

INAIL

ISTITUTO NAZIONALE PER L'ASSICURAZIONE
CONTRO GLI INFORTUNI SUL LAVORO

Safety improvements of agricultural machinery through mechanical and digital innovations

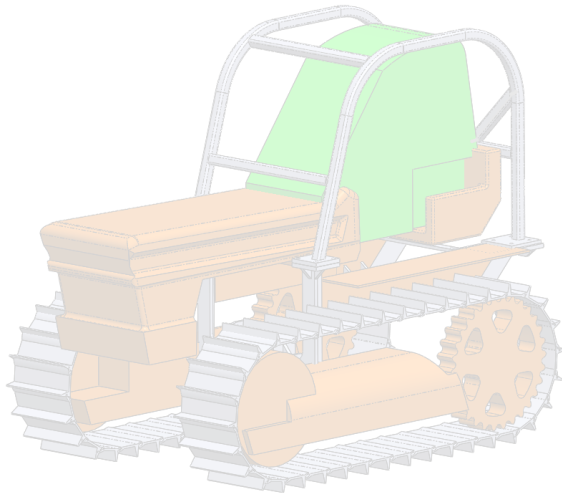
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Rome, July 7th 2023

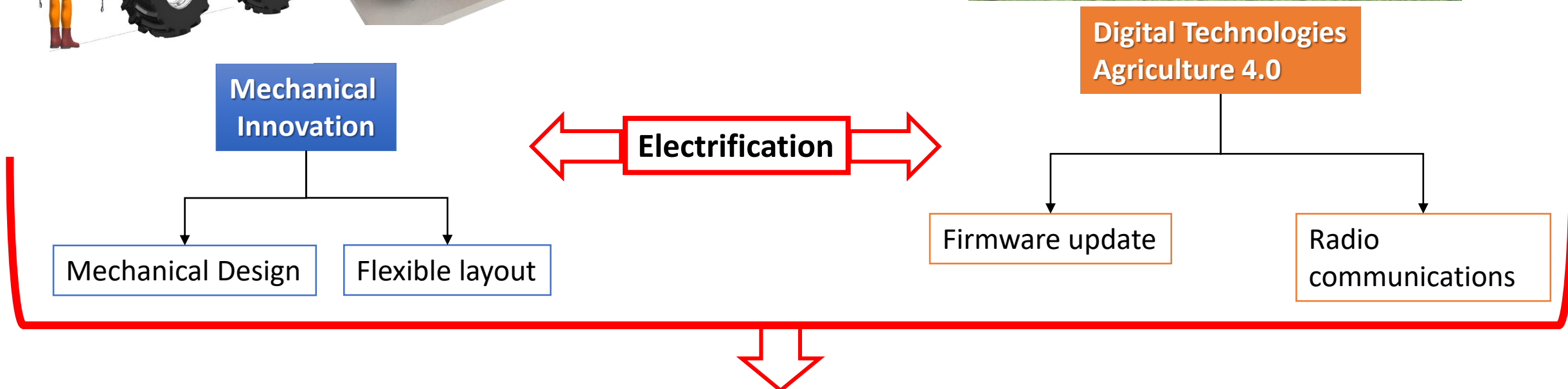
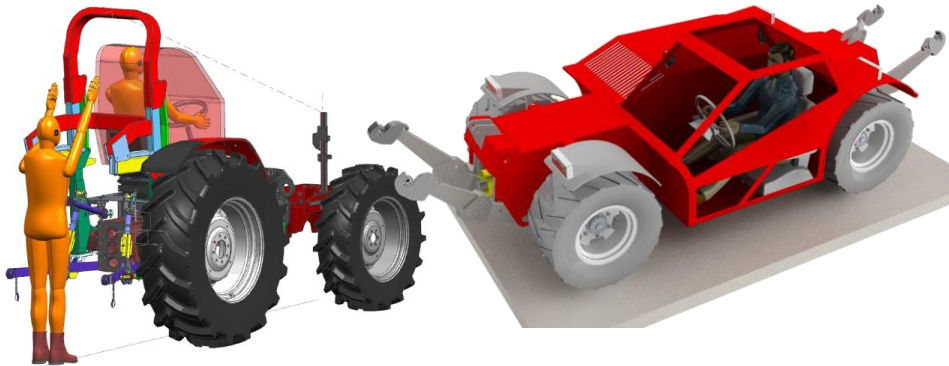
Summary

- Research activities
- Technological Innovations
 - Roll Over risk
 - Inclusion of disabled workers



Background

Nowaday safety improvements of agricultural machinery is matter of two aspects



SAFETY IMPROVEMENT IN AGRICULTURE

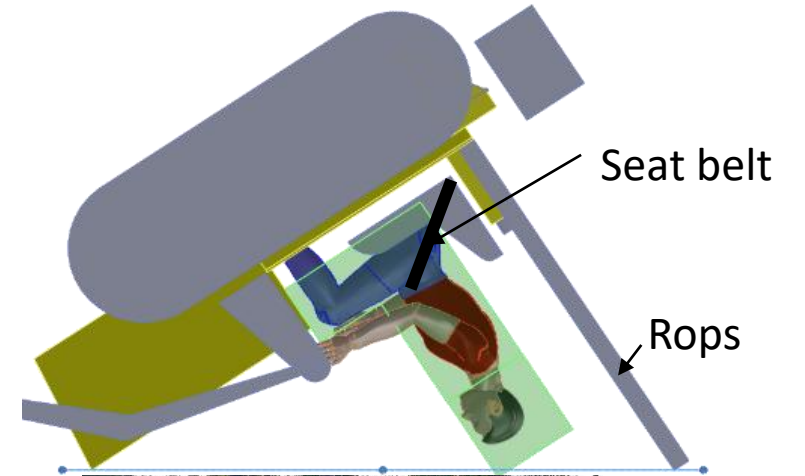
Roll Over Risk


Injuries data: half of the fatal accidents in agriculture are caused by overturning

Tractor without ROPS



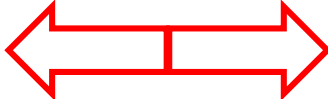
Tractor with ROPS



Unsafe  Safe

Foldable ROPS



Unsafe  Safe

Examples of ROPS and retrofit ROPS

Until the end of 90s tractors were placed on the market without ROPS



Standard tractors
1974



Orchard tractors
At the end of the 90s



Crawler Tractors
90s

INSTITUTIONAL INTERVENTION

National Guidelines

1974

1999


2006



X00.000
Tractors not
equipped
with ROPS

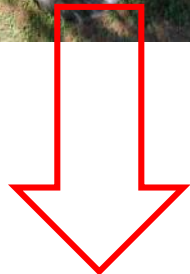


 **Ministero dell'agricoltura,
della sovranità alimentare e delle foreste**

 **Ministero delle Imprese
e del Made in Italy**

 **Ministero del Lavoro
e delle Politiche Sociali**

 **Ministero delle infrastrutture e
dei trasporti**



Fatal accidents



LINEA GUIDA

L'installazione dei sistemi di ritenzione del conducente nei trattori agricoli o forestali

Adeguamento dei trattori agricoli o forestali ai requisiti minimi di sicurezza per l'uso delle attrezzature di lavoro previsti al punto 2.4 della parte II dell'allegato V al D.Lgs. 81/08



Protection



AGRICOLTORI ITALIANI



Retrofitting process Results

“ There is real **progress only when the benefits of a new technology become for everyone**” Henry Ford



