Project Statement
Wire Tester

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**Statement of Need**

Students at UConn health center need updated equipment to research the field of biomechanics, specifically in the field of orthodontics. The equipment currently in use, a spring tester, is severely outdated and needs to be remodeled. Orthodontics is the corrective movement of irregular teeth using particular devices such as braces. This is accomplished through the principles of biomechanics, specifically vector forces, moments, and couples. In order to ensure this movement is controlled, it is essential to have machinery which has the capability to accurately and efficiently measure these applied moments, forces, and couples.

The spring tester which is presently in use at the health center to perform these biomechanical tests is technologically out of date and requires added capabilities. The spring tester is almost a decade old, and therefore lacks progressive user-friendly software that allows the testing and control of more varied conditions. The spring testing apparatus also uses only two attachments where orthodontic wire to be tested can be attached. Due to this, it is incapable of accurately representing the mechanical conditions which cause teeth to move. Also, the points of attachment are not as accurate as an actual orthodontic bracket would be in representing forces present when in application.

**Basic Preliminary Requirements**

Initially, the spring tester was created to assist medical school students in their research of specific orthodontic apparatuses. However, the device was only created to test one particular orthodontic fixture, the T loop, which was background behind the name “spring tester”. The so-called spring tester can now be called the generalized wire tester. Previous testing of wires not in the T loop formation was simply a manipulation of the somewhat primitive machinery. Calibration of this antiquated equipment is painstaking and requires a good deal of patience. In order to improve measurements, manual adjustment is constantly required. The spring tester has been out of use for several years due to the unfamiliarity students with the equipment. Modification is required in order for biomechanical orthodontic research to continue at the health center.

Several equipment modifications are needed. One such improvement is the addition of a third wire attachment point. Two moveable attachment points are now capable of testing the forces acting in two directions. With the addition of a third, stationary attachment point, this acts as an anchor, and forces acting in a third direction can be tested and measured.

A limitation of the current design is that a screw holds the wire in place. A bracket would have more accurate measurements of the orthodontic wire, since forces act differently on a screw as opposed to a bracket. A bracket consists of a slot, and two tie wings where the wire can be secured. The shape of the wire, and its placement in the slot can result in various mechanical forces which are effective in the movement of teeth. The forces acting on the teeth can be manipulated to achieve particular results which are to be measured using the wire testing apparatus.
The use of a bracket in place of a wire can better represent the mechanical forces acting on teeth. A single force on a tooth will cause tipping, however, the use of a force combined with a moment causes translation of the teeth. Couples of forces are created by the size and shape of the orthodontic archwire and its placement in the bracket. Lastly, a rather rudimentary control panel is the only means by which the user is able to modify experimental conditions. In order to improve and modernize this user console, a new user interface must be implemented.

Limitations:

The first limitation is that mechanical equipment can not perfectly replicate a biological system. There are many other factors in the mouth that play an active part in dental mechanics. The representation of the force system using the wire tester will give a close approximation. However, the force on two teeth cannot be represented in a system even with the addition of a third bracket since all teeth play a role in the movements of surrounding teeth. Attempting to recreate the true conditions of forces acting in the mouth is impractical. This is because one would need to completely mimic the oral environment, with the inclusion of brackets and sensors representing every tooth. Due to the high cost and extreme precision necessary to complete this task, this is not practical, and even this would not be infallible. Environmental factors in the mouth play a part in the movement of teeth, so a completely accurate description of how teeth move can not be achieved.

Other Data:

The client, Michael Holbert, is currently working on his masters at the University of Connecticut Health Center school of dental medicine. The university is consistently one of the top research funded dental schools in the country, with grants totaling over 6 million dollars annually. The school of orthodontics has had a history of specializing in the specific field of biomechanics within orthodontics.

Michael Holbert is using biomechanical principles to research tooth movement namely, how frictional forces effect rotational tooth movement. By determining the effect of friction, orthodontists can predict the effect of frictional forces, which are now causing unwanted side effects, and use them to his benefit. The wire test would serve an essential role in his data collection.

Questions:

- How will software replace the control box?
  - Will the software be able to perform more tasks than the control box?
  - What type interface will be used between the computer and wire tester?
- Can we completely replace manual adjustment with software?
- Can we use the existing motor or will it need to be replaced?
- Will the motor be compatible with the new software?
  - Does it need to be replaced due to wear?
- What type of device will be used to mimic the bracket?
  - How will it be attached?
- Will the existing sensors need to be replaced?
  - Are the current sensors useable with the new brackets?
  - Will the new sensors be able to measure force in three dimensions