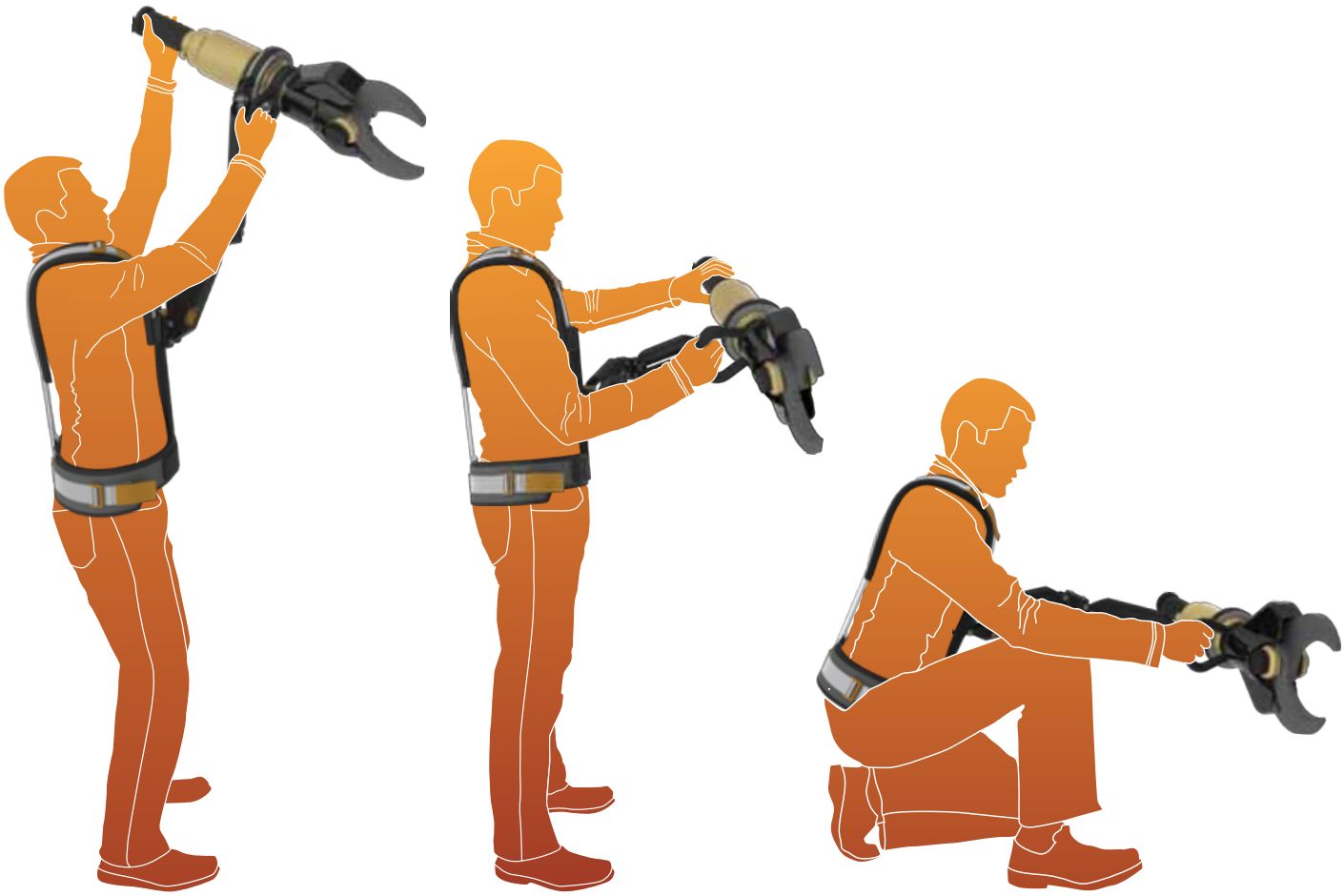

Product report

Hydra

Hydraulic Tool Support System

MA4-ID1 Fall 2009 | Andreas Hammershøj Olesen

Title page

Master thesis
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Hydra
- Hydraulic Tool Support System

Themes
Semi-technical products
User Centered Design
Functionality and ergonomics

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Supervisor
Christian Tollestrup

Introduction

This report presents the resulting product of a 4th semester master project from the Industrial Design education at Architecture & Design, Aalborg University. The product consists of a support system for hydraulic rescue tools used by firemen to free persons trapped in cars during automotive accidents.

The support system relieves the operator of physical stress, enhances endurance and precision making it possible to work faster for an extended period of time.

The product report features a presentation of the product and its various aspects. A documentation of the process of developing this product is available in the process report.

Contents

Hydra

Hydraulic Tool Support System

Hydra is a support system that through a harness in combination with a load-bearing arm relieves the operator of heavy hydraulic rescue tools of physical stress.