THE IMPACT OF THE GUIDELINE

The French Ministry of Agriculture



MINISTÈRE DE L'AGRICULTURE ET DE LA SOUVERAINETÉ ALIMENTAIRE

Ministre Espace presse Mes démarches

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Production et filières Alimentation Enseignement et recherche Ministère

Accueil Production & filières Agricultrices et agriculteurs Renversement des tracteurs et protection contre les chutes d'objets

18 octobre 2022 Info +

Renversement des tracteurs et protection contre les chutes d'objets

sécurité au travail machinisme agricole

Cheick Saidou / agriculture.gouv.fr Partager la page

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L'Italie propose des fiches pour différents types de tracteurs, certaines ont été validées et traduites :

Fiches italiennes traduites

Notice d'utilisation des fiches issues du guide italien développé par ISPESL-INAIL

pdf - 865.5 Ko

Liste des fiches italiennes ISPESL-INAIL traduites

xlsx - 13 Ko

Tracteurs :

Fiat

• 120C et similaire (60C, 70C, 80C, etc.) –

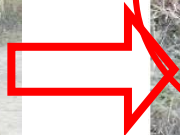
fiche 2a

Roll over risk considering foldable ROPS Structures

Foldable structures can be misused



ROPS folded down

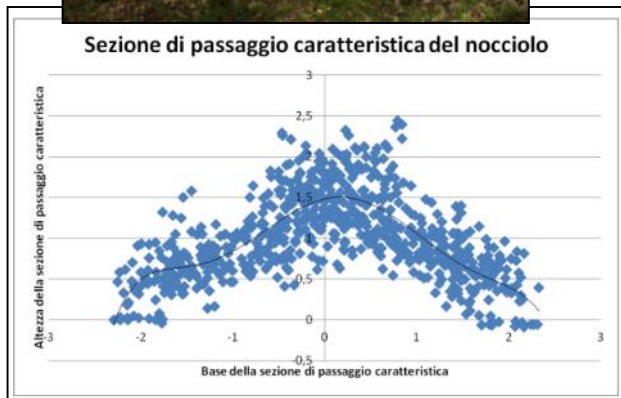


Fatal accident

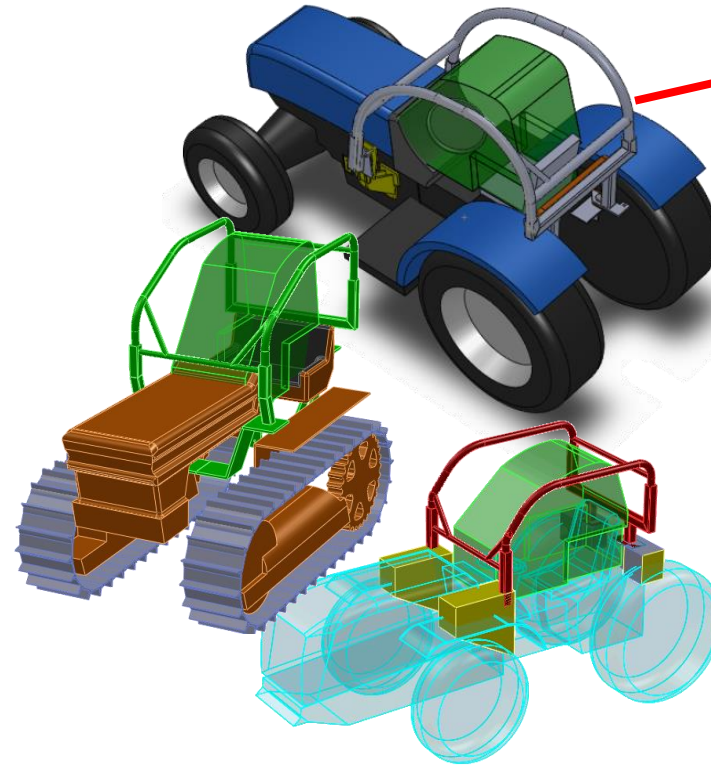


Compact Roll over protective Structure: CROPS

Design, prototype and testing of compact structures



Extrapolation of the tree profile by processing tree pictures



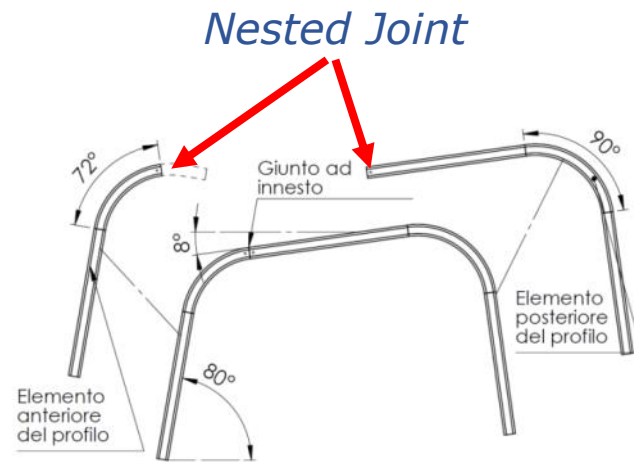
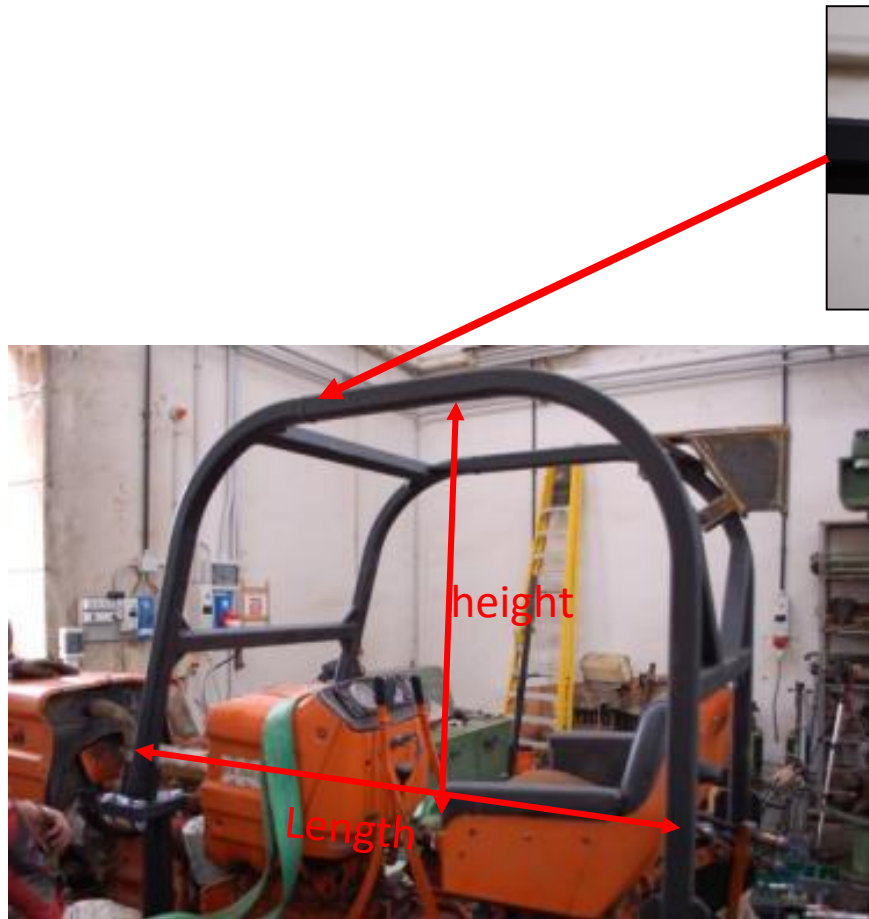
Design of the structures



