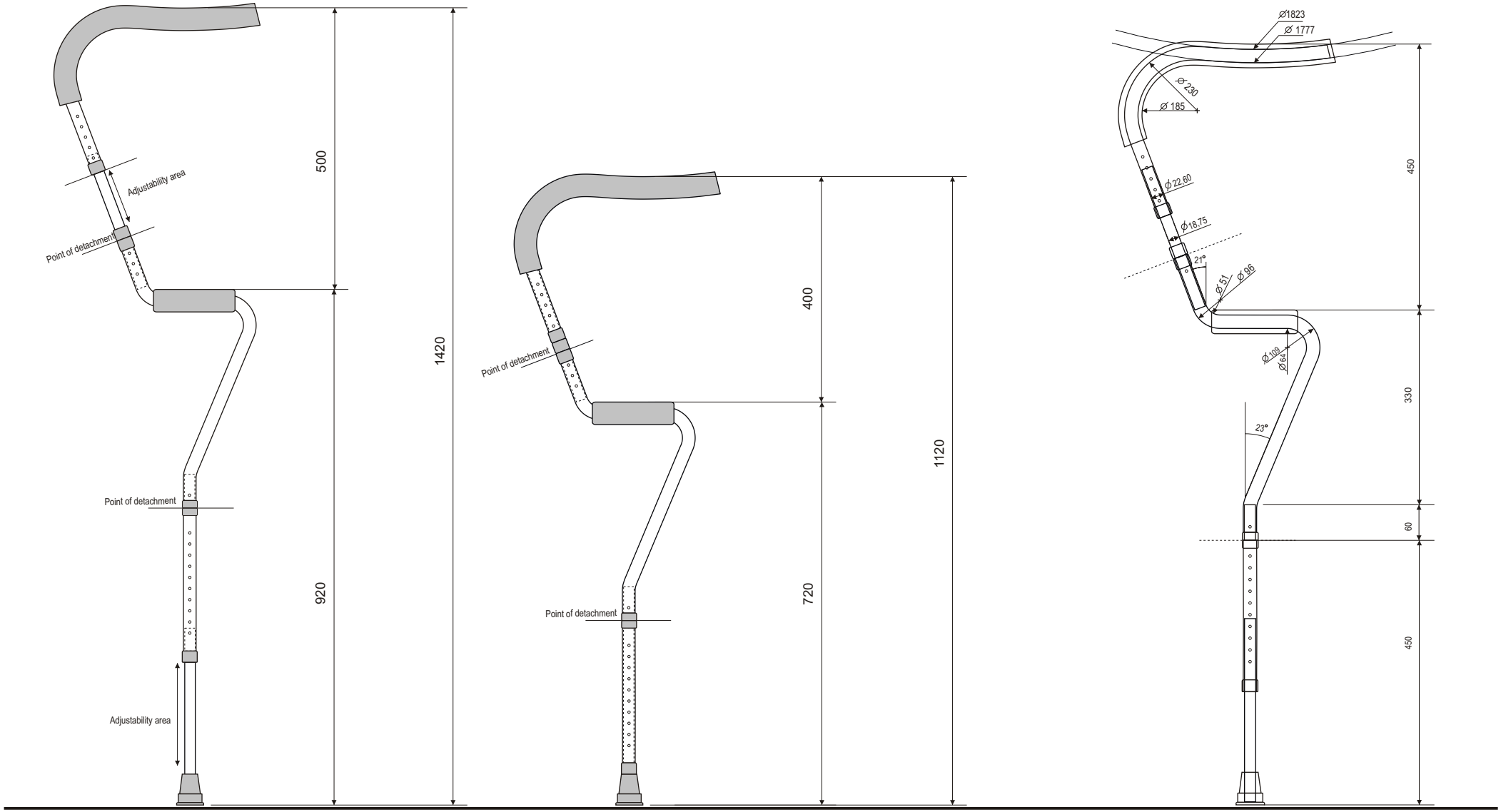
Underarm crutch



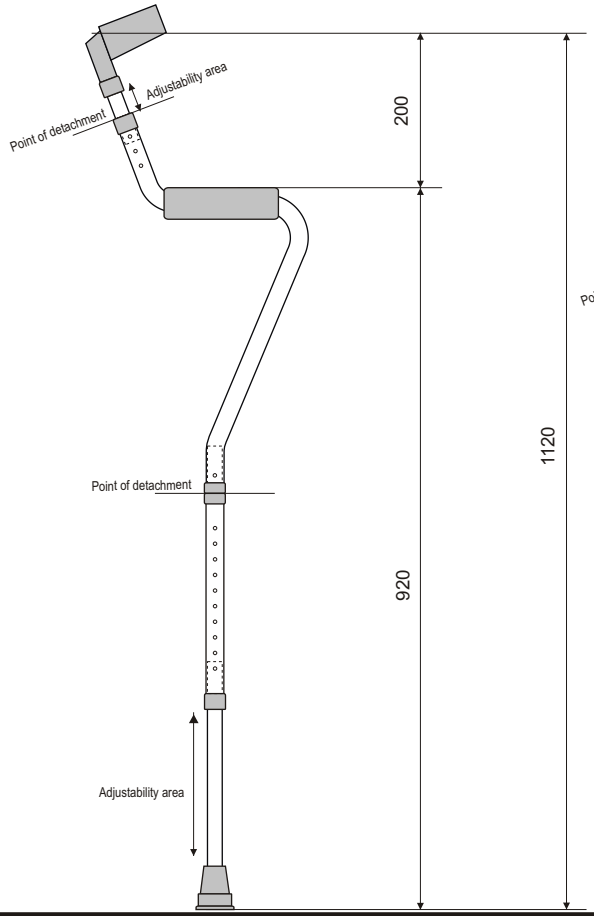
Maximum Height

Minimum Height

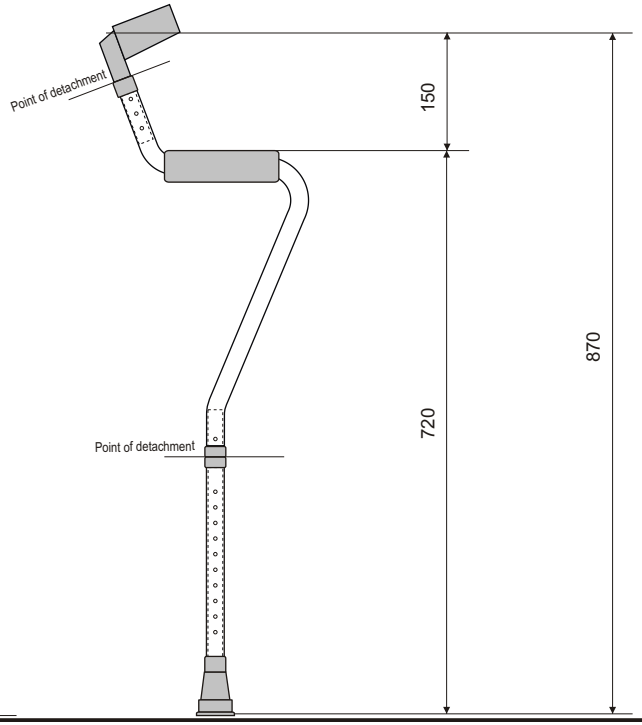
technical drawings

Forearm crutch

The crutch is adjusted and folded by pressing a button (Figure 36)
Materials:
- aluminum alloy tube;
- foam (cradle & grip)
- nylon (cuff)
- rubber (tip)(