The support system enables the operator to work faster, more precise and with higher endurance.

16 kg?

Philips 42” Essence TV.

An average four-year-old.

A mountain bike.

Two frames of canned soda.

A Brio Combi Compact pram.

A five months-old Chicargo Amstaff dog.

Thule Atlantis 780 roof ski box.

The problem

Handheld hydraulic equipment used by fire fighters to liberate restrained passengers in automotive accidents is heavy and difficult to handle.

The RS165-65 cutter weighs in at 16 kg. The main body houses a hydraulic cylinder that drives a scissor blade cutting mechanism.

The tools are used in many different situations for extended periods of time causing high physical stress to the operator. Using the tools is exhausting affecting performance, precision and endurance.

The Weber-Hydraulik RS165-65 cutter


Marievej

The pain

Exhaustion

From planning and setting up, through using the tools, to cleaning up the site and reseating the tools, their massive weight is a burdon on the operators.

During use, several operators take over to keep operation performance to a maximum.

The cure

Endurance

When relieving the operator of physical stress, the operator is able to work focused for an extended period of time.

Longer work rotation results in less time being wasted on switching operators.

The pain

Inaccurary

When performing difficult cuts or spreads, the operator often requires the help of another firefighter to achieve optimum working angles and points of attack for the tool.

Often the operator has to repositioning the tool several times for a more optimum cut.

The positioning of the tool is very important to maintain a high degree of efficiency.

The cure

Precision

With the support system, the operator is able to carry out more operations singlehandedly.

Not only does the decreased physical stress allow the operator to work unassisted, but actions are performed faster and with higher precision.

Achieving better cuts more rapidly results in faster rescues lessening risc of or the affects of physical and psycological trauma to patients.

Features

Shoulder tension straps adjust the vertical hight of the support system.

Soft padding material reinforced by reflective webbing for increased traffic safety.

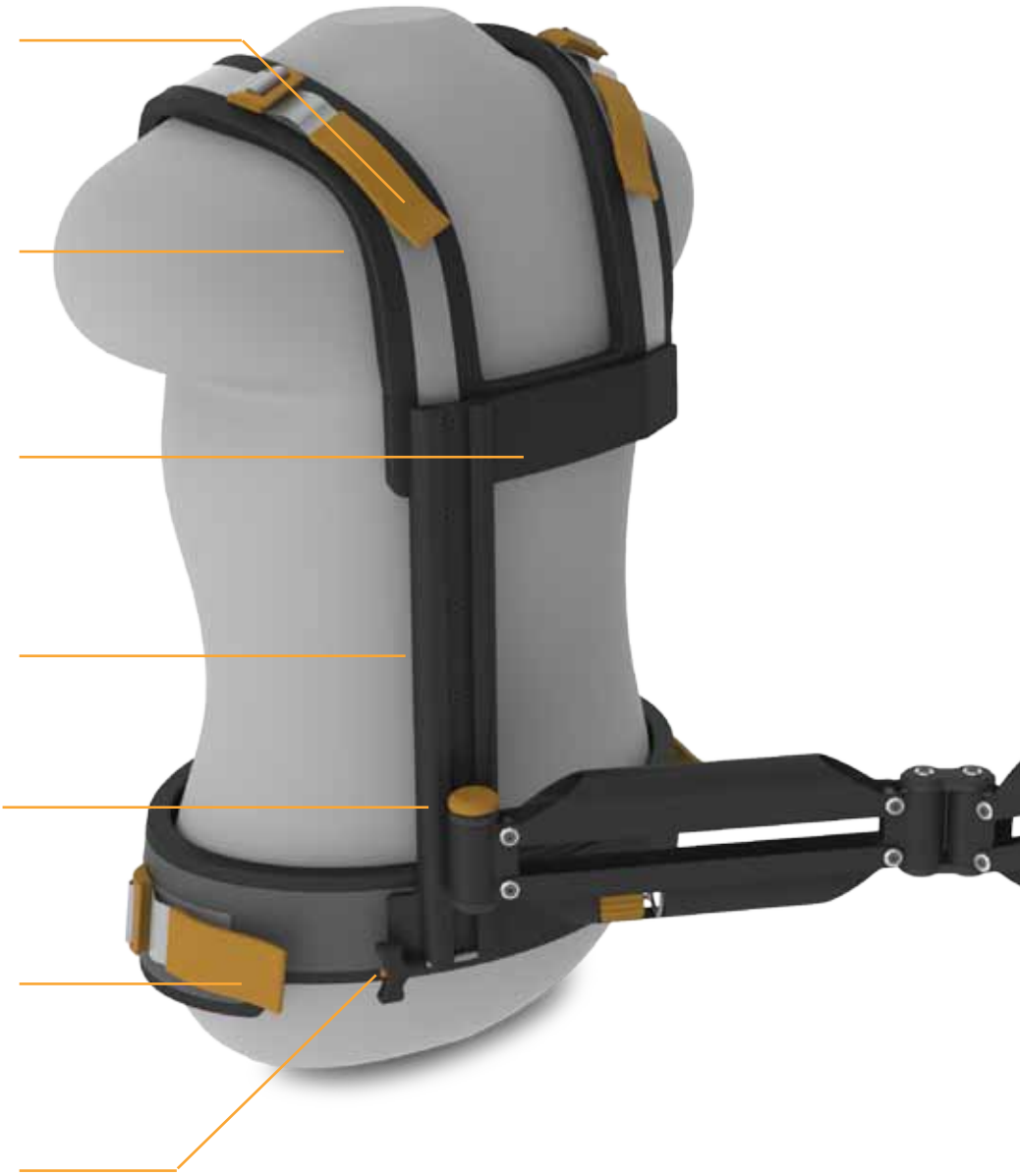
The front mounted steel plate transfers load to pressure on the upper back and front waistline.