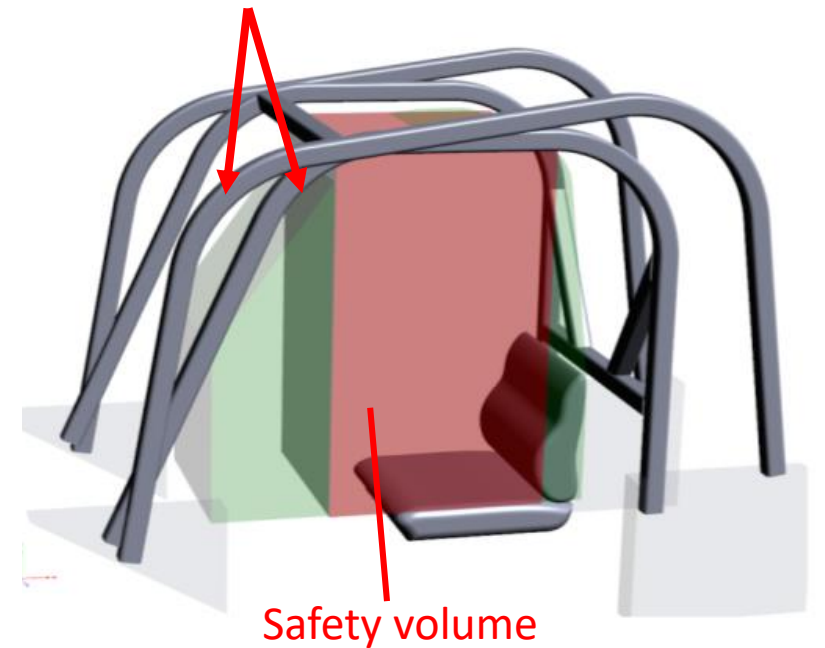
Testing on the field

Compact Roll over protective Structure: CROPS

CROPS are four posts ROPS with a smooth and useful lateral profile



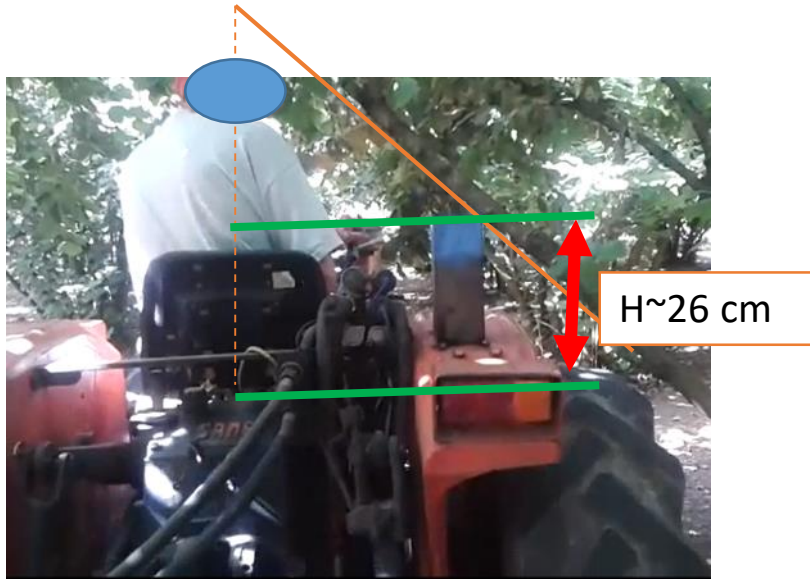
Weldment profiles of different shape ensure the operator protection



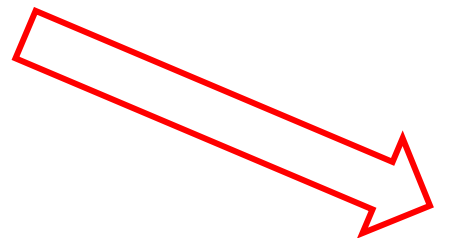
Functional needs

the height of the CROPS structures is excessive for some tasks

Tractors equipped with folding structures remain in service



Functional need



Reduce the physical effort associated with handling

Introducing assisted foldable ROPS

Study new vehicle

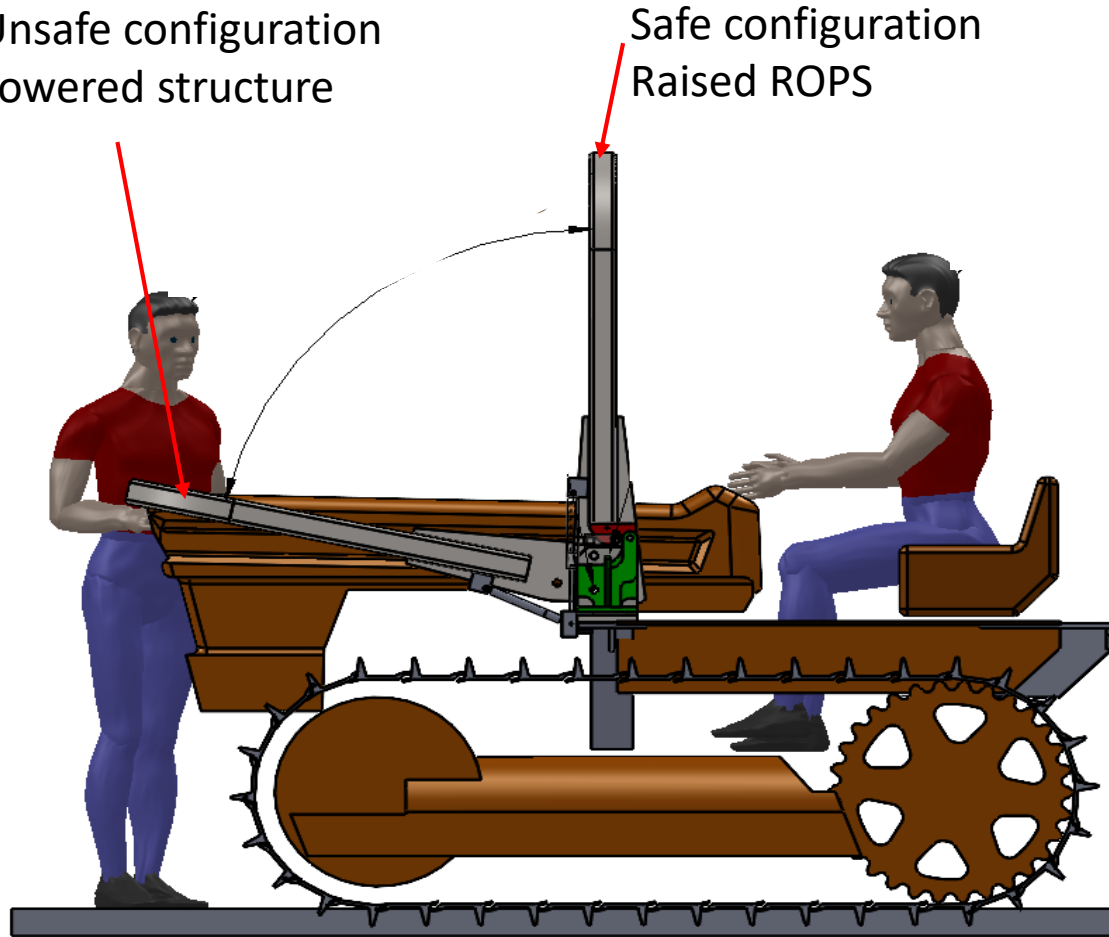
ASSISTED SYSTEM

Introducing actuators able to assist and reduce the effort required to move the ROPS