Maximum Height



Minimum Height

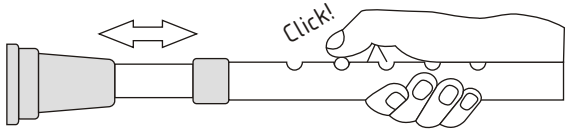
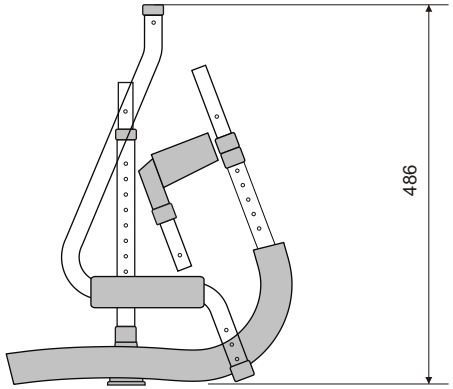
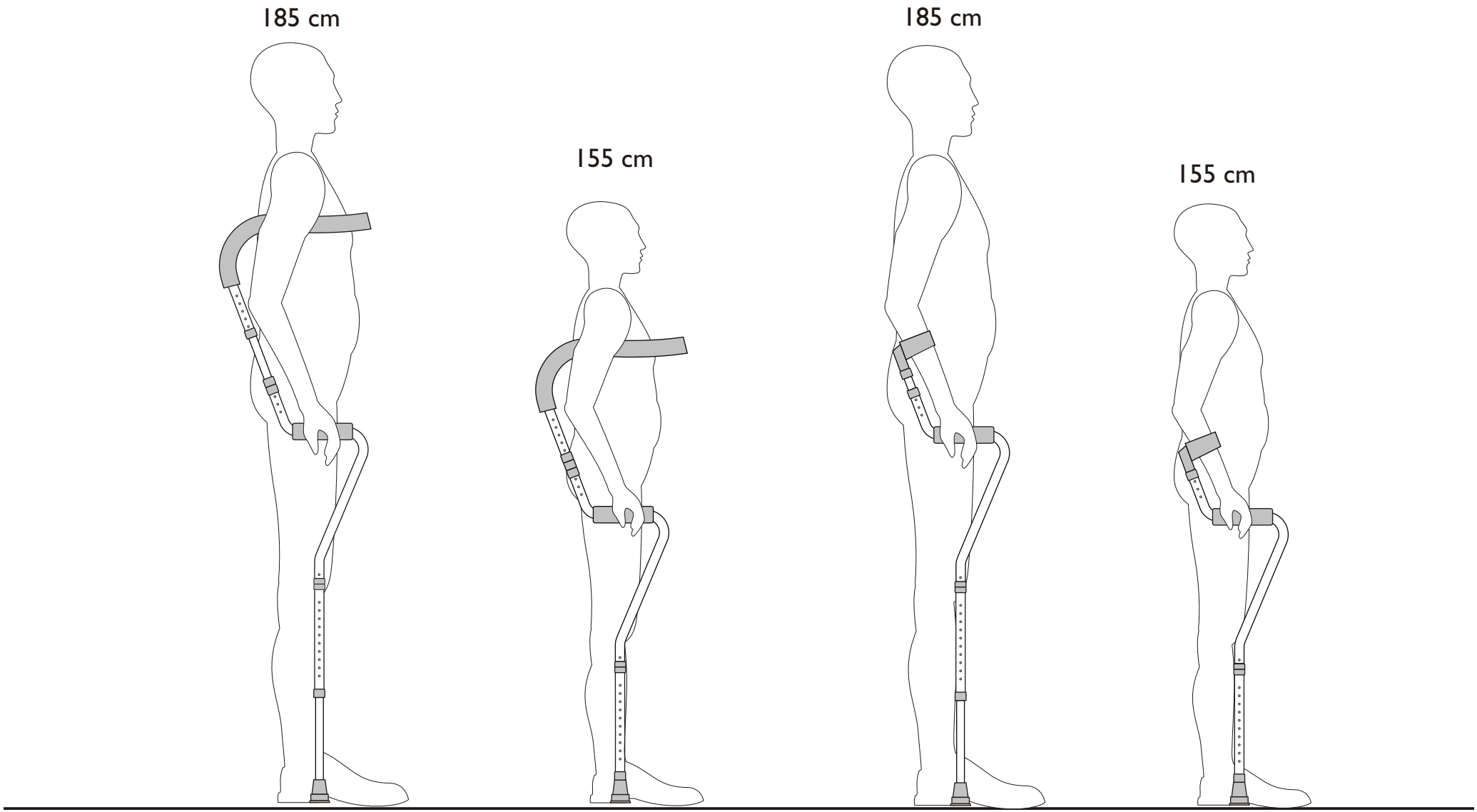
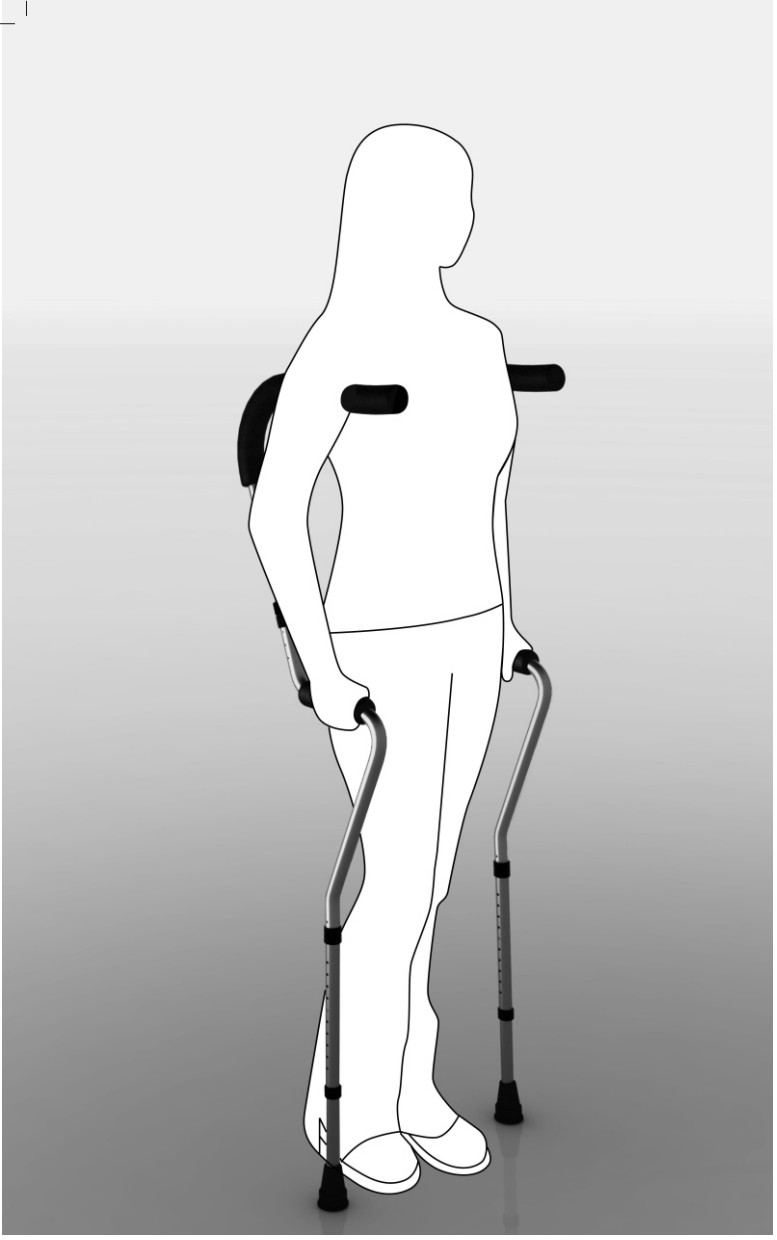


