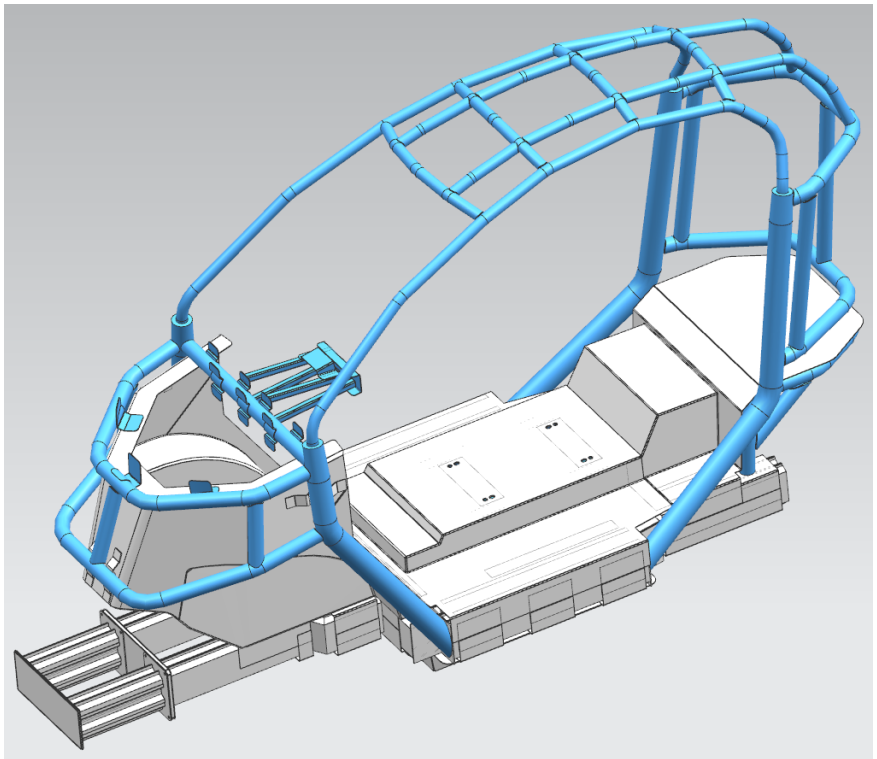
Design

Composite structure for safety

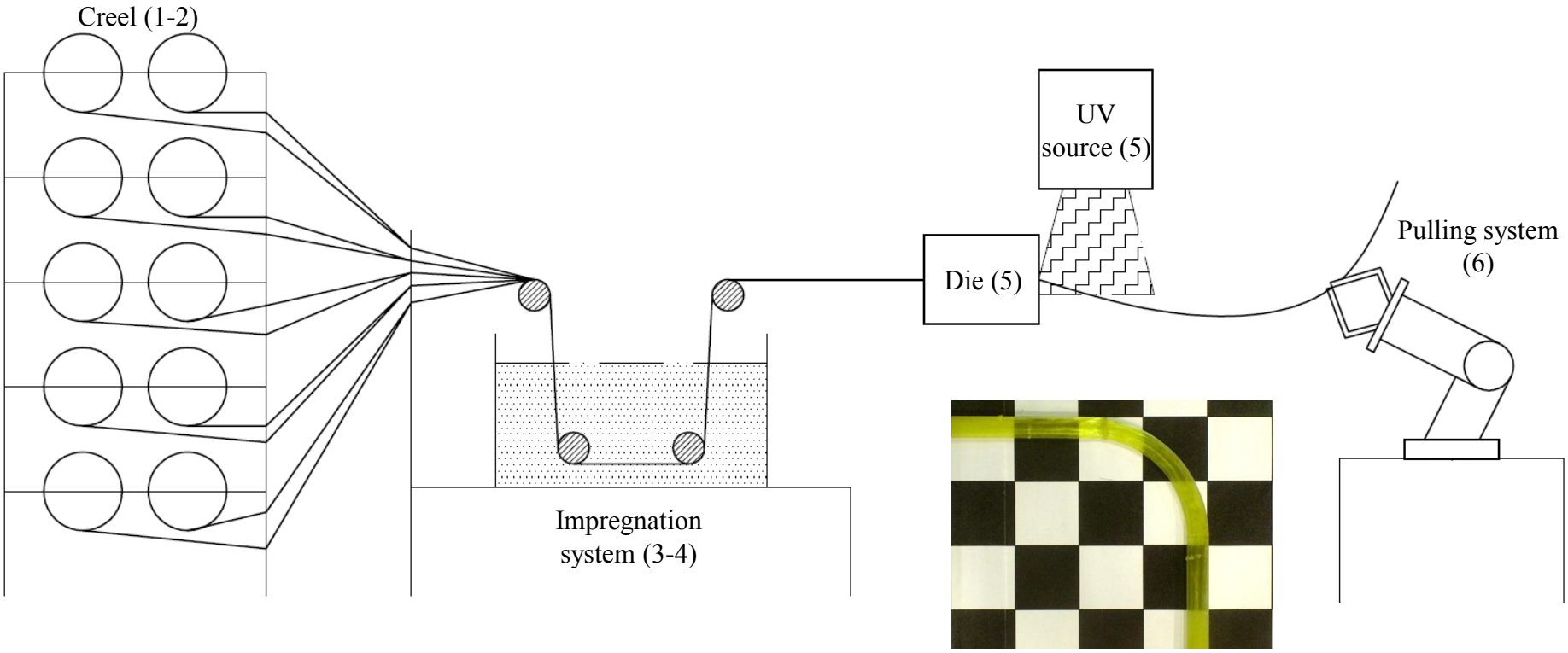
Main structure, underbody: composite-made via 3D out of die UV-cured pultrusion