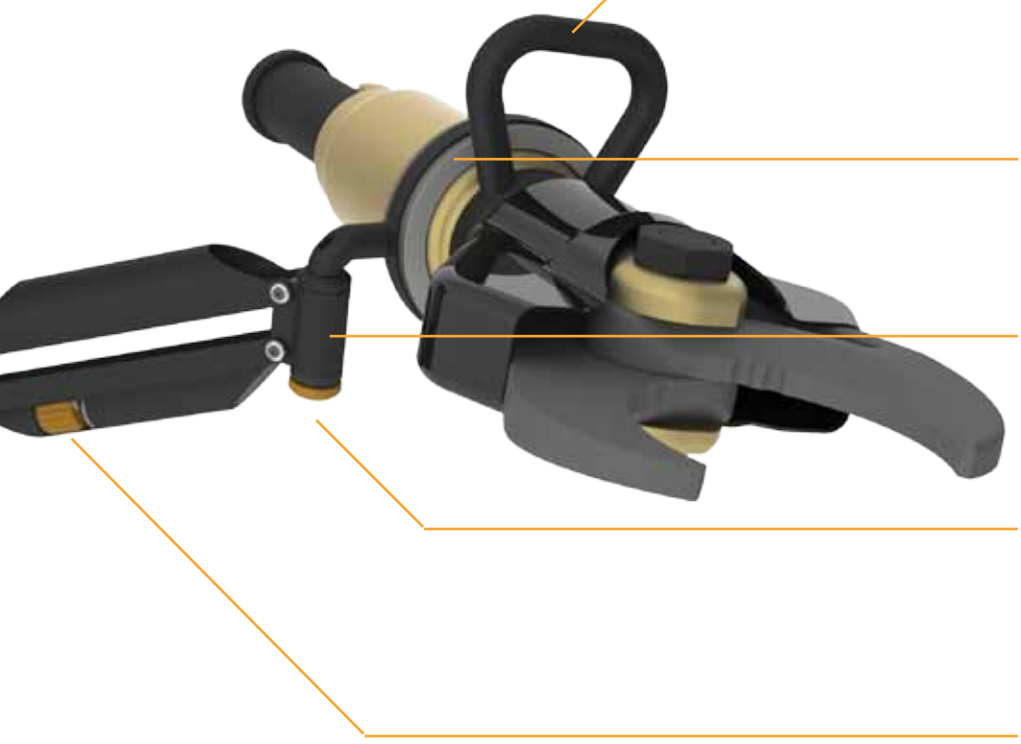
A rail allows the arm mounting point to move upwards for high reach situations.

Push-button activation allows downwards movement of the arm mounting point.

Waist tension straps adjust the width of the waist belt.

A pull-out pin allows the arm mounting point to be removed in a downwards direction.





The system integrates the existing handle of the tool retaining existing functionality even if decoupled.

Ball bearing joints allows the rotation of the tool around all axes.

Simple bushings allow the arm to articulate freely.

Push-button activation allows easy removal of the tool.

A rotating knob adjusts spring tension and thereby the supporting force of the system for various different tools or user preference.

Orthographic views

Colors

The dramatic context of automobile accidents feature many different colors and “noisy” elements.

To avoid adding to this confusing environment, the support system uses a discrete charcoal black as the main color.

Functions such as buttons and tightening straps are highlighted by a bright orange, while the tightening webbing features reflective material to aid in traffic security.