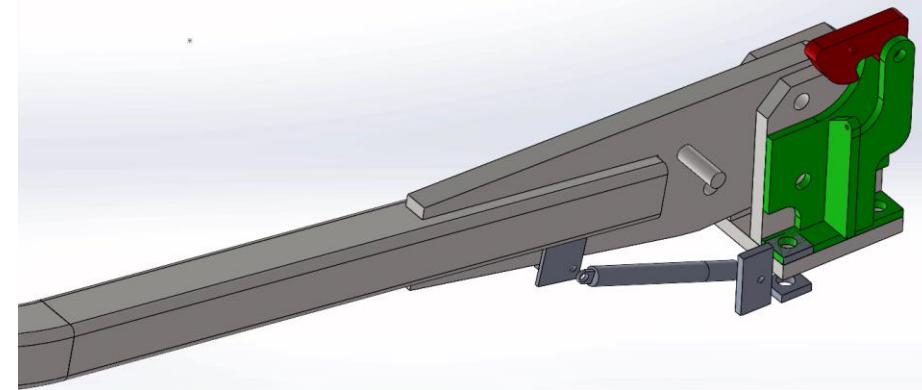
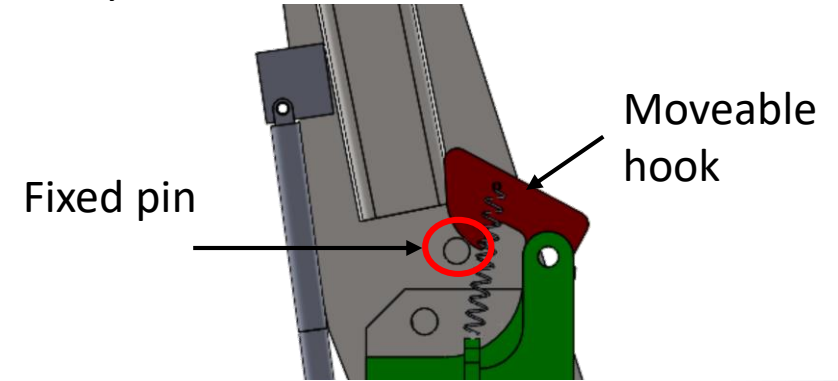
Introducing automatic locking systems

Unsafe configuration
Lowered structure

Safe configuration
Raised ROPS



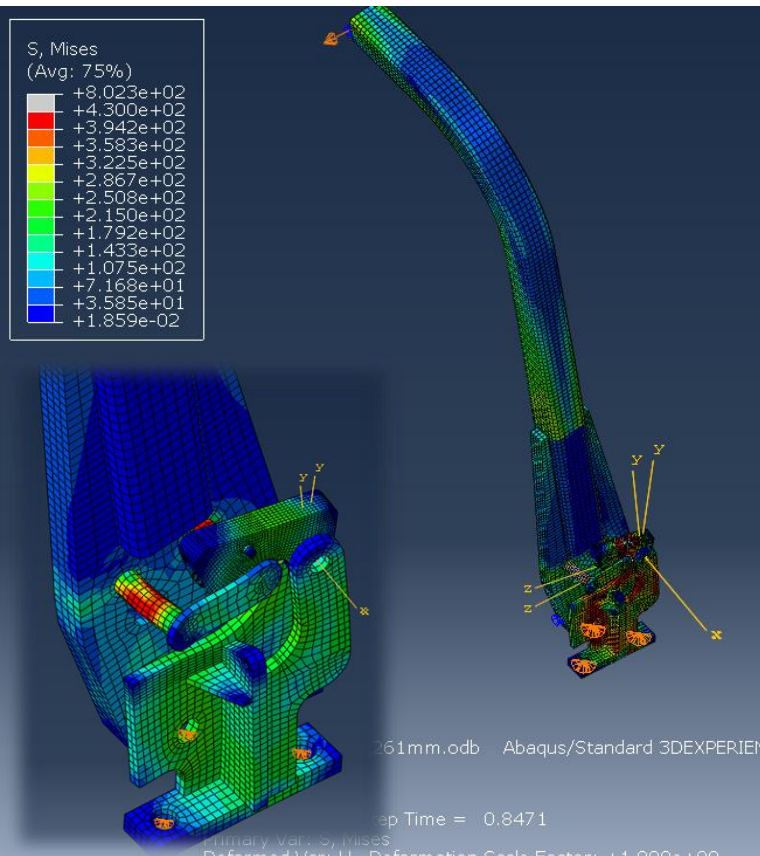
Dynamic simulation



AUTOMATIC LOCKING DEVICE

Manufacturing and testing phase

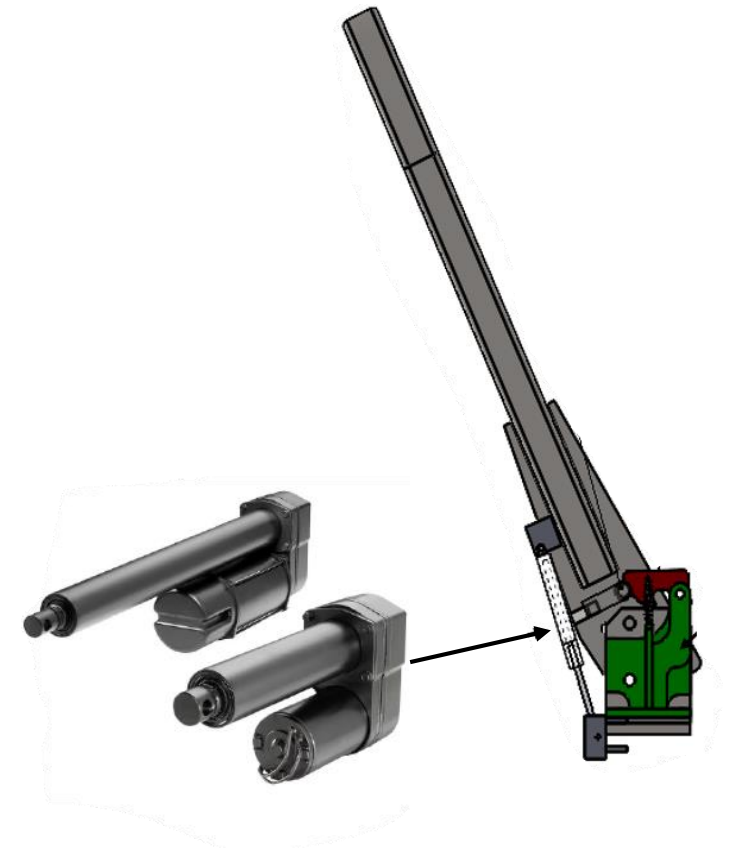
The locking systems have been tested according to OECD code Rules.