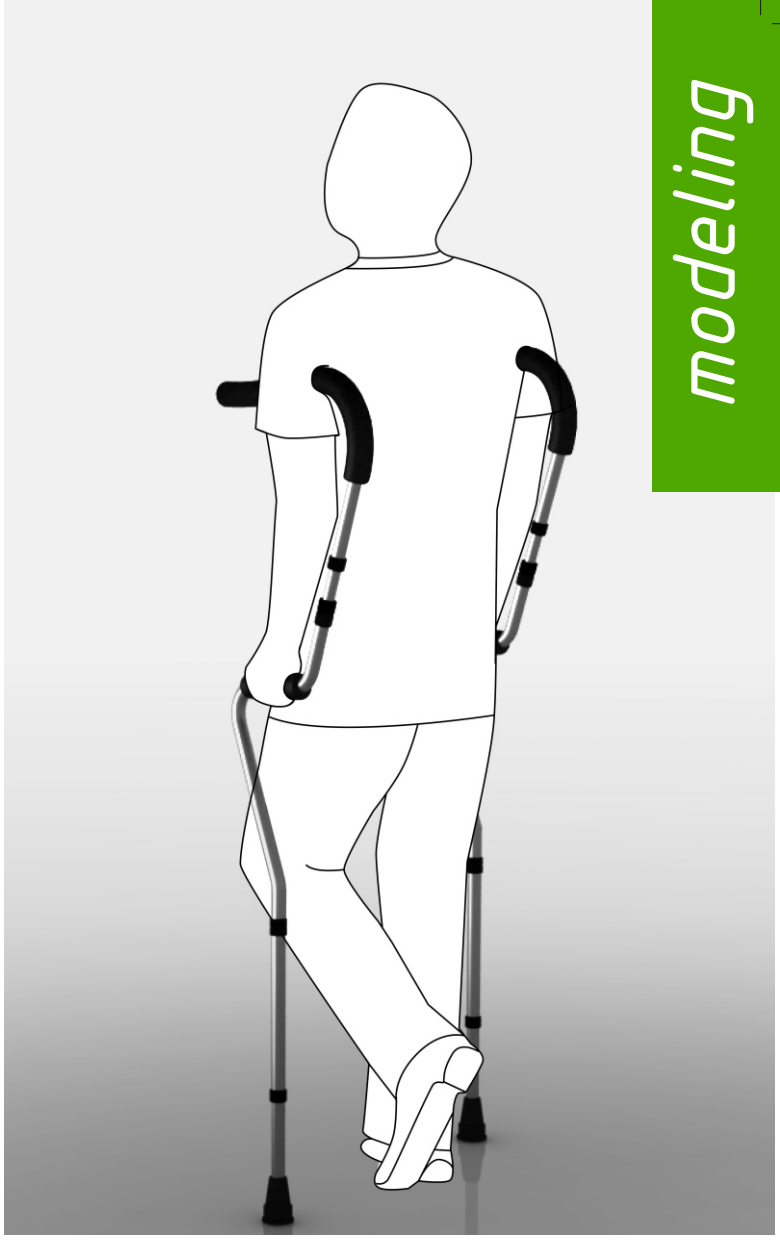
Figure 36.