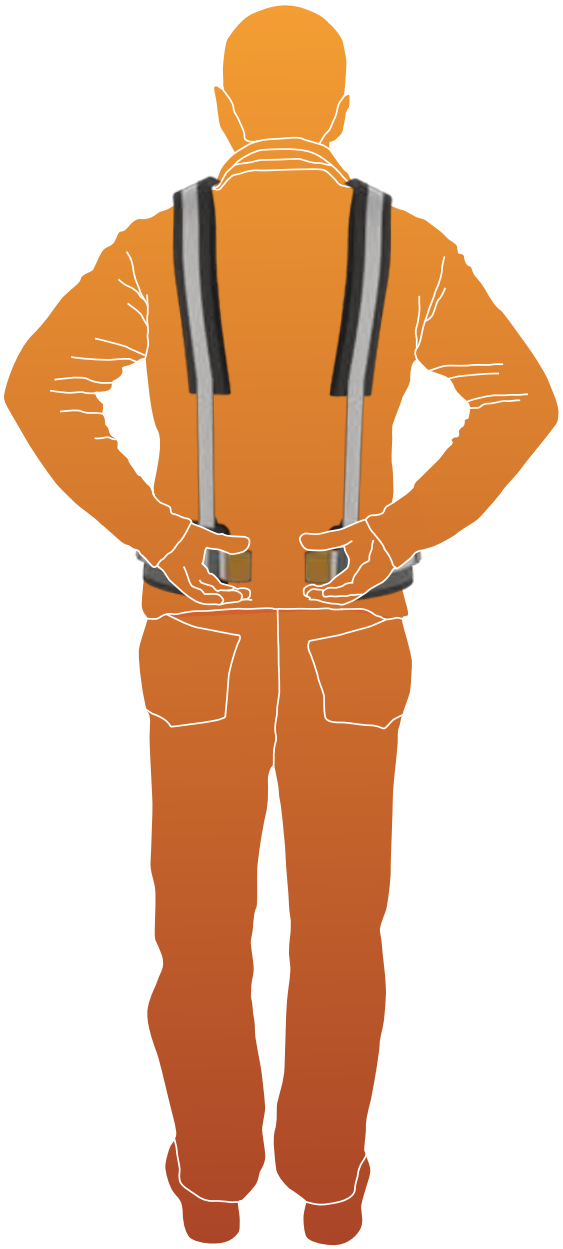
The reflective webbing highlights the lines lines of the product.


