# Knee Traction Device

## Product Design Specifications

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*Client*: Kim Skinner

**Problem Statement:**
With the growing need for knee replacement surgery, finding methods to stave off risky operations is becoming increasingly important. Knee replacement surgery, in particular, is rarely a one-shot deal, often requiring multiple replacements, physical therapy, and frequent doctors appointments throughout the life of the patient. Mechanical traction is used as a treatment intervention for degenerative joint disease, particularly in the knee. Our goal is to create a device to offer rehabilitative joint distraction for those with chronic knee problems while aiming for simplicity, portability, and affordability.

**Function:** The device will provide mechanical distraction to the knee joint by gently separating the upper and lower portions of the leg.

**Client requirements:**

- The device must be affordable, i.e. within a $400 project budget.
- The device must be easy to transport, i.e. lightweight and compact.
- The device must be aesthetically pleasing.
- The height of the device must be adjustable.
- The angle must be adjustable around 30°.
- The force applied to separate the joint should be adjustable around 311.4 N (70 lbs).
- The device should be comfortable to use.
- The device should be simple to operate and suitable for home-use.
- The device should be designed with marketability in mind.

**Design requirements**:

**1. Physical and Operational Characteristics**

a. *Performance requirements*: The device is intended for daily use, at approximately 20 minutes per application. It should be able to provide a constant, consistent force to separate the joint, approximately 311.4 N (70 lbs). It must also be comfortably usable by a wide range of patient sizes and weights.

b. *Safety*: The device will provide mechanical distraction at the knee joint, and as such, care must be taken that any potential failure will not harm the user. Padding will be used where necessary, and no sharp edges/points will come in contact with the user. In addition, care must be taken to not inadvertently distract the hip or ankle joints.

c. *Accuracy and Reliability*: The device will include a gauge to measure the applied force, and must be designed to administer up to 311.4 N (70 lbs) of force consistently for around 20 minutes, several times a day.

d. *Life in Service*: The device should be able to reliably operate for at least ten years under daily usage with the possibility of minimal maintenance.

e. *Shelf Life*: Provided the device is stored under reasonably temperate conditions (i.e., within the home), one should expect it to last indefinitely when not in use.

f. *Operating Environment*: The device is intended for home or clinical use, by anyone from patients to licensed physical therapists.

g. *Ergonomics*: The device is intended for use on a human leg only. The height, knee angle, and applied force will be adjustable to suit most, ideally all, patients. The design of this prototype will be based off of an anthropometrically idealized human 1.72 m tall and 70 kg in mass.

h. *Size*: The device should be compact, collapsible, and designed in such a manner that it may be unobtrusively stowed. It will be designed to be adjustable around an average chair height of 48.26 cm (19 in).

i. *Weight*: The device should be designed with elderly patients in mind, therefore it should be as lightweight as possible. However, durability will not be sacrificed in pursuit of lower weight.

j. *Materials*: Materials must be lightweight, yet durable. They must also be non-irritable since the device will be in contact with bare skin.

k. *Aesthetics, Appearance, and Finish*: Given that potential marketability is a goal, the device must appear polished and aesthetically pleasing.

**2. Production Characteristics**

a. *Quantity*: One prototype, with reproducibility in mind

b. *Target Product Cost*: $400 or less

**3. Miscellaneous**

a. *Standards and Specifications*:

- FDA approval
- Possible IRB approval for human testing

b. *Customer*: The device is intended for patients suffering from osteoarthritis in the knee. No two patients have the same body size or type, and thus the device must be usable by a range of customers.

c. *Patient-related concerns*: The device must be both simple to operate and comfortable to use frequently so that the patient is not under any additional discomfort than they already are with osteoarthritis.

d. *Competition*: Similar products exist for other joints of the body, and surgical knee distraction devices as well. However, no home or clinical use devices are on the market.