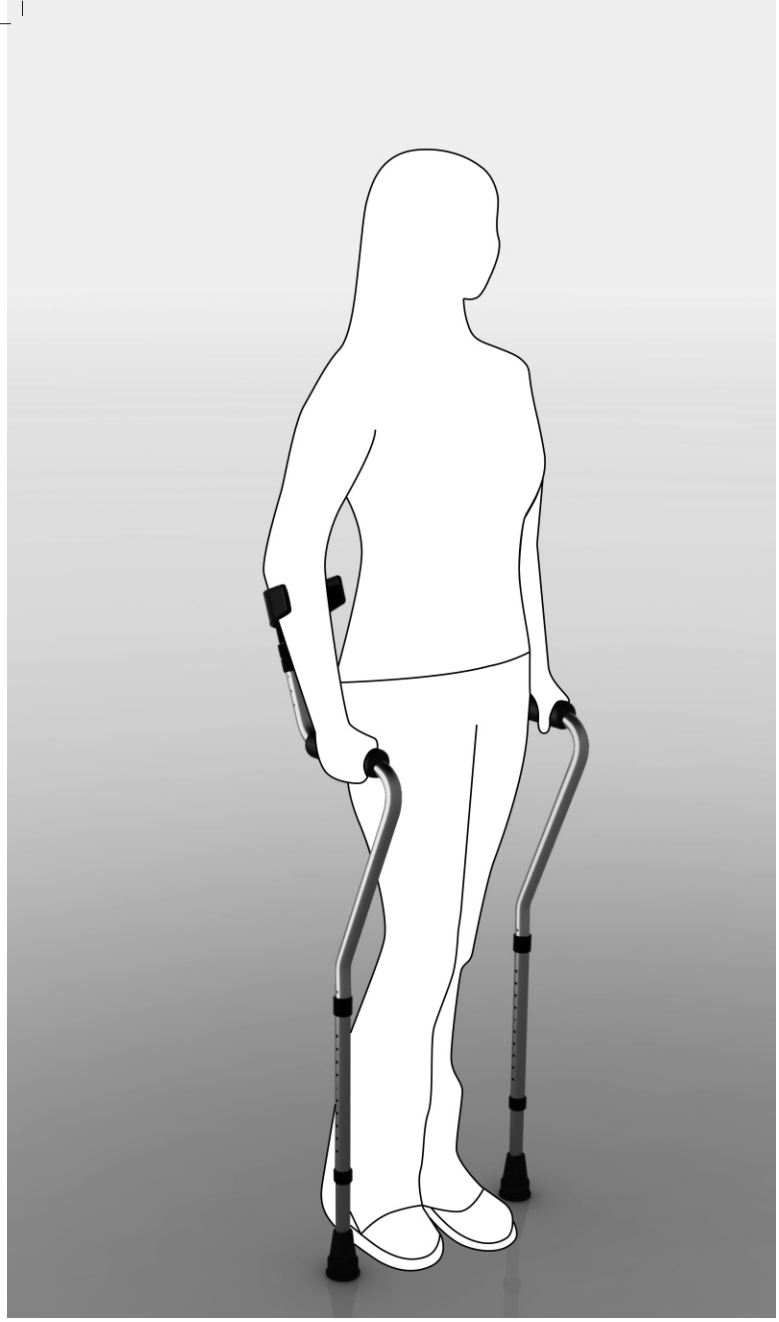


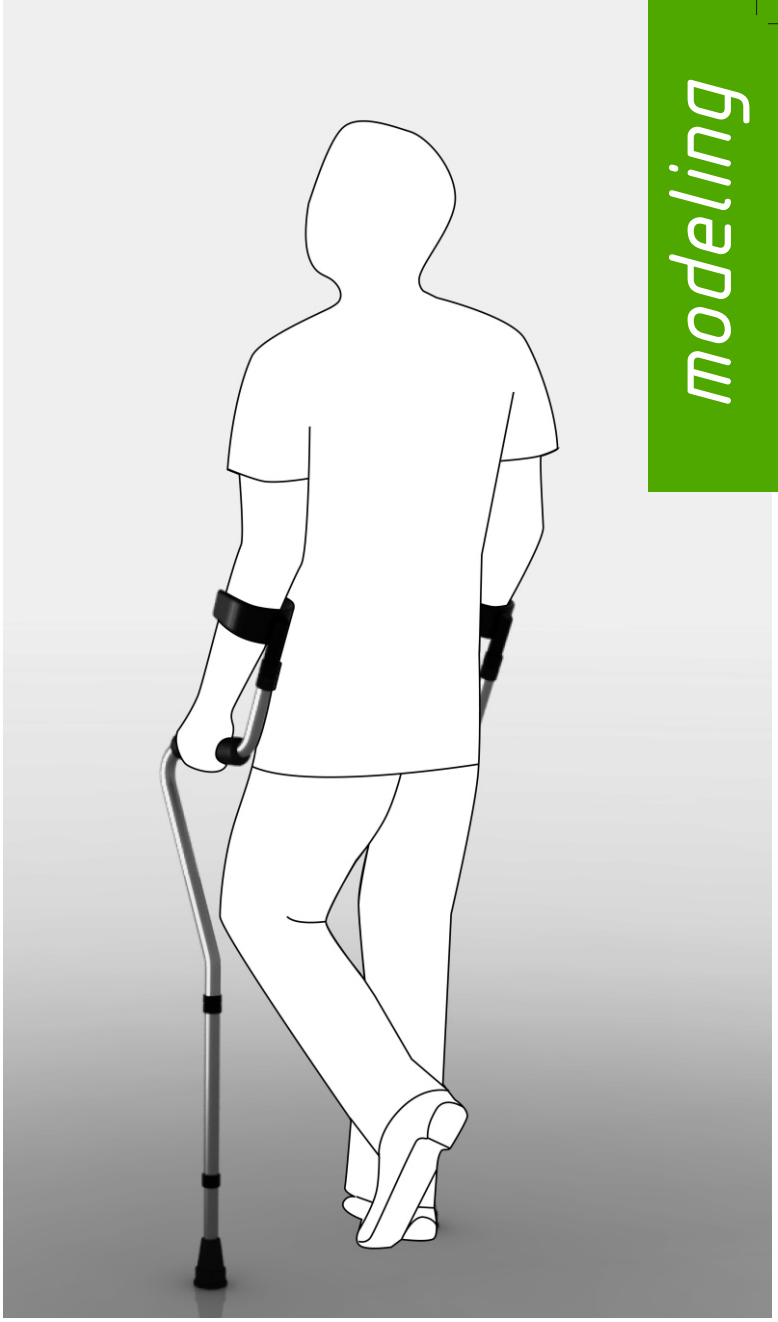
Body heights

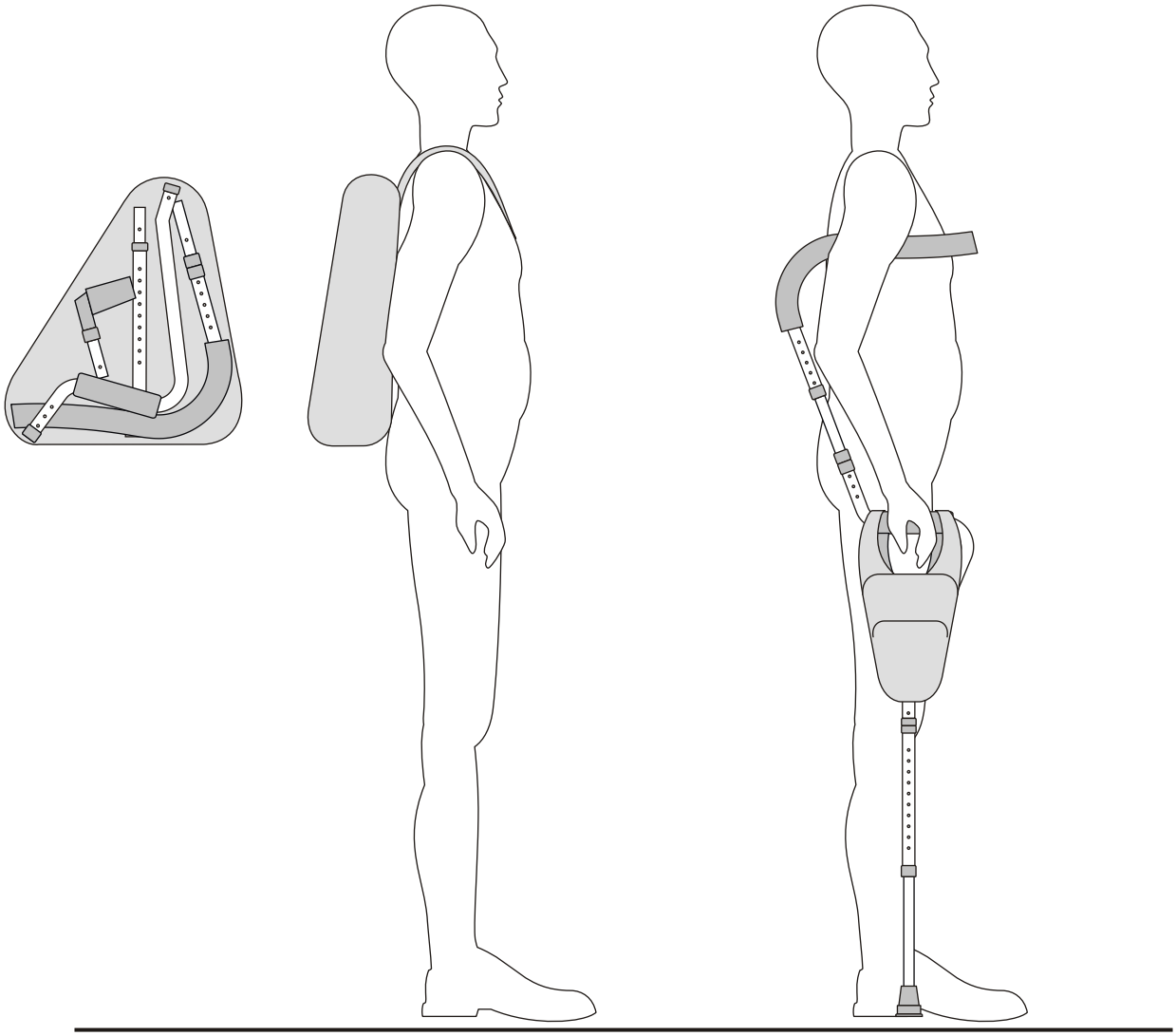




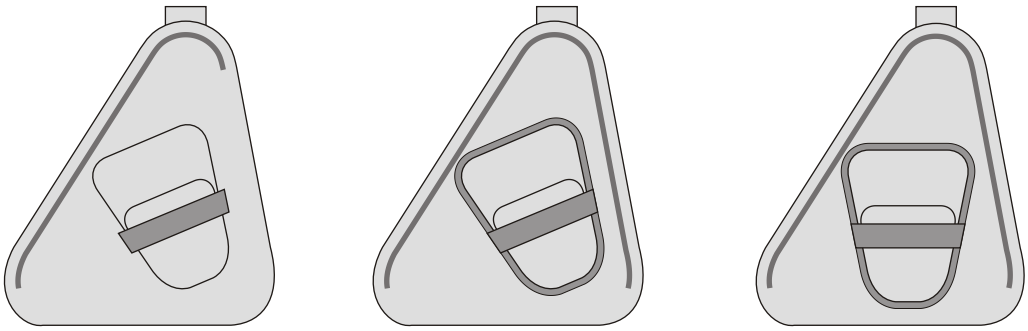


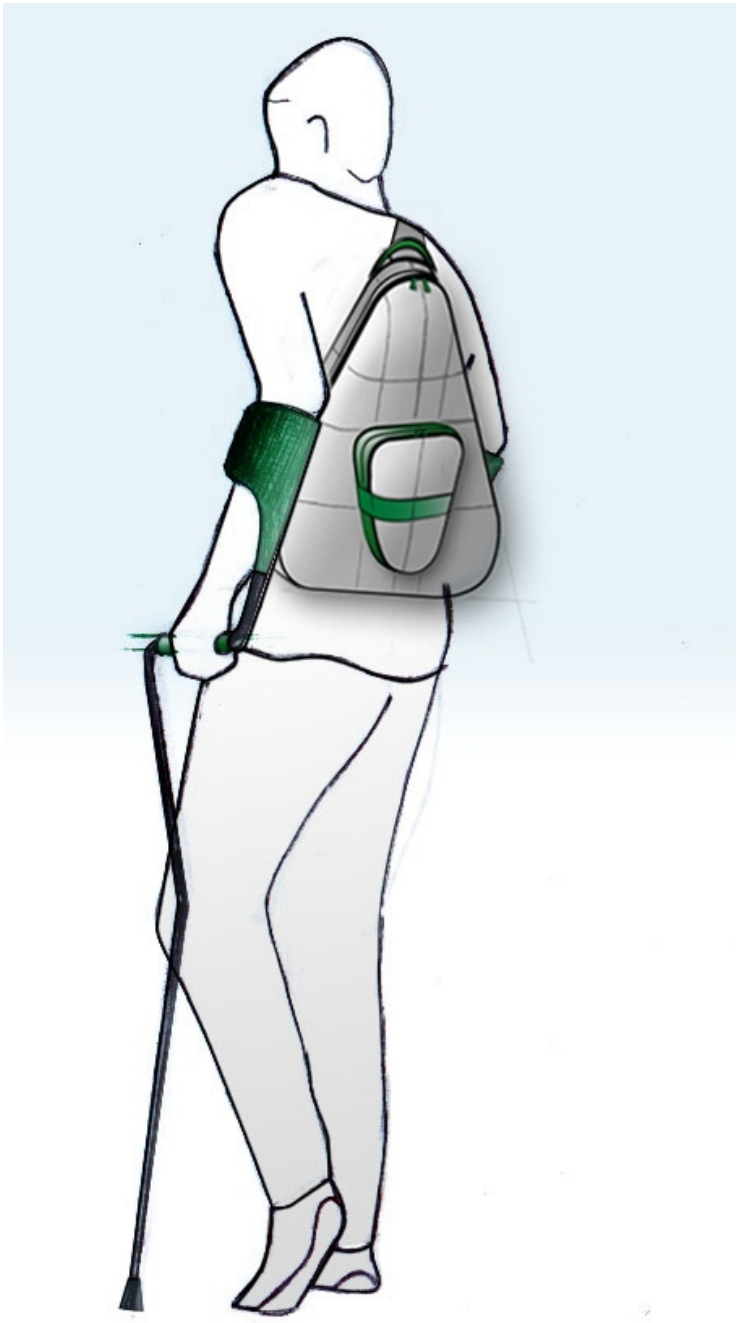


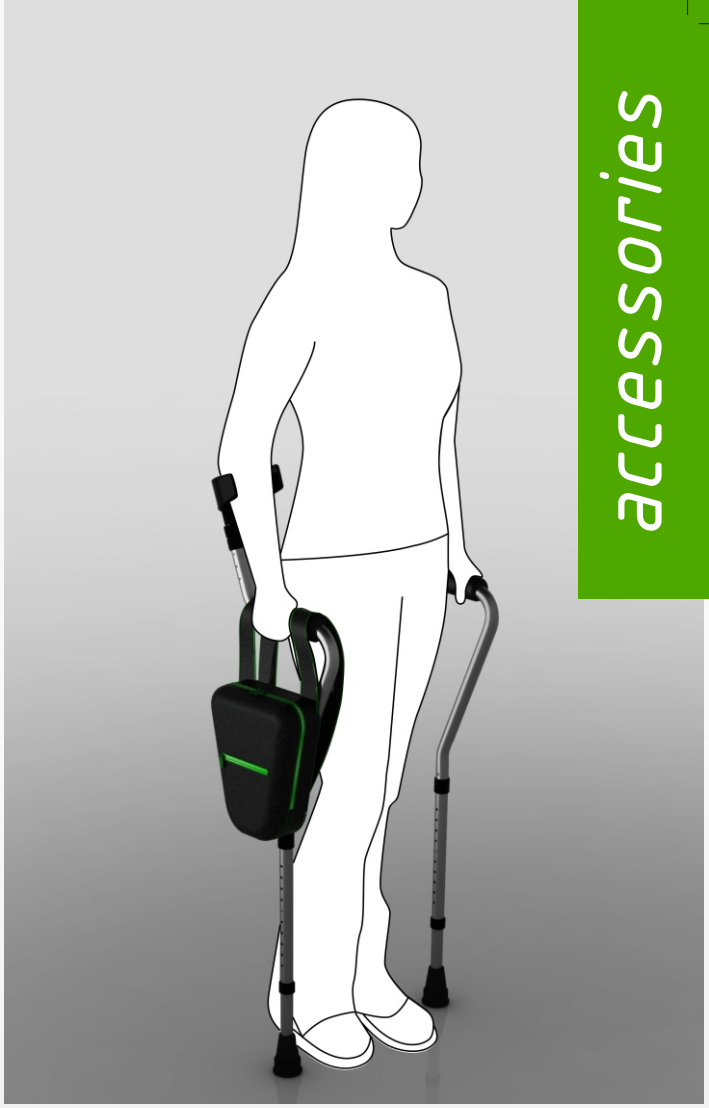