285
700

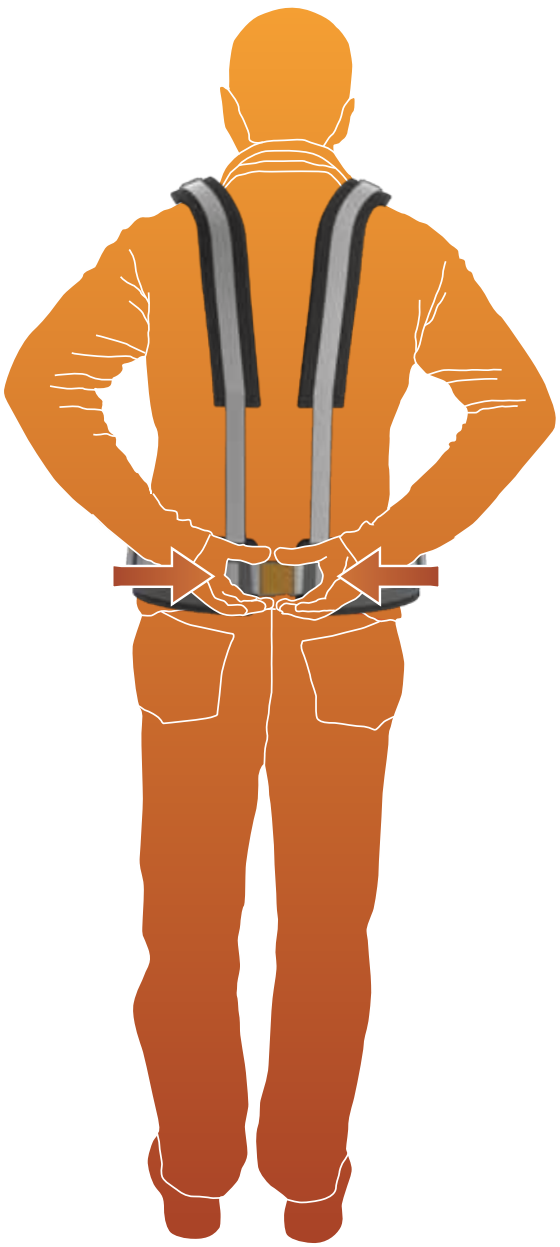

550
415

Interaction

Entrance

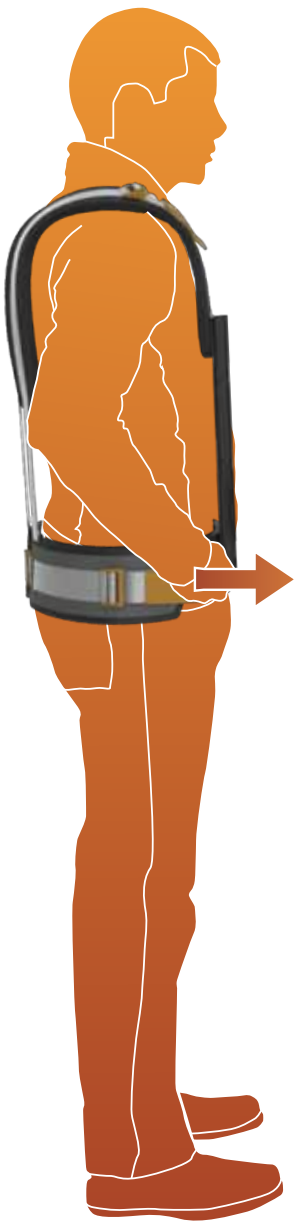


The shoulder straps are spread and the support system entered similar to wearing a backpack the wrong side around.



The rear buckle is closed and the support system can now be adjusted according to user anatomy.

Adjustments



The waist belt is tightened and released by a combination of webbing and tensioning locks.

The vertical length is adjusted by tightening the should webbing and tension locks.

Working postures

Working area

The hydraulic tool support system has a very large working area.

The support system extends to most operational positions and allows a high degree of rotation and flexibility for various different tasks.

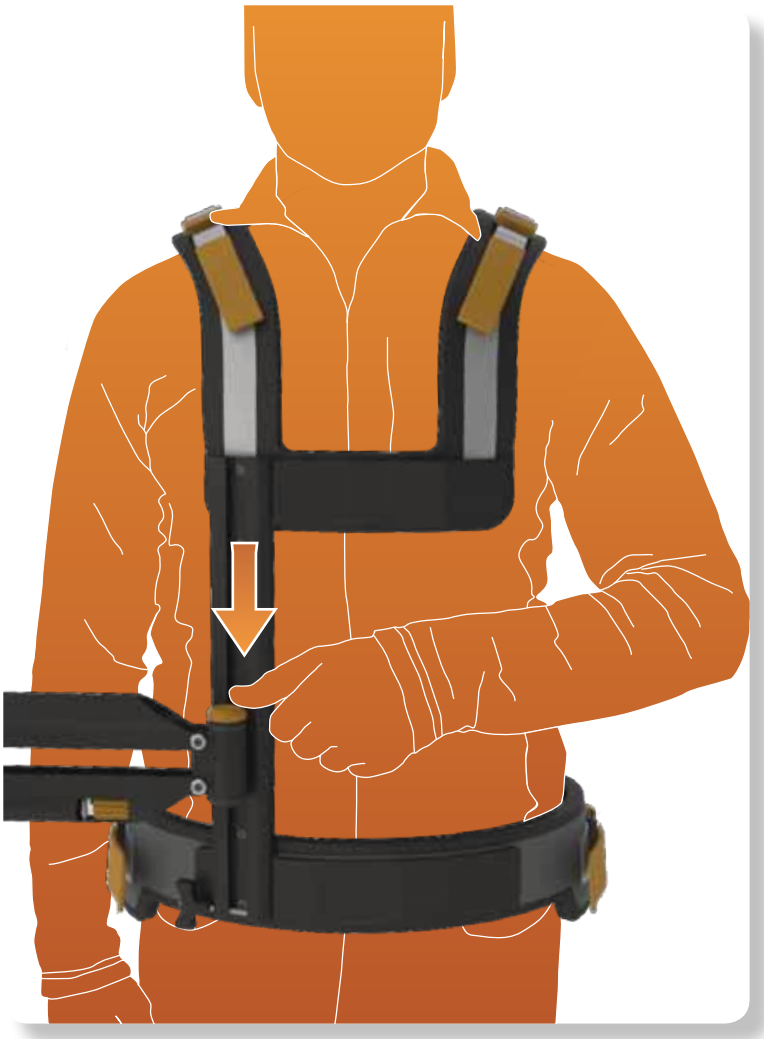
From kneeling postures through regular working positions to high reach situations, the support system supports the weight of the hydraulic tool.

By transfering the main load of the tool onto larger, stronger muscles (legs, upper, lower back) in combination with a long working range, the operator is able to move the body further away from the “action area” where sharp protruding elements are a danger.

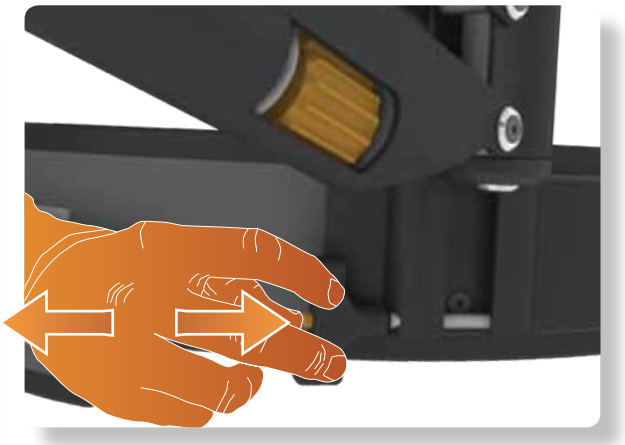
The working area is larger than the possible extension of the operators arms allowing the possibility of one operator supporting the main weight of the tool while another carries out the actual tool operation.

