A Preliminary Study and Designing of Smart Cushion

The Sitting Theory

This paper 1 proposed the necessary conditions in good posture:

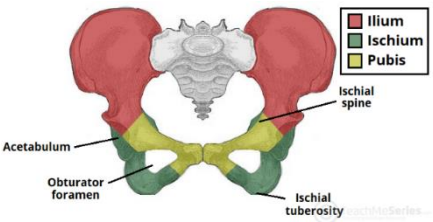
If people sit on a chair in a way that is not in the natural shape of the spine and dividing the weight unequally, the inter- vertebral disc is subject to an abnormal pressure distribution, which can cause waist discomfort over a long time.

When the angle between the trunk and thighs maintains about 115°, **the spine is close to the natural shape**, while the lumbar part must be supported. Body mass divide around the body's center of gravity, subject has an increased probability of stability.

People who use a back about 90° will **feel uncomfortable**, because the trunk upright sitting posture will produce a lot of spine twisting force, at this time the weight of the upper body will also have a negative effect on the lumbar spine. The posture with trunk forward will straighten the originally lordotic lumbar, and makes it bend backward. This affects the normal curvature of thoracic and lumbar vertebra, leading to kyphosis (**Namkoong et al. 2015**). At the same time the increasing isometric trunk muscle strength for head supporting will cause fatigue in neck and back.

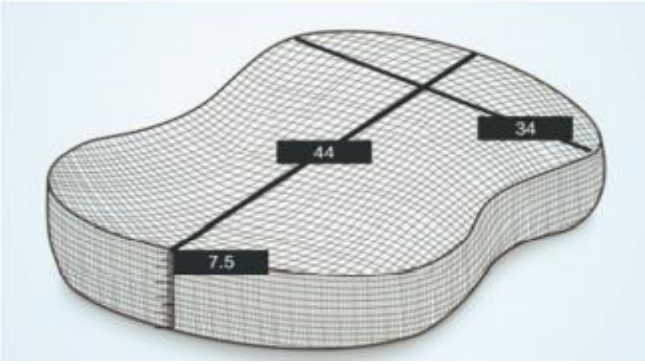
Right Posture of Sitting

Under upright sitting position, the center of body's gravity will deviate from the vertical of ischial tuberosities (about 2.5 cm in front of navel), which further aggravated the instability. Only by increasing the leverage effect provided by the legs and feet can people offset this instability. For example, sitting with leg crossed, arms relying on the desktop or supporting on the handrail, etc. are common ways to solve this instability. Good posture is often in a nearly natural state to balance the pressure of the body. Distributing your body weight evenly on both hips

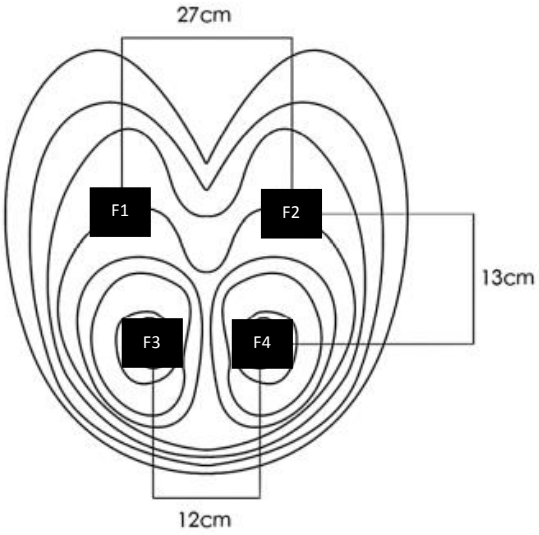


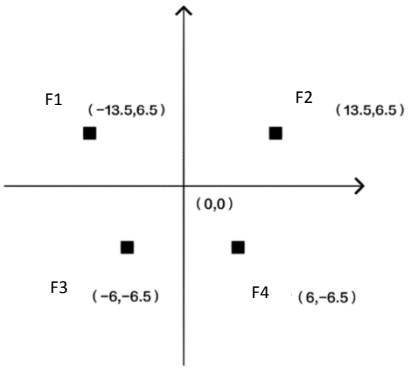
The Cushion Design

Based on study in paper **1** the size of general office chair and average human hip size, the overall dimensions of the cushion is 44 cm × 34 cm × 7.5 cm, as shown: -



According to general human physiological characteristics, referring to the distance between ischiums under upright sitting position, the placement of pressure transducer is shown: -





Design

With this design, the force applying on each FSR will be effectively measured and used to determine the pressure center of body along the x/y axis by differential method. According to the coordinates of the pressure center, the balance of sitting posture can be determined. We will perform tests to determine position of pressure center for balanced siting posture.