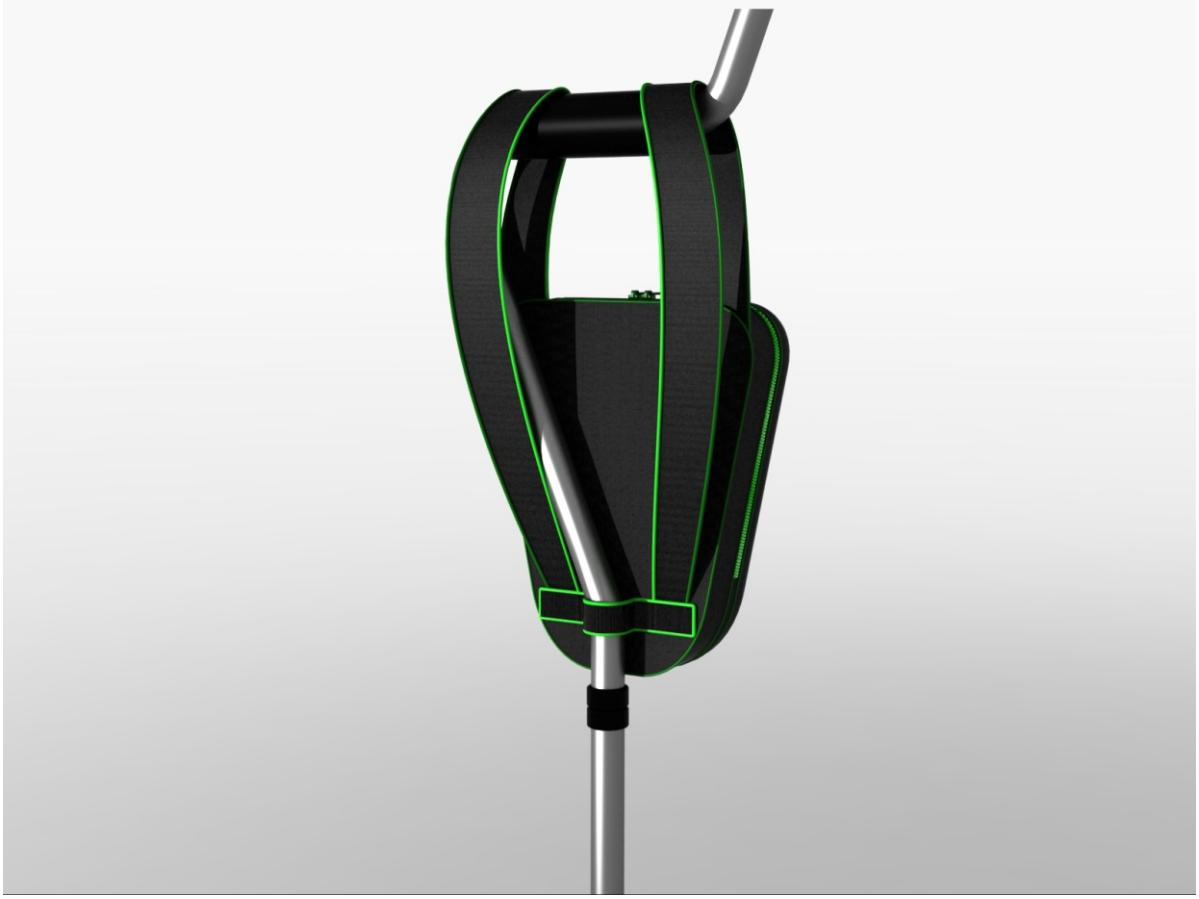
Both - the backpack and the crutch bag are made of two-layered textile filled with foam rubber to keep their shapes.
The front of the backpack is made of plastic covered by textile to keep debossed shape.