Upperbody: aluminum





Out of die UV-cured pultrusion



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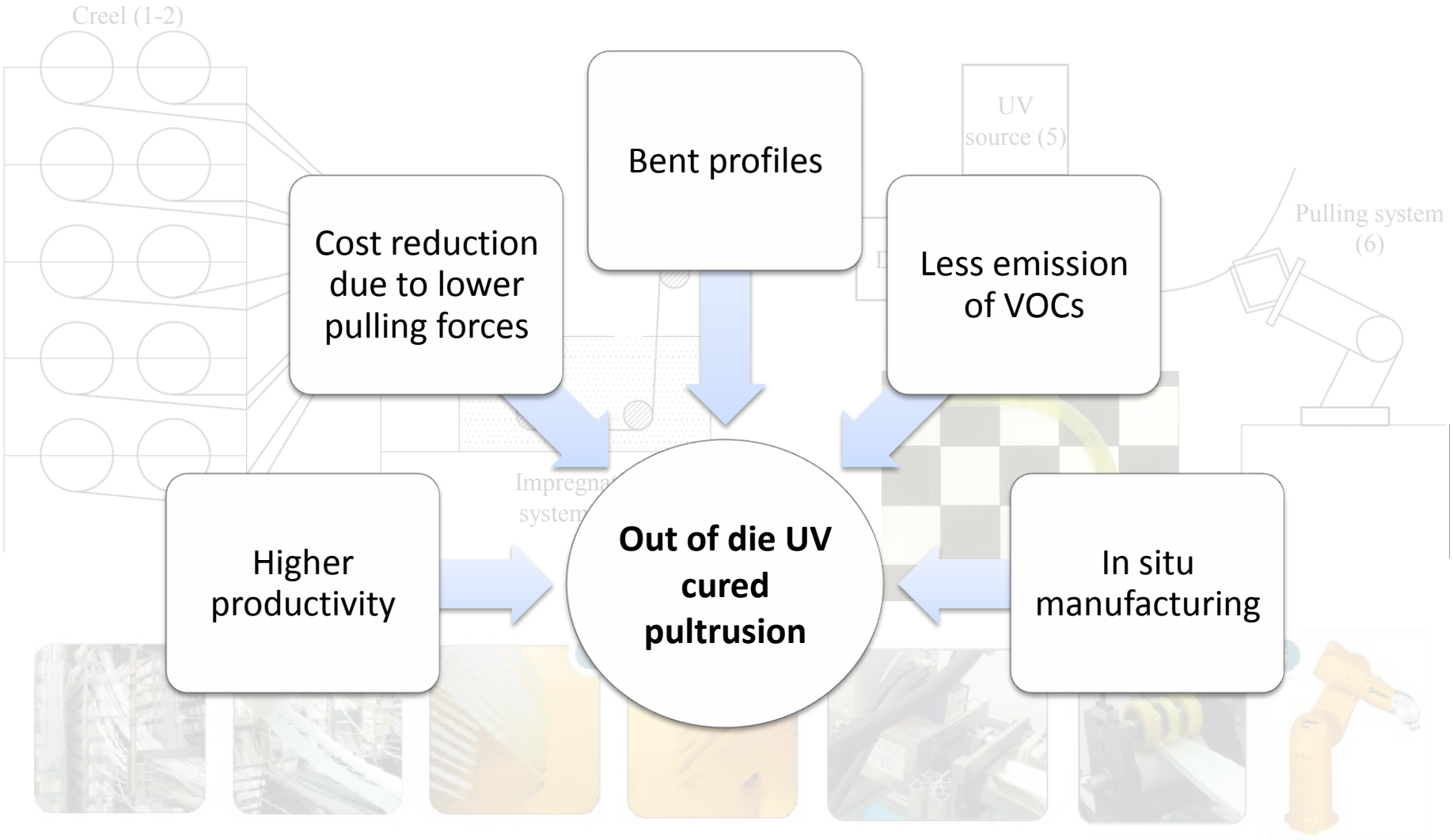
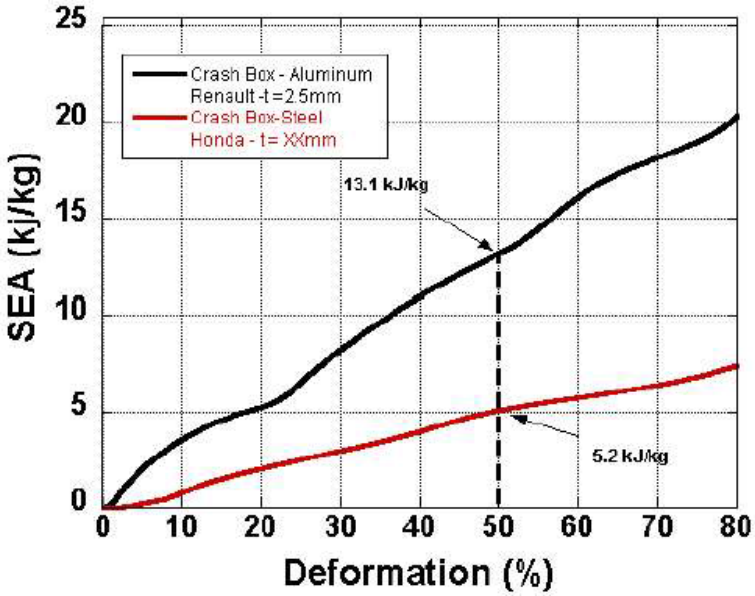


Energy absorbing capability

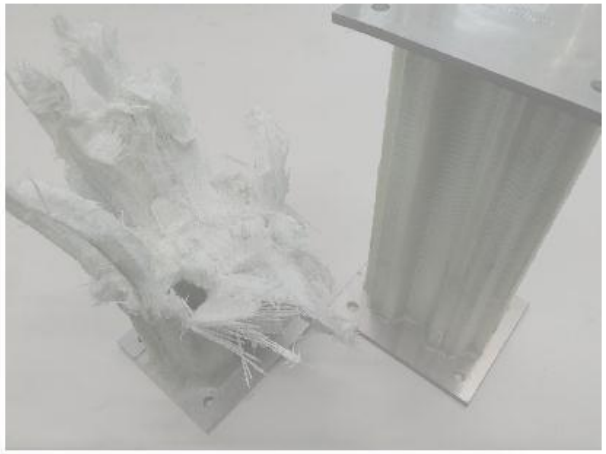
Steel crash-box:

Aluminum crash-box:



A. K. Toksoy, "Optimization of the axial crushing behavior of closed-cell aluminum foam filled welded 1050 al squarecross section crash boxes", PhD. Thesis, İzmir Institute of Technology, 2009

Pultruded composite crash-box:



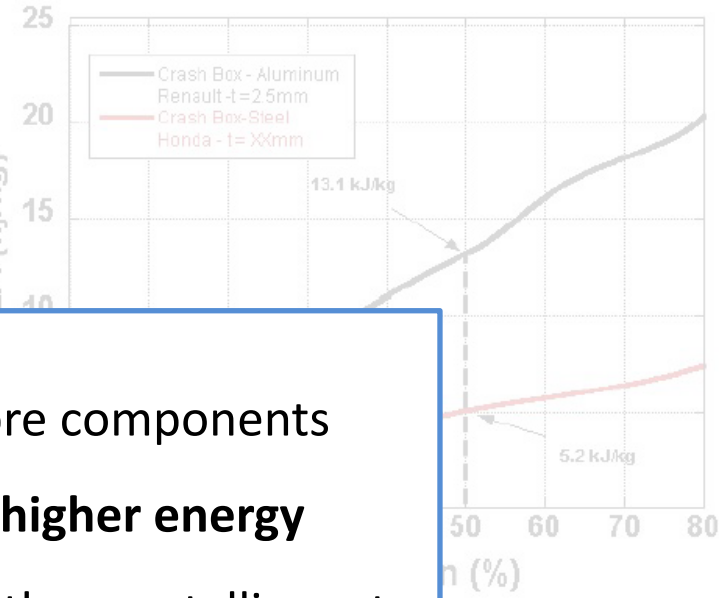
Specimen	Compression tests
	SEA (kJ/kg)
UV arc lamp	44.56 ± 1.92
UV LED	48.65 ± 1.32

Energy absorbing capability

Steel crash-box:

Aluminum crash

Pultruded comp



hing behavior of closed-cell
ecross section crash boxes",
chnology, 2009

Pultruded glass fibre components presents **3 times higher energy absorption capability** than metallic parts

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PINCER system

Wheel width varying mechanism:

- Wider at high speeds for stability
- Narrower at low speeds for space optimization and parking