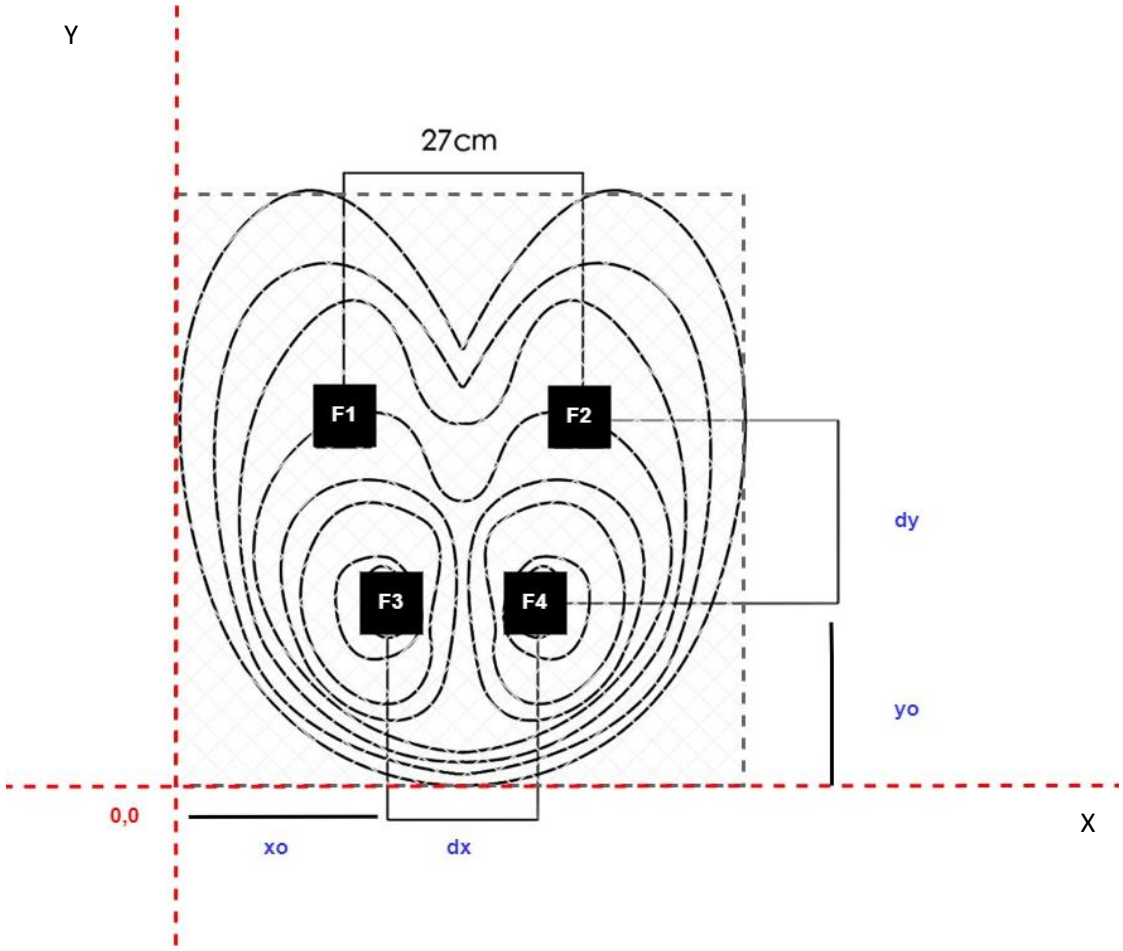
Calculation of pressure center (2)

For analysis purpose, the formula is built on the base of the following assumptions:

- Ignore the individual differences in the body part, and under the standard sitting posture trunk is both front-back and left-right symmetrical;
- The effect of non-observed variables such as the environment, physiological state of mutation and other uncontrollable factors on the observed quantities is small.

$$Xcop = xo + \frac{(F2 + F4)dx}{F1 + F2 + F3 + F4}$$

$$Ycop = yo + \frac{(F1 + F2)dy}{F1 + F2 + F3 + F4}$$



Reference

1 file:///C:/Users/HP/Downloads/Smart%20coushion-Research%20paper_4.pdf

2 https://www.resna.org/sites/default/files/legacy/conference/proceedings/2005/Research/JEA/Sachafer.html