FEM Simulation



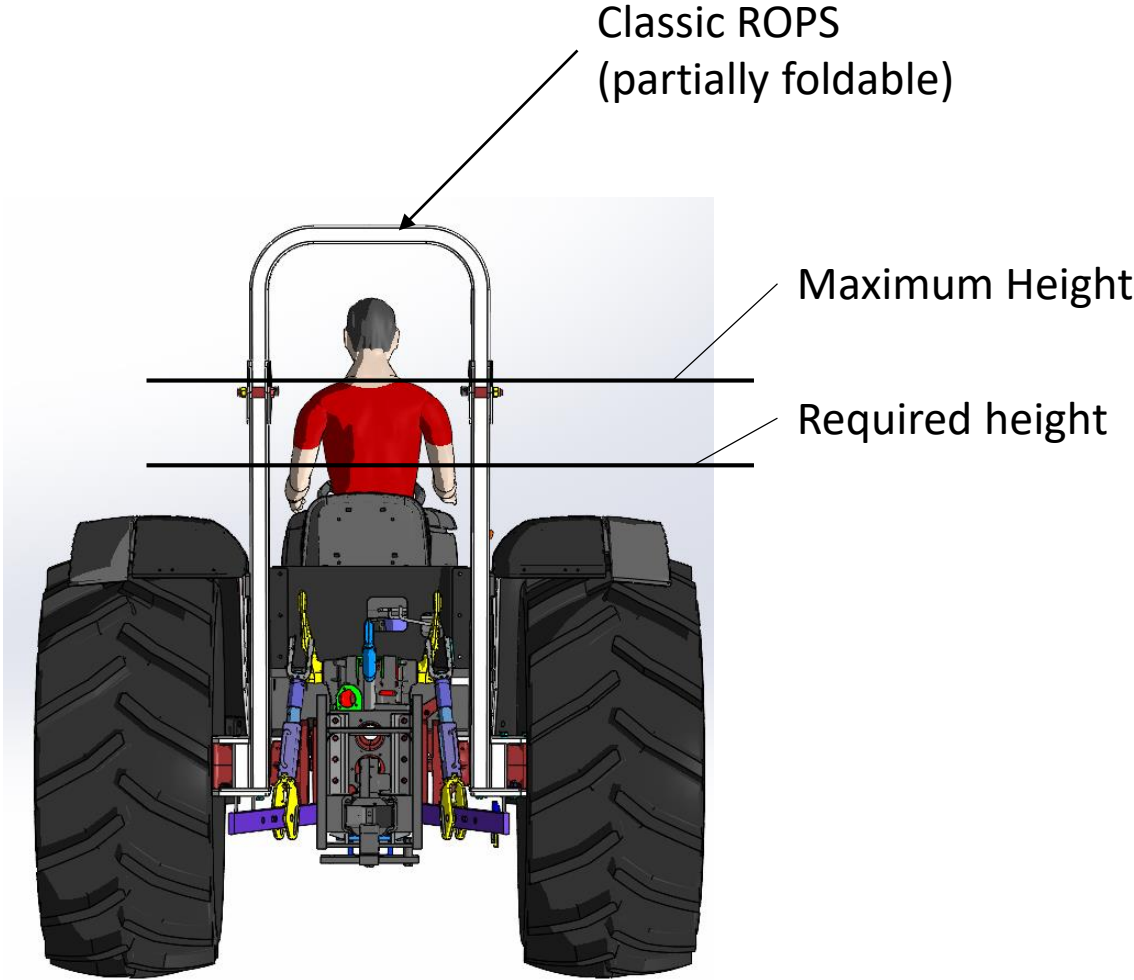
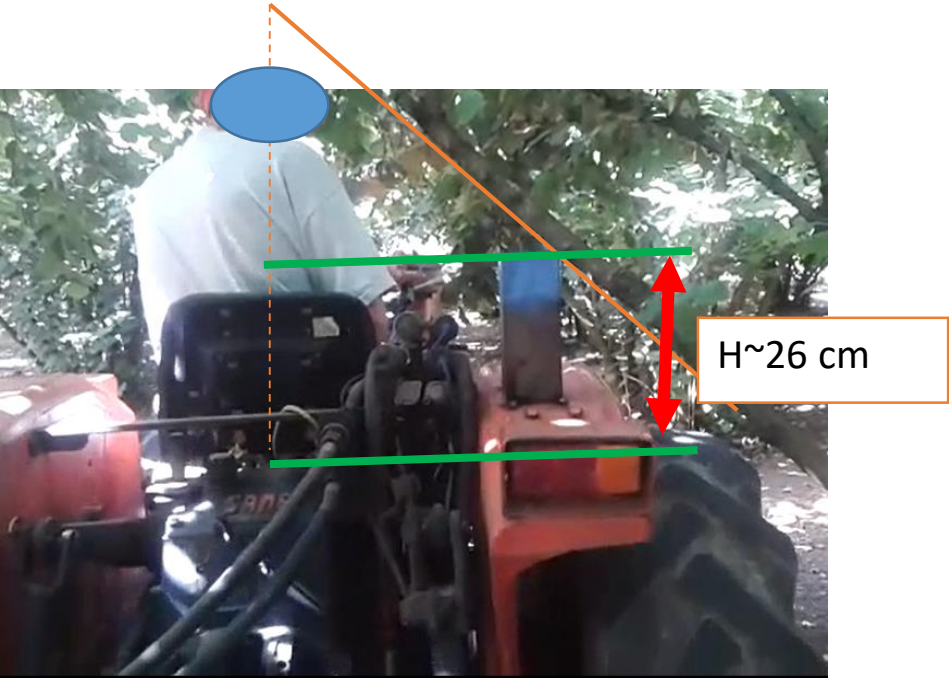
Functional and strength tests