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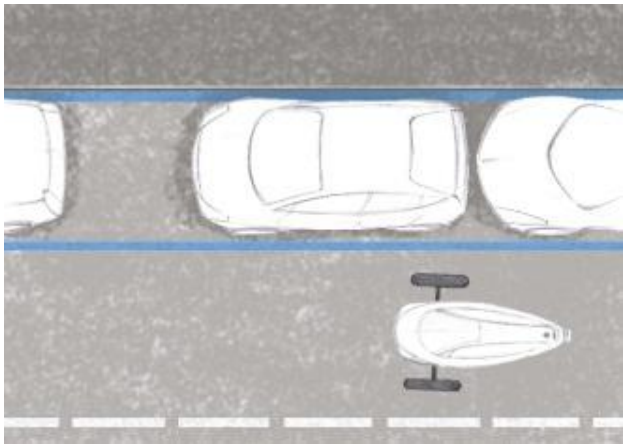
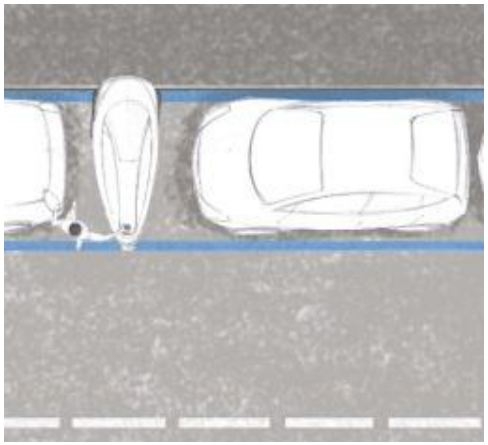
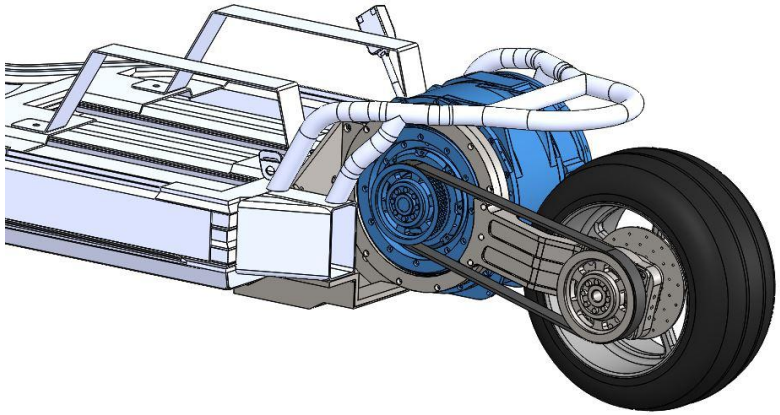
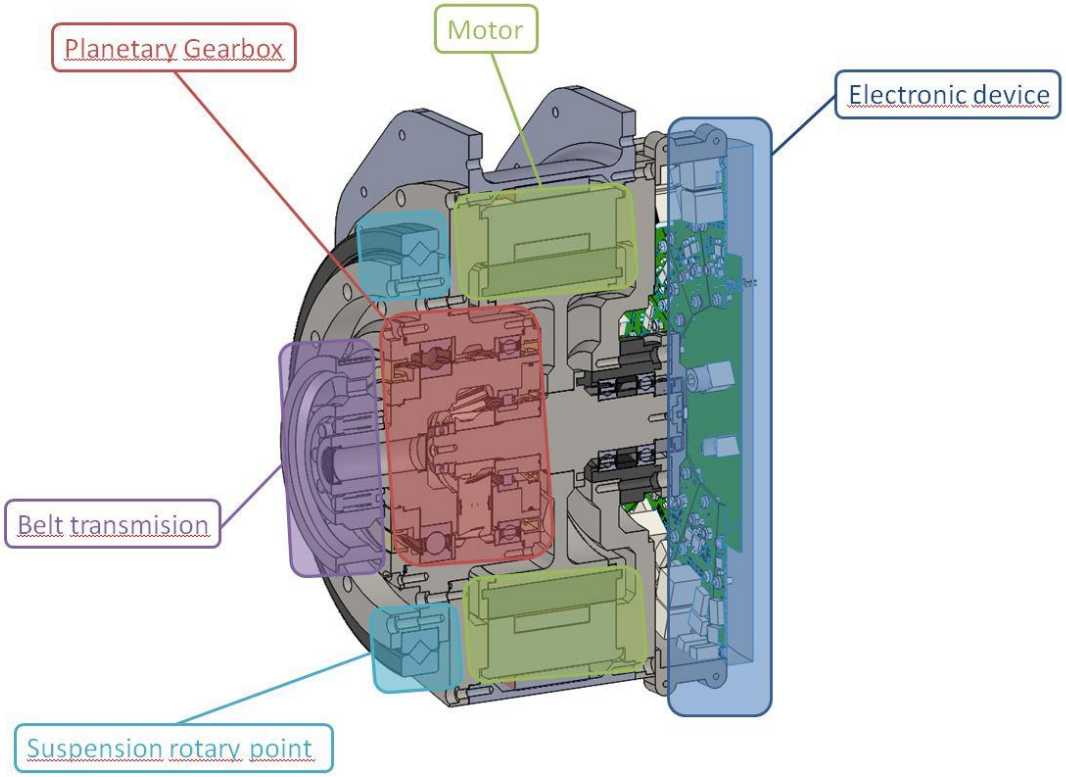




Integrated drive-train

- Motor
- Power electronics
- Planetary gearbox
- Belt transmission
- Suspension





Interchangeable battery system

Allow to equip the vehicle with any kind of batteries: technology, performance, producers and costs.

- Standard communication protocol
- Different chemistries compatibility
- Competitive market price
- Fast charging compatibility (AC Type 2)
- Energy power block all in one
- Easy to remove
- For OEM, Aftermarket, Industries and Services

Boston Power Swing 5300 (cilindrical): 9759 Wh

Sinopoly 66 Ah (prismatic): 5069 Wh

Consortium

IK4 TEKNIKER Research Alliance	Project coordinator
FAGOR FAGOR AUTOMATION	Electric motor
IAAD.	Vehicle Design
kaitek power solutions	Battery system
HEXAGON studio	Vehicle Chassis
iki COATINGS IRURENAGROUP	Composite structures
MONDRAGON HUMANITY AT WORK Finance Industry Retail Knowledge	Pincer system
COMARTH	EV Manufacturer
PIMOT	Test & Homologation