For situations where the support system is not applicaple (e.g. working in tight spaces or through narrow openings), the tool can detach from the system and continue operation.

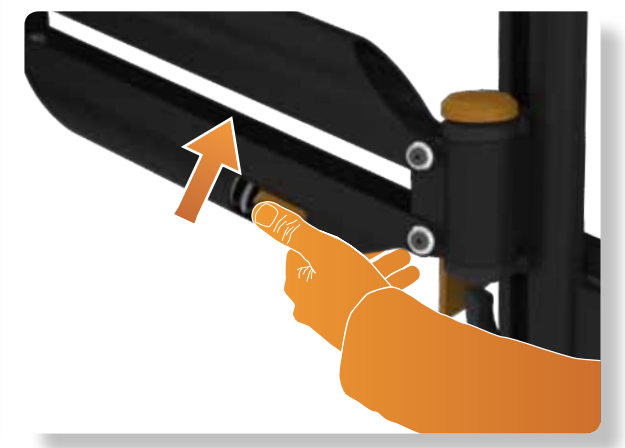
Rail



When lifting the tool above the extension range of the arm, the arm mounting point follows along the rail without user interference. To release the locking mechanism and allow downwards motion of the arm mounting point, a push-button is activated.

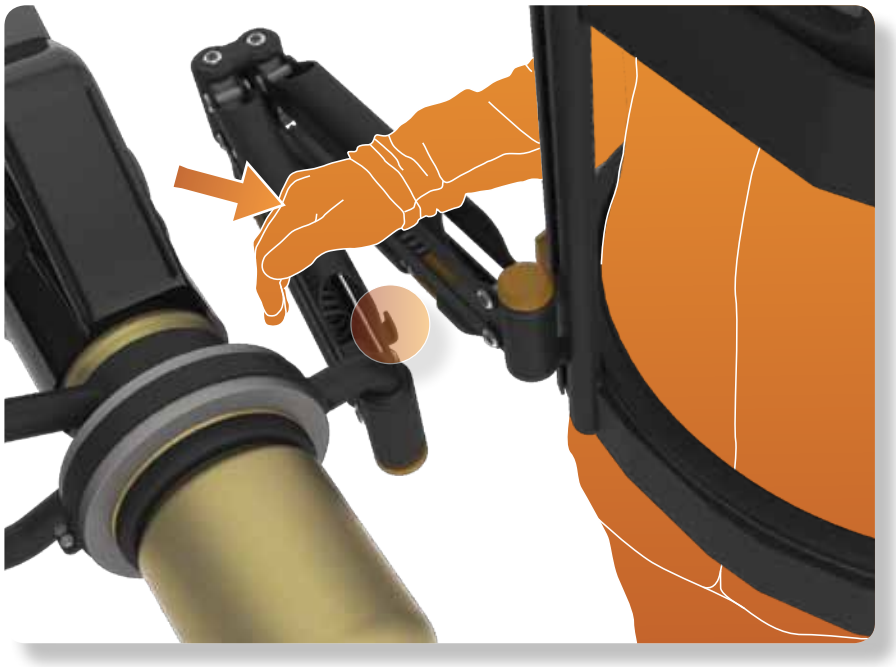


A pull-pin on the bottom of the rail allows complete disengaging of the arm e.g. for emergency situations.



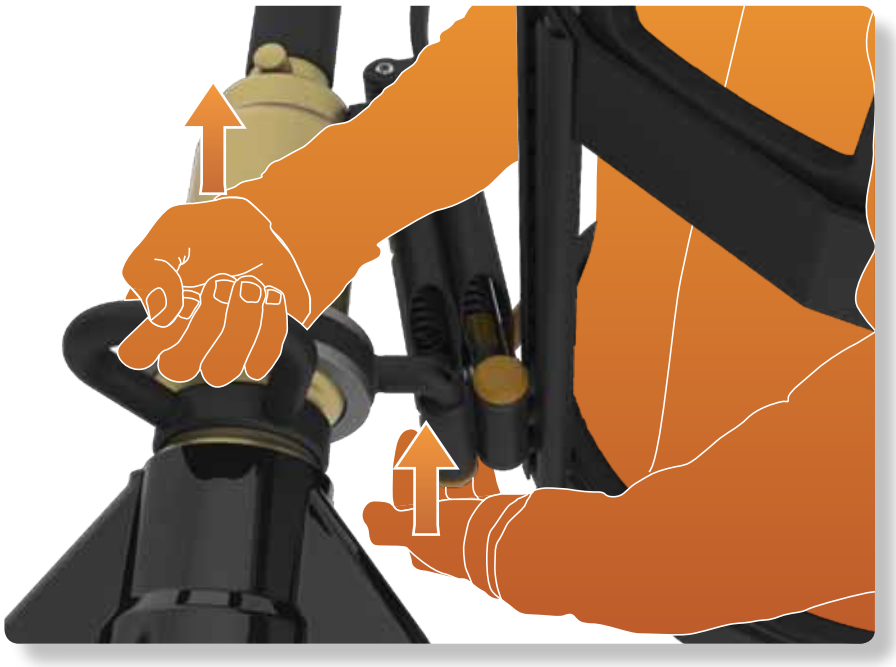
Rolling knobs on the arm allow tension of the load-bearing spring to be adjusted depending on the tool or user preference.