Electric actuator

QROPS: foldable ROPS

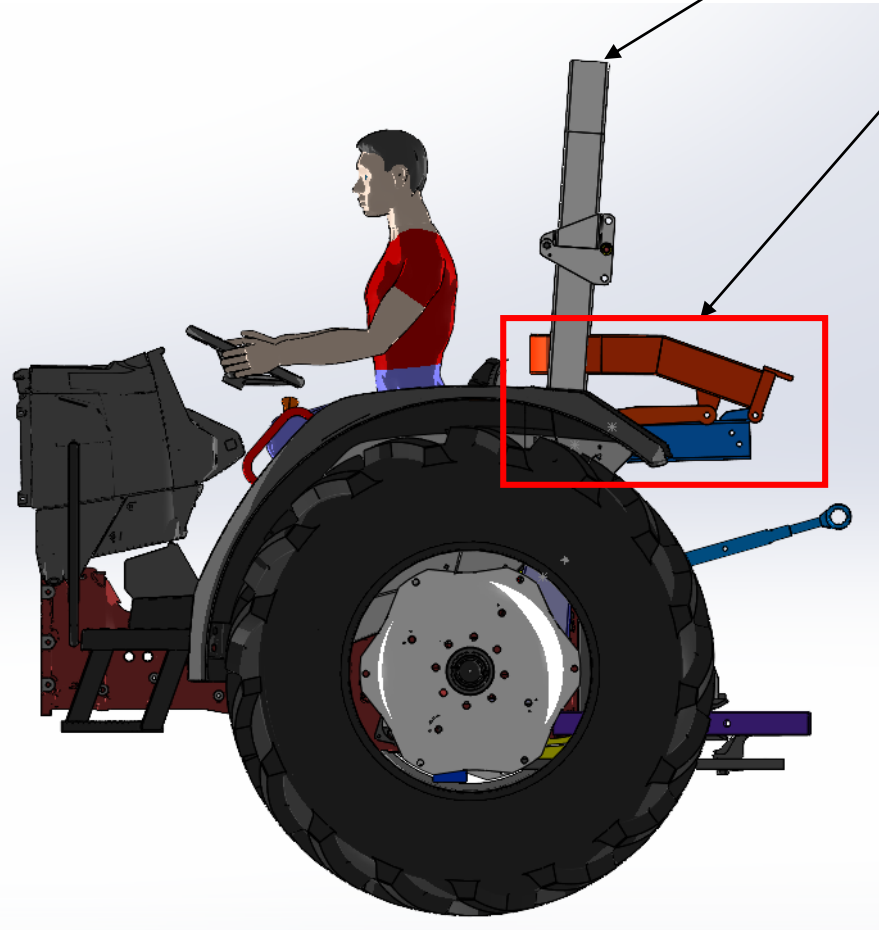
Research activities



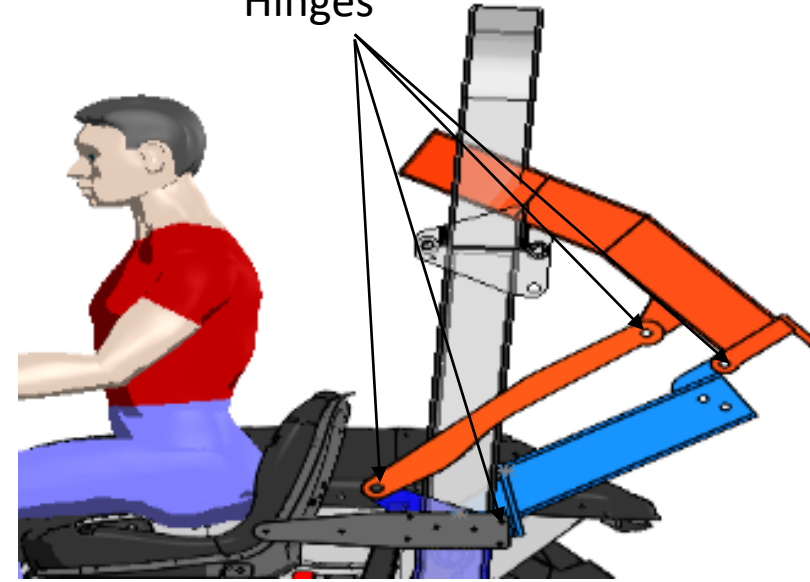
Deployable Rops: kinematic synthesis

Original ROPS

Folded QROPS size

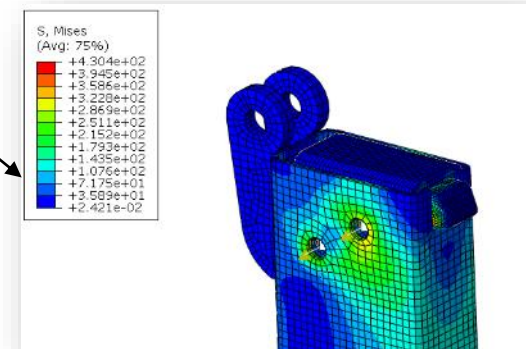
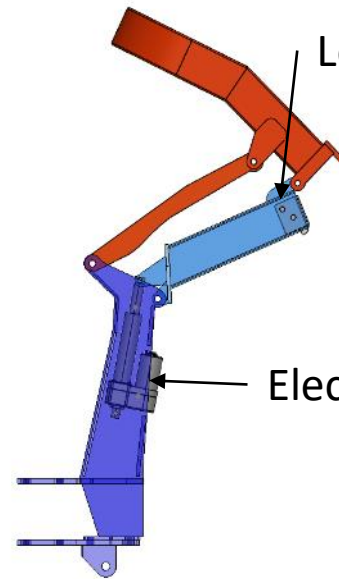


