# Bench Test Station Challenge

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## Problem Statement

One of the many bench test performed at Guidant (GDT) is destructive tensile testing of materials in the Receiving Inspection (R.I.) area. The tester is a large piece of equipment. The chassis design is such that the clamping jaws are located high up between tall rails, and the controls and data view screen are located on the base. Operators complain that the procedure requires too much reaching to load and unload test samples. Some operators actually use a small step stool to do this. The controls and display are below eye level. The operators sometimes sit down to record the data.

## Analysis


The equipment is located in a well-lit and climate-controlled environment. It is placed on a standard bench-top work surface. This station is laid out for a standing operator. The test samples are cut from longer items such as polymer tubing or spools of wire and are prepared on an adjacent bench. The large working area prohibits sitting. However, a chair is located at the station because some operators naturally try to sit down when recording data. The chair is an obstacle when it is not in use, which is most of the test cycle.

There are two primary operators of this equipment, one on each shift. Therefore, the problem was assessed based on their needs. Additional operators fill in on occasion, however the anthropometric data for those operators are within the ranges presented below. The bench top is 36” above the floor.

| Applicable Anthropometric Data | Operator “A” | Operator “B” | Related Equipment Design Elements | Height from Floor |
|---|---|---|---|---|
| Gender | Male | Female | - | - |
| Stature (Ht.) | 69” | 65” | Frame Height | 84” |
| Elbow Height – Standing | 43” | 40.25” | Run Controls with Data Display | 48” |
| Arm Length | 30.5” | 29” | | |
| Overhead Reach | 85.5” | 82” | Top Grip | 76” |
| | | | Grip Controls – Open/Close | 68” |

Kroemer, et al, (2001)[1] states that the main reference point in workstation design for the standing operator is elbow height. The data presented above illustrates the following key points:

- The equipment controls are well above elbow height.
- The data display is in the same location as the controls and well below eye level, obvious from the distance (17"-21") below the stature measurement.
- The height of the top grip (76") is greater than either stature measurement. All samples must first be loaded into the top grip for testing. Loading and unloading of all samples is accomplished by overhead reaching. This is the main reason for the operator complaints and why they employ the stepstool.

(Note: The top grip is stationary on this equipment. The bottom grip moves downward during the test.)

Cumulative Trauma Disorder (CTD) would probably result if the operator's complaints were not addressed. Reaching and leaning puts the body out of balance and causes the limbs to stretched awkwardly. Too much bending (flexion) or straightening (extension) in the cervical or lumbar regions forces the spine out of its neutral position and increases the risk of injury. Incorrect posture stresses the body causing pain and stiffness.[2] The use of the stepstool adds further risk to an off-balance posture.

## Solution

Replacing the equipment was the least desirable action because of the expense. The equipment is only two years old.

The Facilities Department was contacted to determine any possibilities for redesigning the layout. Facilities had other benches readily available. These benches had less surface height when installed. A replacement bench was ordered and installed under the equipment. The replacement bench height was 30" from the floor. The adjacent sample prep bench was left at the original (36") height. Lowering this bench would have introduced a second (excessive bending) issue.

The anthropometric data for the operators is repeated in the next table with the change in equipment heights attributed to the lower bench. All of the previous equipment dimensions were reduced by six inches with the following results:

- Run controls are now within the range of elbow height.
- The top grip is more easily accessed. The height is within a comfortable range of reach.
- The operators can perform the task while maintaining a more normal posture. The lowered bench top (30") is closer to waist height. This allows the body to rotate forward at the hips, instead of flexing the lumbar spine.

[1] Kroemer, H.E., et. al. (2001), Ergonomics, How to Design for Ease and Efficiency, Prentice Hall.
[2] "Cumulative Trauma Disorder (CTD) In A Nutshell", S.O.A.R. On-Line, http://www.soarmedical.com/medical-library/ctd/

| Applicable Anthropometric Data | Operator "A" | Operator "B" | Related Equipment Design Elements | Height from Floor |
|---|---|---|---|---|
| Gender | Male | Female | - | - |
| Stature (Ht.) | 69" | 65" | Frame Height | 78" |
| Elbow Height – Standing | 43" | 40.25" | Run Controls with Data Display | 42" |
| Arm Length | 30.5" | 29" | | |
| Overhead Reach | 85.5" | 82" | Top Grip | 70" |
| | | | Grip Controls – Open/Close | 62" |

The challenge to comfortably view the data display was not fully addressed by the bench-top solution. The display actually moved farther away from eye level. When analyzing the equipment design, it was discovered that imbedded equipment software contained a feature to print out the current test data at the end of each test, but was never utilized. An inexpensive dot-matrix printer was purchased and attached to the equipment parallel port to remedy this part of the problem. The operator no longer needs to bend down or sit to carefully transfer data from the screen. Instead, the chair has been removed and replaced with a resilient floor mat to reduce leg and back fatigue.

## Verification

The final step in this redesign was to verify the efficacy of the change. The solution to this problem was determined primarily by the anthropometric data for the affected operators and the availability of the workbench and printer. It was an attempt to address the potential safety issues associated with a sub-satisfactory layout. Therefore, a follow-up investigation was performed.

This change was actually implemented in my area. The change was in place for approximately two weeks prior to the culmination of this research paper. Subjective information was gathered to evaluate the change. Task observation for the two-week period (both shifts) verified the following:

- The stepstool is no longer needed.
- The chair is no longer used.
- A neutral standing posture is preserved for the majority of the task. Enough movement is provided between sample prep and test activities to minimize static positions.
- Interviews of both operators reported that the task was no longer "a chore", and that the task has become easier.

An additional verification activity could also be performed using the resulting test data. Data is archived for each lot of received material. Historical receiving inspection data could be compared to data recorded for the same material after the change using statistical methods or visual plots. Any reduction in variation attributed to the change would verify an improvement. This was not possible due to the time constraint of the term paper deadline. It is a recommendation to be accomplished in the future.