Switching tools



The arms feature a locking mechanism which is engaged by a clip placed on the front part of the arm. When engaged, the arm lifts the tool to a position to allow removal of the tool.

The locking mechanism can be used for easier storage or transport of the support system.



With the locking mechanism engaged, the operator releases the tool by a push-button mechanism. The tool can then freely be removed and operated independently or replaced with another tool.

Components and materials

Harness

The harnes consists of a rigid construction in front with a steel plate onto which the rail mounts.

The steel plate transfers weight from the tool onto the front waistline and upper back of the operator through a harness.

When sideways force is applied the steel plate applies the torsional force to the waistbelt.

The harness consists of a polyurethane core in a cloth outer shell.

The shoulder straps are reinforced by webbing, which is adjustable by the use of tension locks and buckles.

The waistbelt is further reinforced by a thin sheet of spring steel. The reinforcement allows the waistbelt to adapt to users of various sizes while providing torsional stability to the construction.

Tension locks and buckles are made of fiber reinforced plastic (ITW Nexus military grade buckles).

Webbing is made of polypropylene a strong and wear-resistant material. Reflective features are achieved by the use of 3M™ Scotchlite™ reflective material with context-relevant features such as wear resistance and flame retardency.

15 mm polyurethane foam with fits to the contours of the operators body.

25 mm polypropylene straps are used for the shoulder straps and 40 mm for the waist band.

A thin 0,5 mm sheet of spring metal provides torsional stability to the waist belt while retaining adjustment features.

A laser cut and bent sheet of steel transfers forces to the front waistline and to the upper back through webbing.

Components and materials

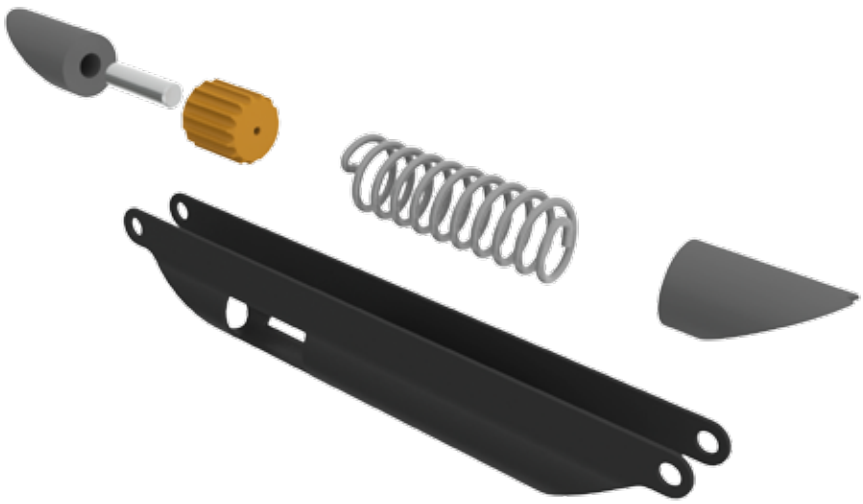
Arm

The arm consists of two identical arm elements that feature the load-bearing spring mechanism housed in the lower arm.

The arm elements form a parallelogram which provides vertical lift. When load is applied, the parallelogram tends to skew which is hindered by the tension of the spring.

The arm tubes are made of aluminum to keep weight low while the studs around which the arm elements rotate are steel to provide high reliability.

The joints for horizontal movement provide easy movement through the use of nylon bushings.

