The importance of force plate testing

Force plates are used to measure the reaction force applied to a substrate (usually the ground). While some force plates just measure vertical ground reaction force (vGRF), those used in full-body gait or motion analysis measure reaction force and moment in all three dimensions, called 6-axis. Force plates either use strain gauges (see AMTI) or piezoelectric elements (see Kistler) to measure the applied load. While they are fundamentally different internally, they behave similarly are are, for all intents and purposes, equally reliable. Some common sources of degraded force plate measurements that everyone who uses them **should** be aware of are:

1. Daily drift associated with temperature or small building shifts
2. Interference from surrounding substrates
3. Damage to the force plate system (including the plate, amplifier, and any associated wiring)

Deal with error in 3 steps

The three factors listed above will affect the integrity of the measurements, and three ways they can be detected and/or accounted for are:

1. “Zeroing” of the force plate channels immediately before recording session. This can be done digitally in the recording software or sometimes in an analog way, by tweaking voltages on the plate amplifiers.
2. Ensuring space between the force plate and surrounding substrate. This could be done by simply sliding a piece of paper all around the plate to make sure there is no contact around the edges of the plate (Sometimes the low-tech solution is the best!). If you frequently move your plates or surrounding substrate, you should do it each time something is moved. If everything is stationary, once or twice a month should be sufficient.
3. Verifying outputs with known loads and known directional inputs. This is the most robust way of testing plates. Whereas the first two steps helped find and correct small sources of error, this step will directly test the force plate’s ability to accurately measure the CORRECT forces and moments. The next section will go into detail on how to perform this part of the testing.

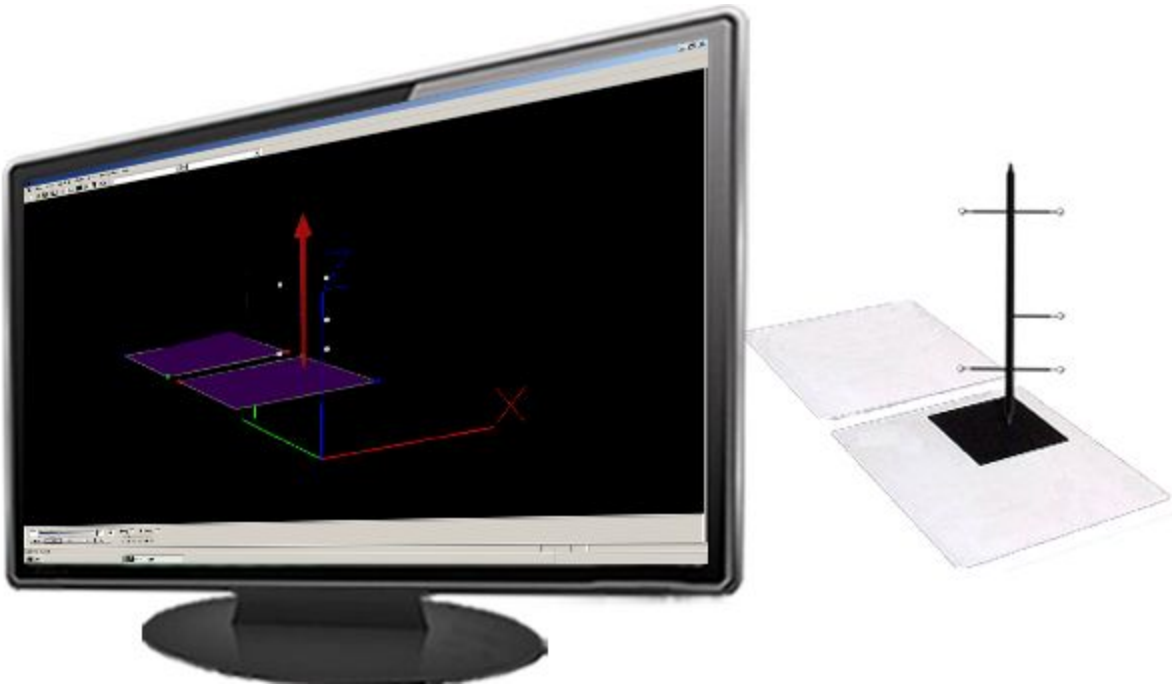
Accuracy testing

To exhaustively test the accuracy of the plate, you must ensure accurate reconstruction of the reaction force **vector**, meaning accurate **magnitude**, **direction**, and **location** of loads measured. There are multiple ways to go about testing these three aspects, which you can choose based on the equipment available. Here are two options:

1. Apply forces with rod instrumented with a load cell and motion capture markers to define the axis
    a. Compare magnitude of reconstructed vector to load cell in rod (load cell must be recorded and synced with motion capture/force plate system)
    b. Compare direction of reconstructed vector to rod vector measured by motion capture markers
    c. Compare the location of the tip of the rod vector to the measured center of pressure (CoP) calculated by the force plate.
2. Apply vertical loads using calibrated weights and, separately, apply directional loads using rod with motion capture markers.
    a. Compare magnitude of measured Z reaction force to actual Mass x Gravity of the calibrated weights (best to test a range of weights representative of the load ranges you expect to encounter)
    b. Compare direction of reconstructed vector to rod vector measured by motion capture markers
    c. Compare the location of the tip of the rod vector to the measured center of pressure (CoP) calculated by the force plate.

For all results (a,b,c), threshold values should be established to determine what level of error is acceptable. The results of each testing session should be recorded and if thresholds are surpassed, appropriate actions should be taken to diagnose and fix the underlying issues.

If funding is available, you could purchase a force applicator rod and analysis software (pictured below). Compared to a motion capture system and force plates though, the hardware and software required is pretty minimal and could easily be developed in in house.



(C-Motion Inc., 2016)[1]

If you would like assistance with any of the testing procedures outlined here, contact me at kylepchad@gmail.com and I can help out as much or little as you need.

[1] C-Motion Inc., (2016). Retrieved from http://www2.c-motion.com/products/caltester