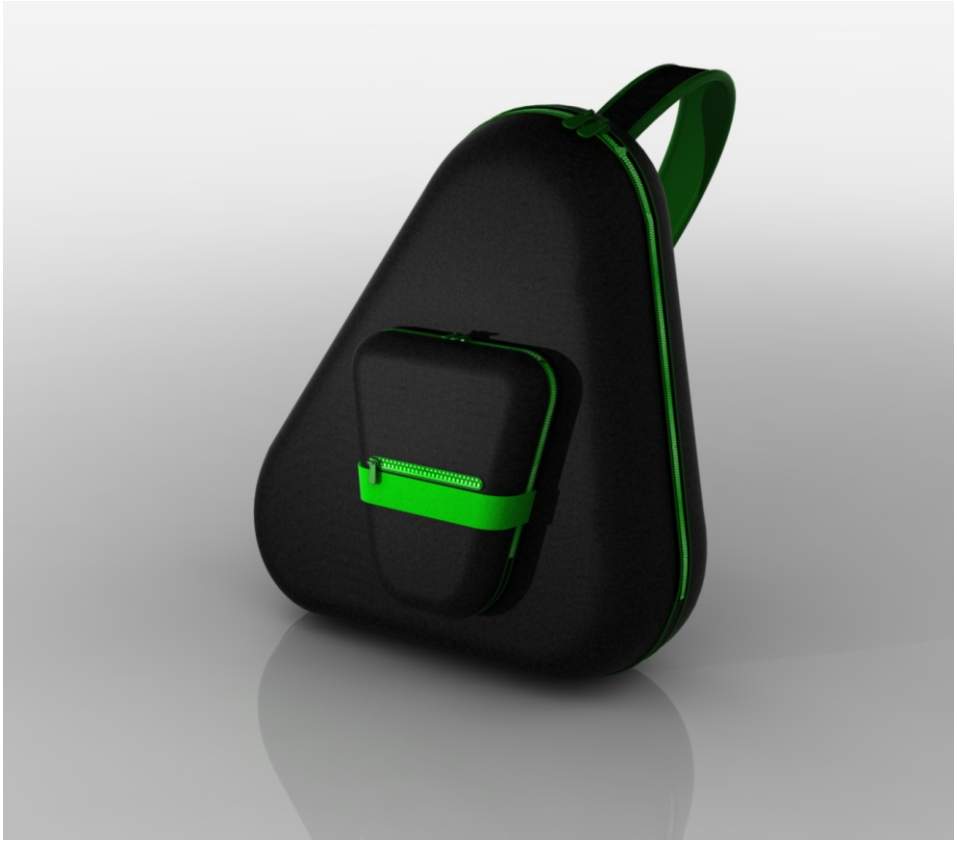




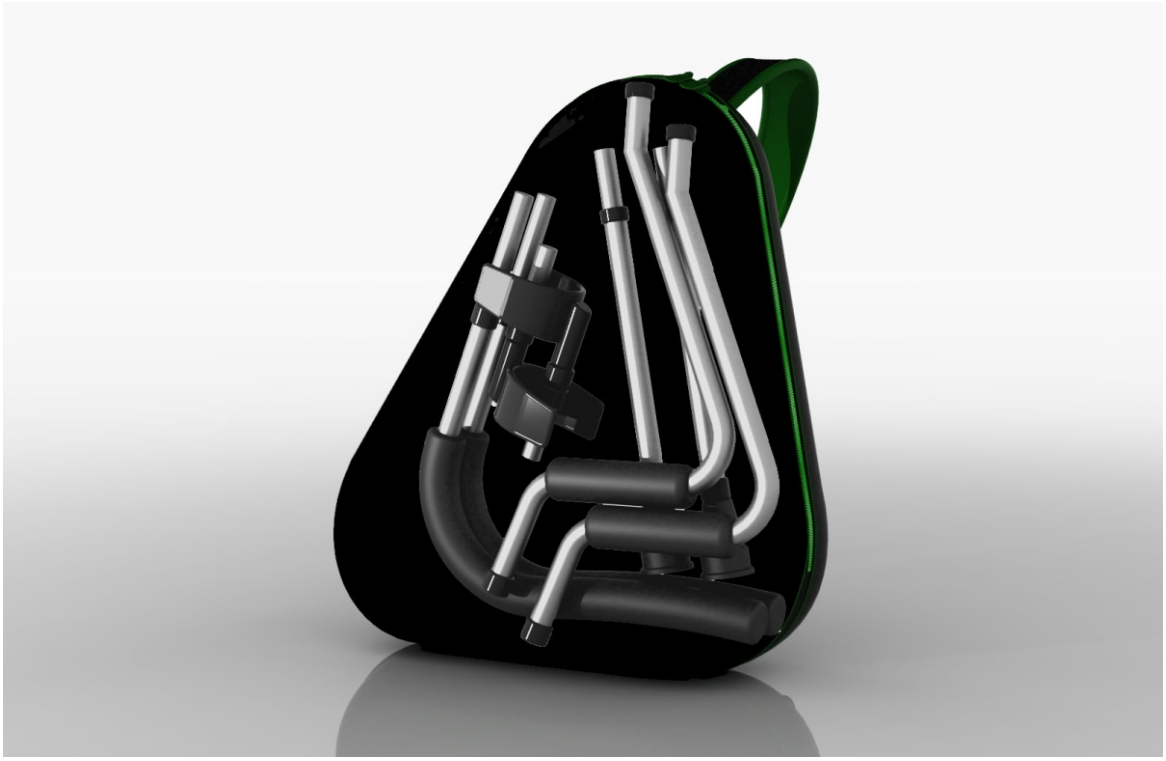
The crutch bag is attached to a crutch by two straps with velcro on their end. The inner side of straps is from non-slipery material to protect them from sliding from a foam handle. It is very important to avoid swinging of the crutch bag while walking.



The backpack and the crutch bag can be attached together and be carried on the user's back. The front of the backpack has debossed shape of a crutch bag for better attachment. There is a wide rubber stripe to hold the crutch bag in its' place. For comfort and better stability reasons it is advisable not to wear crutch bag on a crutch while wearing backpack.



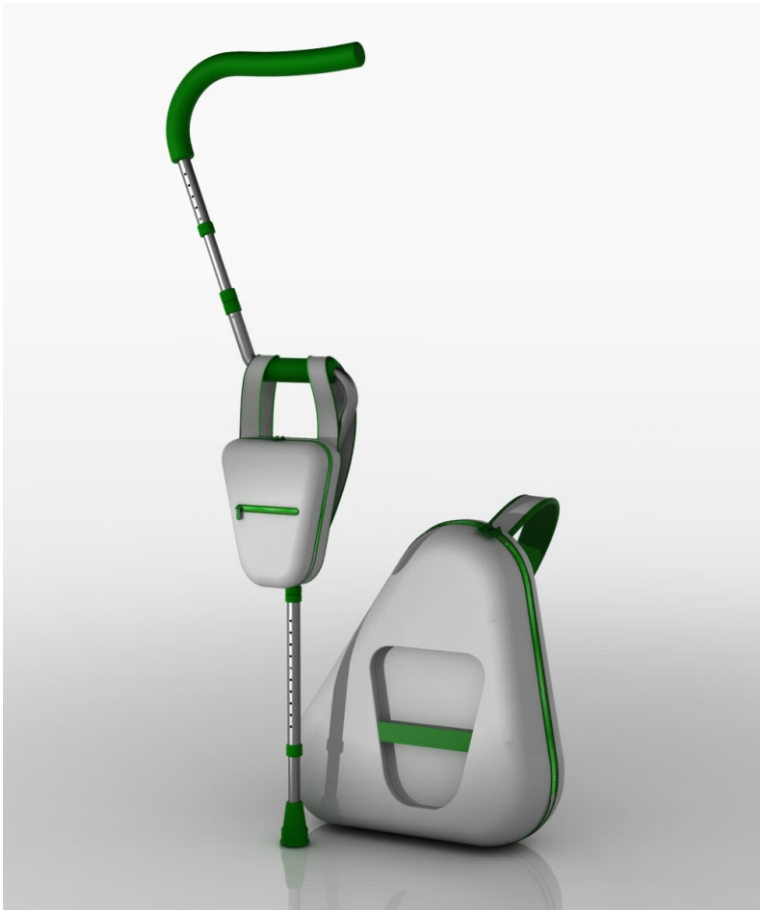
The backpack can be used for carrying spare parts of crutches, personal things, going shopping.
Two disassembled crutches can easily fit into the backpack and can be stored or transported.