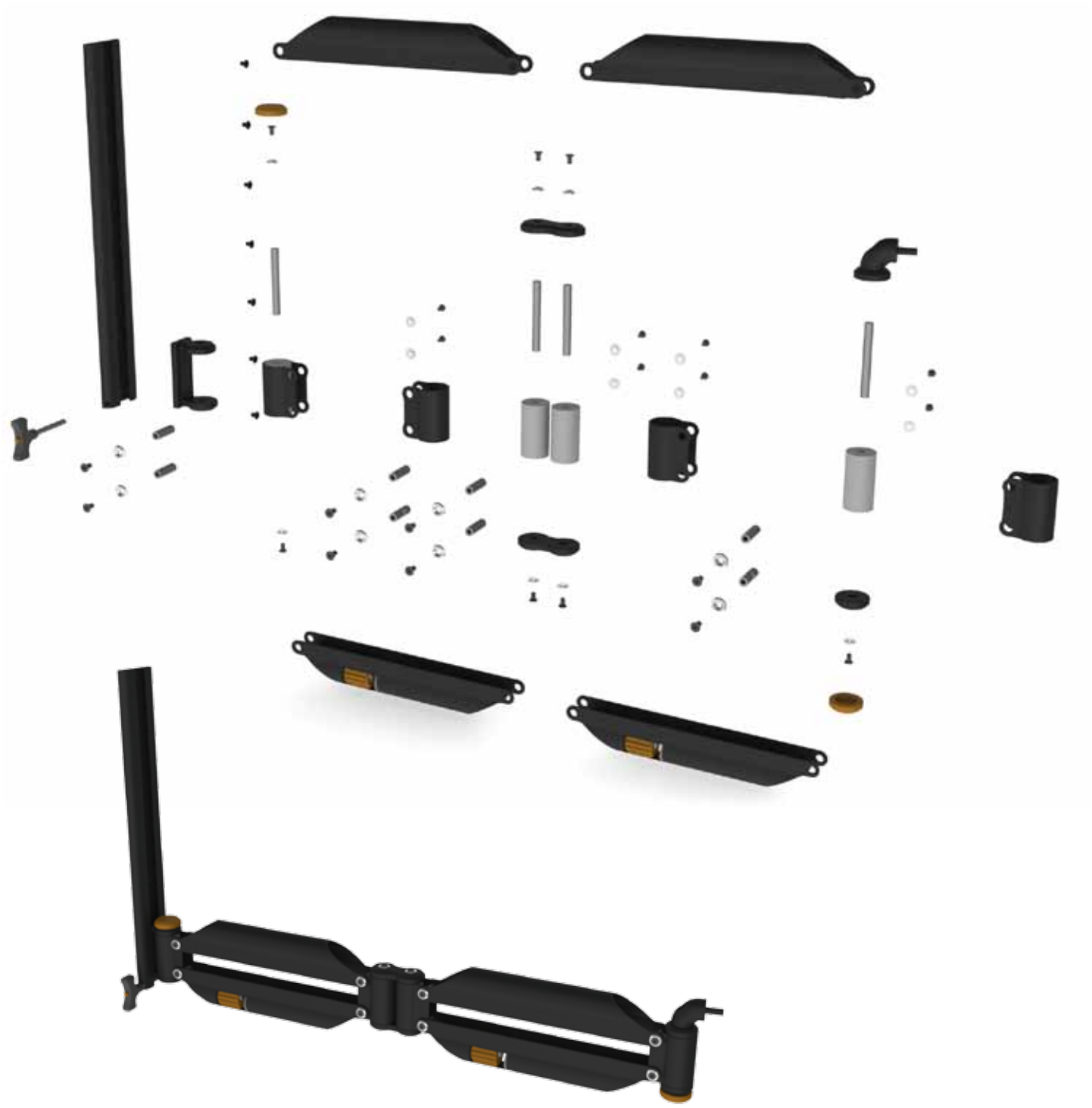


The tool joint

A large roller bearing is attached to the tool via a locking nut on which the bearing rolls.

The roller bearing allows to tool to be rotated indefinetely only hindered by the hoses.

A tightening steel ring secures the tool onto another set of bearings in combination with the roller bearing and the joint attached to the arm provide freedom of movement on all axes.



Impact

Benefits

The benefits of the hydraulic support system are tangible.

Relieving hydraulic tool operators of physical stress and thereby increasing endurance will allow them to work with higher precision for an extended period of time.

Trapped persons will be relieved faster but also safer through increased precision. Thereby the support system would be a factor in saving lives or minimizing the effects of physical and or psychological trauma to patients.

As operators are not influenced to the same extent by physical stress, the support system could lead to fewer sick days, fewer injuries for the operators etc.

Limitations

In situations where the support system would not be applicable such as when entering narrow openings (illustration opposite page) it must be disengaged either by completely removing the support system or disengaging the arm or tool independently.

Thereby the planning process requires the commanding fire fighter and the operator to take a new factor into consideration.

Market

The hydraulic tools globally are very similar in design and the system could be applied to several different hydraulic products of similar use.

The fluctuating economic and functional requirements of the various different markets could necessitate several different models of support systems ranging in features and thereby production cost.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