Hinges



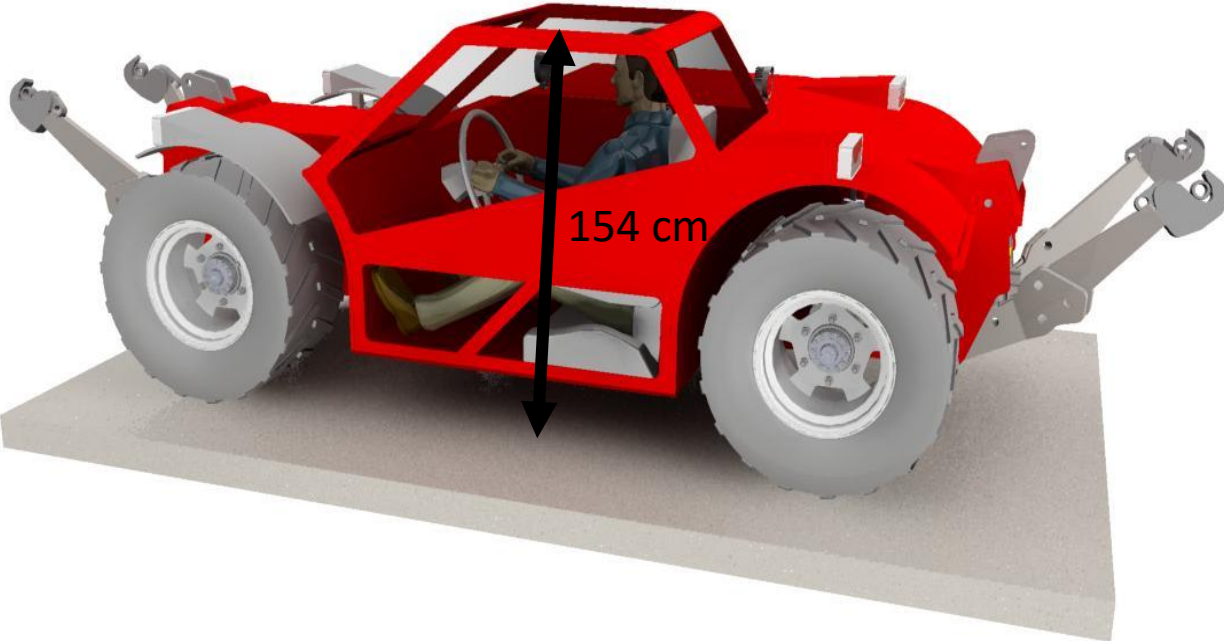
Locking device

Electric actuator

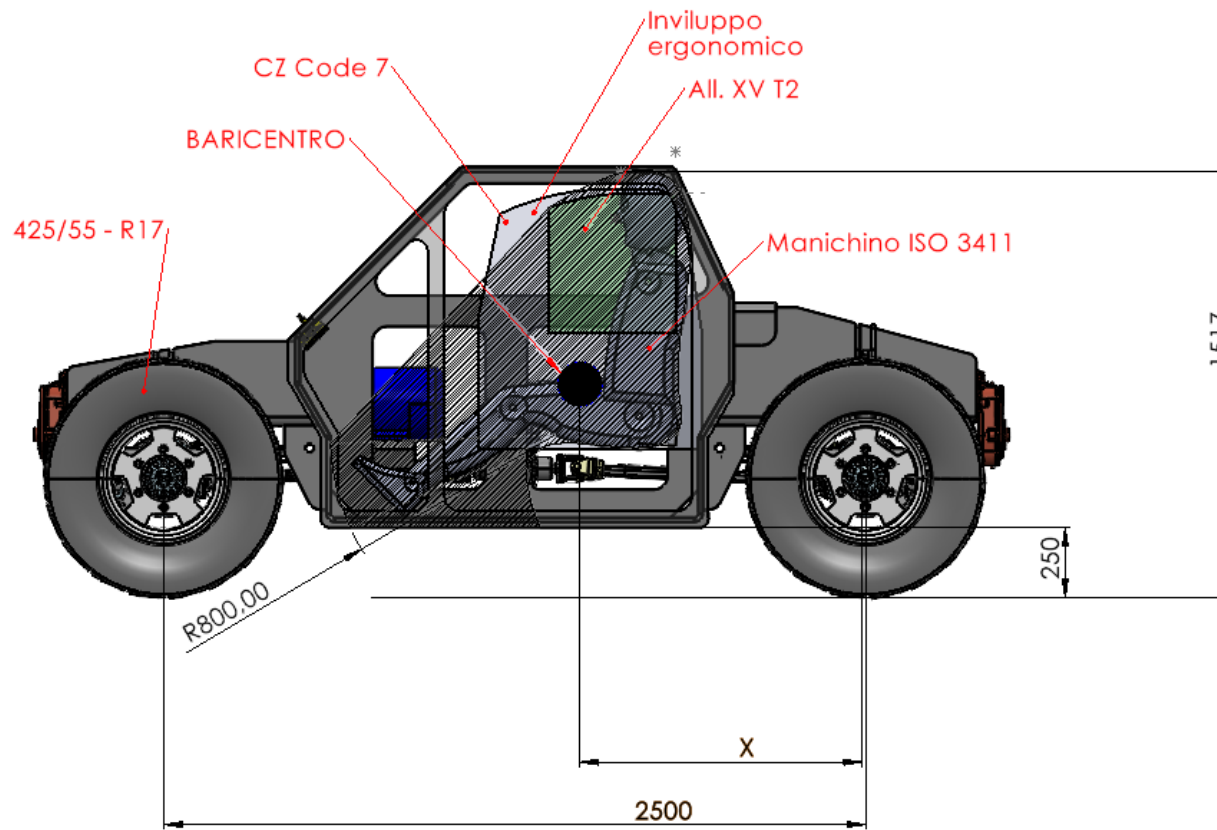


Virtual prototype of Compact Tractor

Hybrid solution



Full electric



MOBI.RU.D

Disabled Rural Mobility



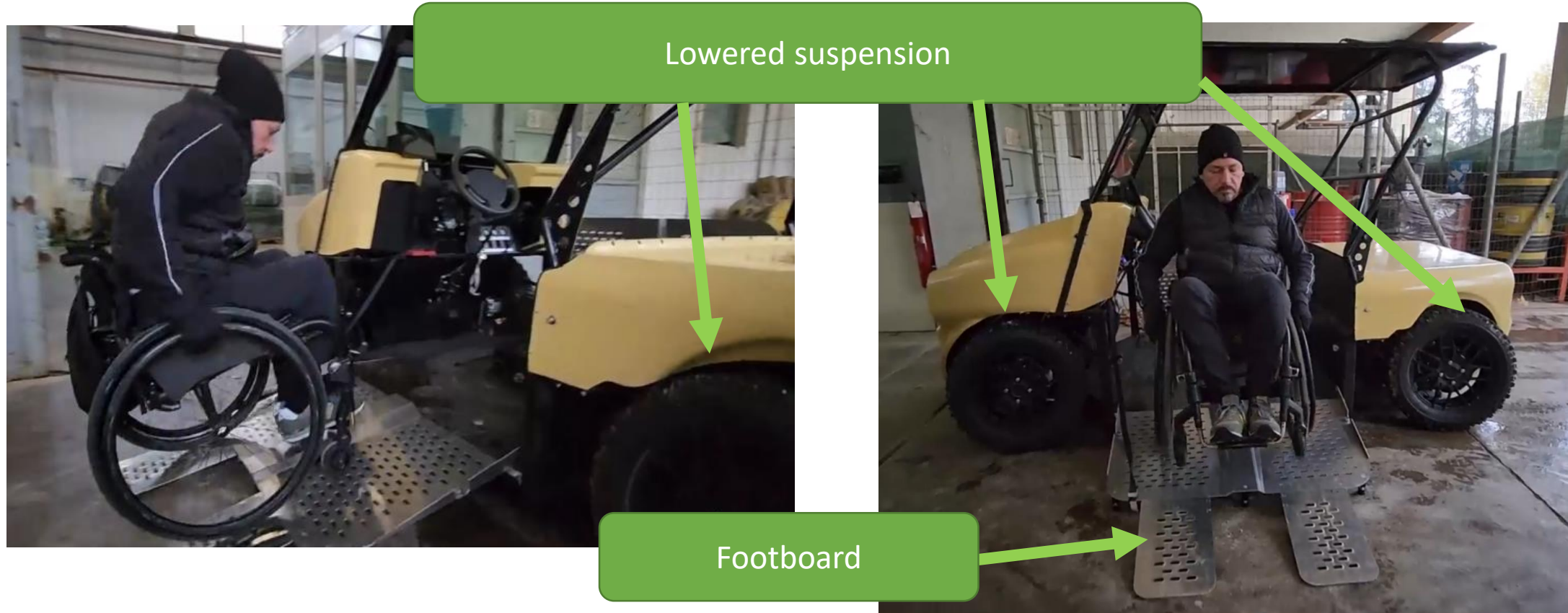
Air suspension

The vehicle can be used on rough terrain

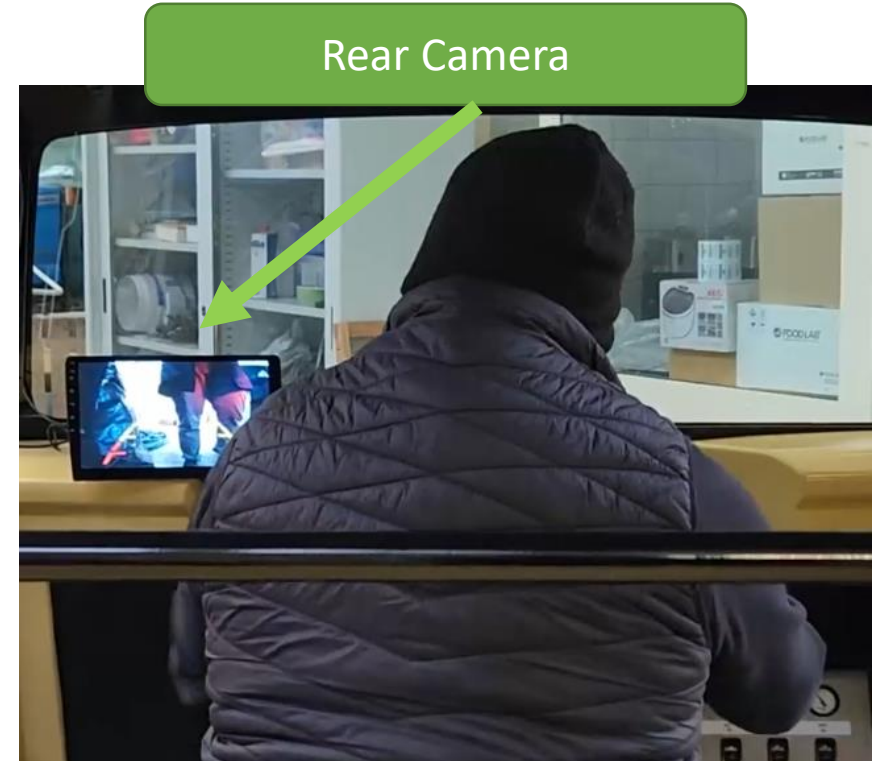
The operator can access the machine with his own wheelchair:

- Air suspension
- Folding aluminum platform on both sides of the vehicle
- Turntable
- Wheelchair coupling / release system via pin

Autonomous use



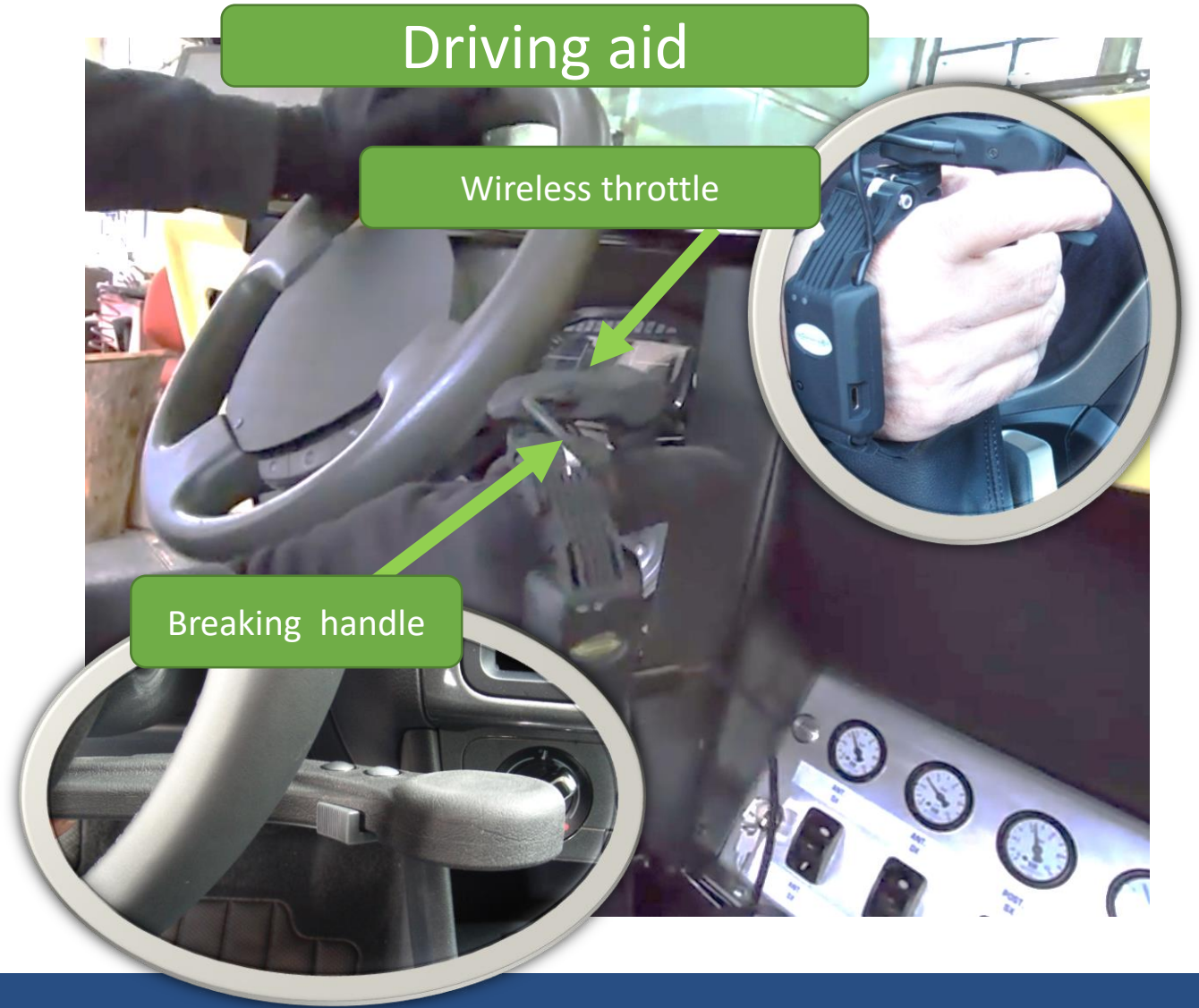
Safety



Controls



Rear steering system



Main characteristics



Compactness and driving practicality for **rural contexts**

Operational flexibility, compatibility with multiple driving aids

Driving comfort and safety with multiple wheelchair coupling system

Electric powertrain with high efficiency and low weight

Mobility on rough terrain

Possibility of entry, use and get off in total autonomy

Drawbacks

The vehicle will be industrialized.

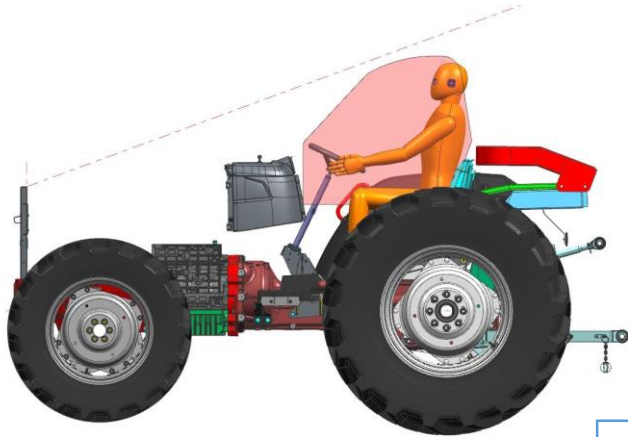
Digital Controls



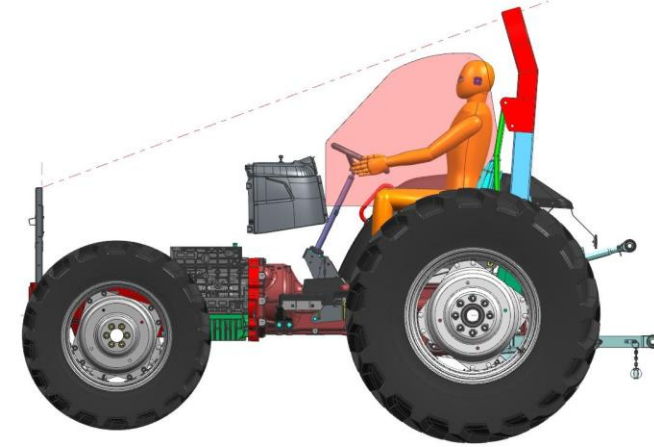
On large scale the safe upgrade of firmware must be taken into account!

Drawbacks Deployable Assisted/Automatic ROPS

Unsafe Configuration



Safe Configuration



ROPS handling by proactive systems

Automatic ROPS

(IMU Sensor detects the Roll Over risk and activates the ROPS suddenly)

Smart Assisted ROPS

(Assisted ROPS by means of Drone.
The drone detects the dangerous zones on the field and communicates with the control system of the ROPS)

The operator could hit some elements of the ROPS in the lifting phase and he/she could get hurt!!!

**Safety Communication Protocol should be implemented!!!
Firmware upgrade!!!**

Many thanks for your attention

National Institute for Insurance against Accidents at Work
Department of technological innovations and safety of plants, products and anthropic settlements
Laboratory I – Safety in the agricultural-forestry sector
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