The backpack has one shoulder-strap to make it possible to reach things in it by not taking it off a back. The backpack can be easily pulled to front (on the belly).

color proposal

color proposal



conclusions & future work

The mock-up to test the solution of a crutch was built. The first step was to produce a one-peace crutch to test the shape, stability and if it can support user's weight.
After testing it, it was clear that the shape works as it was expected. Moreover, the chosen shape gives more possibilities than it was expected – it gives not only good stability and mobility, it also is very weight balance itself – it is easy to hang a crutch or carry it.

Later, the transformable mock-up was built and also tested.

The overall aim of this project was to make an everyday life for people with reduced mobility better.
The suggested solution fulfills the aim of this project and match the design criteria described in the research part.
This crutch helps its users to perform everyday activities easier and feel more comfortable.
It provides:
- better mobility,
- better stability,
- comfort.
It gives:
- possibility to switch from one type of the crutch to another, that not only allows stressed body parts to relax, but helps a user to be able to perform different actions,
- possibility to carry things when using crutches,
- possibility to travel long distances more comfortable.

The appearance of a crutch is also very important to users. It has to support their self-esteem and do not "scream" about being an assistive device.
This concept gives possibility for a user to choose individually between color, material, accessories.
When a user has opportunity to modify and personalize his assistive device, then he likes it better.

This project of the transformable crutch was focused on short-term users, but it suits for long-term users too. The suggestion would be to remove height adjustability function and cut it individually according to user's body measurements.

Future research and development of this project:

- to look more into ergonomics and materials of the hand-grip

- to test shock absorption and energy efficiency in practice

- to test the time needed for assembly and disassembly of the crutch

- to experiment on materials for the body of the crutch

- to test with both, short-term and long-term users

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appendixes

Long-term users' comments (summary):

- Device needs to give the stability (at my forearm)
- It needs to take pressure off my wrist
- Needs to give enough room for a coat or a jacket
- Not bulky
- Good cushion is very important
- How awful they are!
- At my weight, the aluminium ones crack on the armpit because they're made of plastic so wood is the obvious choice for me. Most people pitch aluminium, but I would choose wood anyway: you don't get burned from hot aluminium in the summer or frozen aluminium in the winter.
- In addition to the strength of the crutch, weight of the crutch is a factor too. For me, I prefer a little weight to let me 'feel' the swing of the crutch and when it makes contact with the pavement.
- The adjustment holes soon would "egg-out" from the tremendous amount of applied torque. Before they failed completely they clicked and clacked with every step
- My parents bought the available rubber crutch tips by the case because the hollow end of the crutch tube would catch the floating metal washer inside the tip and eject it through the side wall causing the tube to die-cut through the bottom. This would often send me flying to the ground.
- It's easy to see the same challenge apply to a head of household injured and now unable to carry the required items to work. I can live without my mp3 player and the rest of my junk for a few weeks, but if my daily livelihood depends on it, it stops being a matter of convenience.
- Almost twenty years ago I was searching for crutches that were colorful-I was sick and tired of the "crippled grey" crutches. At the time my crutches were adjustable, where the holes for adjustment were, they would shear from the aluminium. I could see the adjustment hole expanding daily. So, not only were my crutches not good looking but everyone could hear me coming from a hundred yards away!
- I will admit to being a little vain when it comes to how my crutches look. Maybe that's why I have over six different pairs of custom crutches.
- The added stability based at the forearm cradle lends strength to my torso area and provides me with an ergonomic/natural walking posture, minimizing my need to apply pressure on my painful wrist and thumb joints.
- the length adjustments are as easy as pushing a button and turning a ring. The wider rubber tipped base has the unique ability to splay-out upon pressure, giving added stability and manoeuvrability. The tip and rubber grips are latex free which is an added plus for those of us with latex allergies.
- Many crutch users want their crutches to be compact for travel or storage.
- The suggestion by one of the crutch testers is to place a small reflector on the end of the handgrip and on the back of the forearm cuff for visibility at night.
- My crutches elicited that "pity look" when I was out in public. I painted and decoupage my crutches with Native American power animals, and I hung feathers and beads from the handles. As far as the underarm crutches, these tend to take more energy to use than forearm crutches and can cause problems with long- term use. I suggest sticking to the FA crutches for now, as you are learning. I say this because I think UA crutches can cause one to learn bad habits in a way that FA crutches don't, and don't give you the full benefit of using your body the way you need to if you want to learn to walk again. It may just be me, but though I do use UA crutches on occasion, I find that my posture is actually better with FA crutches rather than UA crutches, as I tend to get lazy and stoop with the UA crutches.

Short-term users' comments (summary):

- Under-the-arm crutch can damage some of the nerves and for females they rub against bra straps making them thoroughly uncomfortable to use.
- More stability and limited arm fatigue is important.
- Larger Tip (maybe from a rubber)
- Comfortable grip
- The foam keeps the device from sliding off of tables, chairs and walls it's set against.
- The traditional crutch design is often modified by users who wrap padding, duct tape or even socks around the top portion to make it more comfortable.
- Suddenly, when you are forced to use crutches for more than a month, all everyday activities become an issue, f. ex. carrying your notebook.
- It would be nice to change a type of crutch sometimes.
- The wrist support should not interfere with wrist-watch.
- Personally, I choose crutches more often than my prosthesis, which I turn to for certain occasions when I prefer appearance to comfort, but I know my preferences stem from my rather poor performance potential as far as prosthetics are concerned.
- I only use them to get in and out of the shower, but I would think that all amputees should own a pair of crutches for the occasional unexpected need. All that hopping really isn't good for the joints. I do some short hops, but very few.
- Most part of day I'm on forearm crutches - especial for outdoor activities I use prosthetic only when I need arms free.
- I use crutches every day, mostly in the late evening. But I really don't spend a whole lot of time on them. Oh, and I use them to get to my bike at the start of a race. A really big plus for these is that they match my dirt bike and look kinda cool!!
- What I mean is, I have used this type (underarm crutches) many times in the past, so I know these problems don't set in with limited use. I am only on crutches, usually, for a few seconds at a time, to get from A to B. Most of the time, this distance is no more than 30 feet, but usually a lot less. Even our master bath is so close that I don't use them even to go to the "loo" and really would like to keep the ability to carry such things as a drink. I've never used the Canadian style crutches (forearm crutches), but it seems that carrying a drink would be out of the question. Also, when I am using crutches and not carrying anything, I bare no weight in my armpits.
- Full cuffs are designed so that your arm will slip through the gap in the cuff, if you happen to fall, so that you can save yourself with your arms. My arms are so muscular that my arms don't slip through the gap & that's why I use crutches with half cuffs. Although, I personally wouldn't use a full cuff that didn't articulate, as I think that would be very dangerous...for me, anyway.
If you use a half cuff, your fingers support the crutch for a short period of time during your walking cycle; it's not a big problem, it just takes a little bit of getting used to.
- When I was using axillary crutches I'd carry stuff in a backpack or a bike messenger bag slung around my shoulder. Same thing works for forearm crutches.
- My PTA told me that forearm crutches are much safer to use because you run the risk of jamming the axial crutches too far into your armpits which could cause permanent damage to the nerves running through there.
- armpit crutches are harder to use than forearm but easier to learn how to use them in the beginning.

- I've used crutches for decades. Started on axial and still use them. You can do a lot more with your hands. I like that. Also you can use your upper body to pull up your lower body when you are out in nature. IMO they are better for doing what you want and need to do.
- Be aware though ANY crutch tip CAN and does hydroplane. Doesn't matter which type they are.
- New users jam the top into their armpits and then lean over to keep attached to it. That is the problem with being new to them. They do require arm strength and some trunk strength to use them properly and successfully in most any situation you encounter.
- For everyday walking the forearm crutches are sufficient. But they don't do well in climbing dirt hills or steep steps and a whole lots of other stuff.

I kept thinking maybe armpit crutches would be easier, you could hold things while you walk around that you can't with forearm crutches. Forearm crutches also stand out.

Researchers/Doctors comments (summary):

- Most people with arthritic conditions find it very painful to apply pressure to their wrist and thumb joints while grasping a device handle to ambulate or maintain their balance.
- The traditional crutch design is often modified by users who wrap padding, duct tape or even socks around the top portion to make it more comfortable.
- Modern medicine demands an ergonomically designed, comfortable crutch that helps the patient maintain proper posture, relieves damaging stress, and reduces the overall chance of injury.
- Conventional crutches are not ergonomically designed, and their users run the risk of serious injury.
- Static overloading results when muscles, especially those of the hand and the extensor muscles of the wrist, are traumatized or overstressed repeatedly over time. Injuries common to long-term crutch use include carpal tunnel syndrome, wrist tendonitis, medial epicondylitis or lateral elbow epicondylitis and rotator cuff muscle strains and tears. These injuries result from cumulative stresses on tissues and joints and excessive muscular contraction that impedes blood flow. Other parts of the body, such as the back and the shoulders, are also adversely effected by unnatural stress and increased loads. In addition, long-term crutch use causes fatigue and discomfort, which increases the risk of additional injury from unsafe use.
- Modern medicine needs an ergonomically designed, comfortable, user-friendly crutch that maintains proper posture, relieves damaging stress, and lessens vasoconstriction and compressive forces, thereby reducing the overall chance of injury to the user.
- Ergonomically designed devices mimic the natural angle of the body, thus reducing stress to joints and muscles (natural grip).
- When the hand is forced into an unnatural position, the third metacarpal bone no longer aligns with the radial bone. This causes the muscles and joints of the hand and wrist to be traumatized and overstressed (unnatural grip).
- Since the user relies less on the underarm support, there is a reduction in back and shoulder stress.
- Users of under-arm crutches are essentially doing a push-up with every step. Moreover, under-arm crutches can actually cause injury through repetitive stress on the hands, wrists, and arms. These crutches can also damage the Brachial Plexus, the network of nerves that control the muscles of the shoulder and arm.
- The Right Grip Crutch Handle
- Eliminates Pressure Points
- Ergonomically Designed
- Right & Left Design
- Reduces Muscle Fatigue
- Prevents Carpal Tunnel Syndrome
- Prevents Numbness & Pain
- By making crutches without adjustment holes the strength and durability is substantially increased and they are forever silent because there are no moving parts. They are also much lighter than manufactured crutches and will even float on the surface of water.
- They need to be supportive of the user's weight, facilitative of shock absorption and energy return, durable, lightweight, easily maneuverable, able to remain attached to the user while he or she is reaching for a door or shaking hands, comfortable, quiet, and supportive of a user's self-esteem.

- "Kids with spina bifida and other degenerative disorders have very little strength in their lower bodies. They have to lean their entire weight on those crutches, and it's very hard on their wrists. Every couple of years, they have to have reconstructive surgery." Not only did the crutches cause wrist pain, but the steel cuffs tended to bruise the kids' arms when they fell down.
- Long-term crutch use--years and years of it--leads to wrist difficulties like carpal tunnel, tendonitis and overuse," he says, "though it's more well-documented in the adult literature. [A different crutch] would potentially be helpful in terms of prevention of difficulties.
- When crutches do not fit well or are not used correctly, they can cause damage to nerves in a person's armpit (axilla) from excess pressure. This often happens because the crutches are not properly adjusted and allow people to bend (flex) their elbows too much. This puts too much pressure on the armpit, not hands (where the pressure should be).
- People who bend their elbows too much while walking with crutches, may have a less-efficient gait. But if they know to bend their elbows just slightly, people can use their arm muscles to vary gait speed and change the length of their stride.
- It is important to keep the arms straight rather than flexed. The common procedure for fitting traditional axillary crutches is to have an elbow angle of 10 to 30 degrees of flexion, often vaguely described as "the elbow should be slightly bent." Because smaller muscles such as elbow extensors are inadequate to support the body's weight, they fatigue more rapidly than larger muscles. Keeping the arms straight prohibits the up and down motions caused by bent elbows, and encourages the use of the larger triceps and pectoral muscles.
- When the person is able to stand more erect and not lean forward, this more vertical position allows a greater percentage of the crutch tip to make contact with the floor or ground, providing increased stability as well as smoother transition from step to step.
- The forearm and underarm have such different lengths-I'm not sure it would work but being able to switch positions and rest is a great idea.

Terminology

Brachial Plexus - is an arrangement of nerve fibres, running from the spine, specifically from above the fifth cervical vertebra to underneath the first thoracic vertebra. It proceeds through the neck, the axilla (armpit region) and into the arm.

Carpal tunnel syndrome - medical condition, in which the median nerve is compressed at the wrist, leading to pain, paresthesia, and muscle weakness in the forearm and hand.

Flexor retinaculum of the hand - (transverse carpal ligament, or anterior annular ligament) is a strong, fibrous band, which arches over the carpus, converting the deep groove on the front of the carpal bones into a tunnel, the carpal tunnel, through which the Flexor tendons of the digits and the median nerve pass.

Lateral elbow epicondylitis - Tennis Elbow or Lateral Epicondylitis is a condition when the outer part of the elbow becomes painful and tender, usually as a result of a specific strain, overuse, or a direct bang.

Ligament - is Fibrous tissue that connects bones to other bones.

Medial elbow epicondylitis - is pain and inflammation on the inner side of the elbow, where the tendons of the forearm muscles attach to the bony bump on the inside of the elbow.

Muscular contraction - during muscular contraction the contractile elements exert a force inward upon themselves; the muscle diameter increases as it shortens. During intense muscular contraction, this force inward momentarily occludes the vasculature, backing up blood flow through that particular muscle group. A compensatory increase of blood pressure forces plasma from the congested capillaries into the interstitial spaces of the muscle cells

Orthopaedic impairments - concern disorders of bones, joints, and associated muscles, tendons and ligaments and physical disability; and include spinal curvature, limb deficiencies, talipes (club foot) and juvenile rheumatoid arthritis. Some definitions of orthopaedic impairment include neuromotor impairments such as muscular dystrophy, cerebral palsy and neural tube defects, which, like general orthopaedic impairments, can limit movement and may require similar educational and therapeutic provision.

Osteoarthritis - is a condition in which low-grade inflammation results in pain in the joints, caused by abnormal wearing of the cartilage that covers and acts as a cushion inside joints and destruction or decrease of synovial fluid that lubricates those joints. As the bone surfaces become less well protected by cartilage, the patient experiences pain upon weight bearing, including walking and standing. Due to decreased movement because of the pain, regional muscles may atrophy, and ligaments may become more lax.

Paresthesia - is a sensation of tingling, pricking, or numbness of a person's skin with no apparent long-term physical effect, more generally known as the feeling of pins and needles or of a limb being asleep.

Polyarthritis - is any type of arthritis which involves five or more joints an inflammation of two, three or four joints is an oligoarthritis.

Rheumatism - is a non-specific term for medical problems affecting the heart, bones, joints, kidney, skin and lung. The study of, and therapeutic interventions in, such disorders is called rheumatology.

Synovia - joint fluid.

Vasoconstriction - is a narrowing of the blood vessels resulting from contracting of the muscular wall of the vessels. When blood vessels constrict, the flow of blood is restricted or slowed. It is the opposite of vasodilation, the widening of blood vessels.

Wrist tendonitis - is an irritation and swelling of the tissue or 'tunnel' which surrounds the tendons of the thumb. Pain in the front of the wrist is a common symptom of tendonitis. Bending and extending the wrist is usually painfulh; there may be swelling in the wrist.