Posture Analysis Exercise

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1.0 Objectives:

1. Improve skill for rating over all job and identifying specific force and posture problems
2. Learn how to characterize posture
3. Learn about time based v. event based sampling
4. Practice characterizing posture
5. Practice characterizing force

2.0 Posture:

The body can be characterized as a series of links that roughly correspond to the underlying bones or skeletal system. For example, the fingers are formed by three links that correspond to the first, second and third phalanges. The forearm corresponds to the radius and ulna.

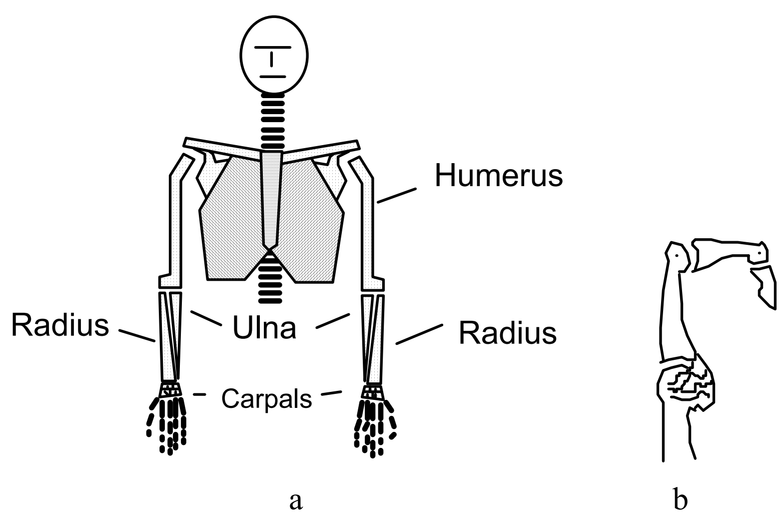
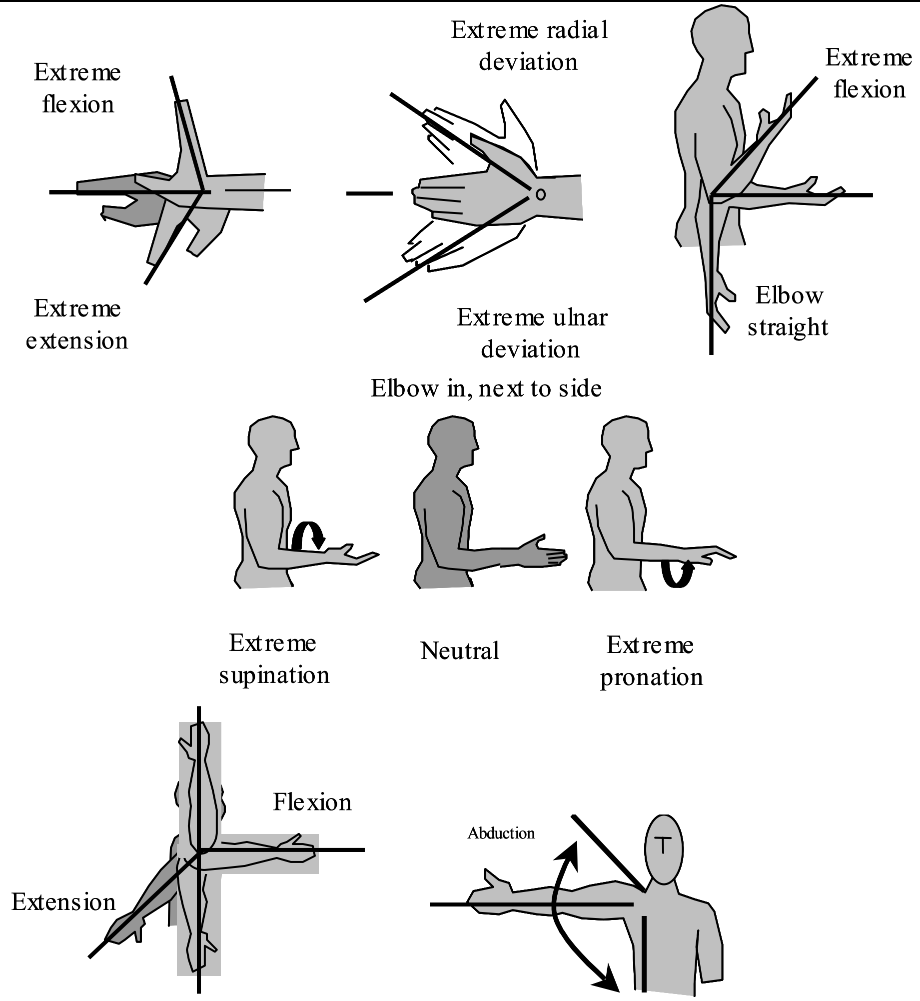


Figure 1: The link system of the body roughly corresponds to the underlying skeletal system, a. Movements occur around joints that are held together by ligaments, b.

Movements of the body occur at the joints between links. Joints are held together by flexible ligaments that may permit movement in one or more directions. For example the second and third knuckles (proximal and distal interphalangeal joints) are able to rotate about one axis – flexion/extension. The wrist joint is able to rotate about two axes – flexion/extension and abduction/adduction (radial/ulnar deviation). See Table 1.

Table I: Postures, movements and ranges of motion of the upper extremity are shown above (Barter 1957).



Joint	Movement		Range Avg±SD
Wrist	Flexion		90±12
	Extension		99±13
	Radial Dev		27± 9
	Ulnar Dev		47±07
Forearm:	Supination		113±22
	Pronation		77±24
	Elbow flexion		142±10
Shoulder:	Flexion		188±12
	Extension		61±14
	Adduction		48± 9
	Abduction		134±17
	Rotation:	Medial	97±22
		Lateral	34±13

3.0 Posture Assessment

3.1. Measurement of Static Postures: Static postures can be assessed using protractors or "goniometers" as shown in Figure 2. The posture can be read directly when the goniometer is placed over the joint of interest and aligned with the distal and proximal links. The posture must be read separately for each axes of rotation of each joint. Although us of the goniometer is straight forward, it is sometimes difficult to locate the exact centers of rotation and clothing and body fat may interfere. Also, it is hard to measure joint angles without interfering with the work. Static postures are characterized as a single number; however, static postures may vary for a given worker over long periods of time or among different workers.

a b

Figure 2: Goniometer used for measuring static posture (from Allheart: http://www.allheart.com/pm47.html?AID=5329523&PID=1077639).

Static postures also can be estimated form photographs or video images. Unless the camera is perfectly aligned with the axis of joint rotation, there will be parallax errors (optical distortions). With experience, it is possible for an observer to adjust for some of these errors. For example, it is not possible to measure flexion/extension angle of the wrist joint from a view of the back of the hand and forearm; however, it will be seen that the length to width ratio of the hand is greatly reduced. Thus, it can be inferred to what extent the wrist is flexed or extended.

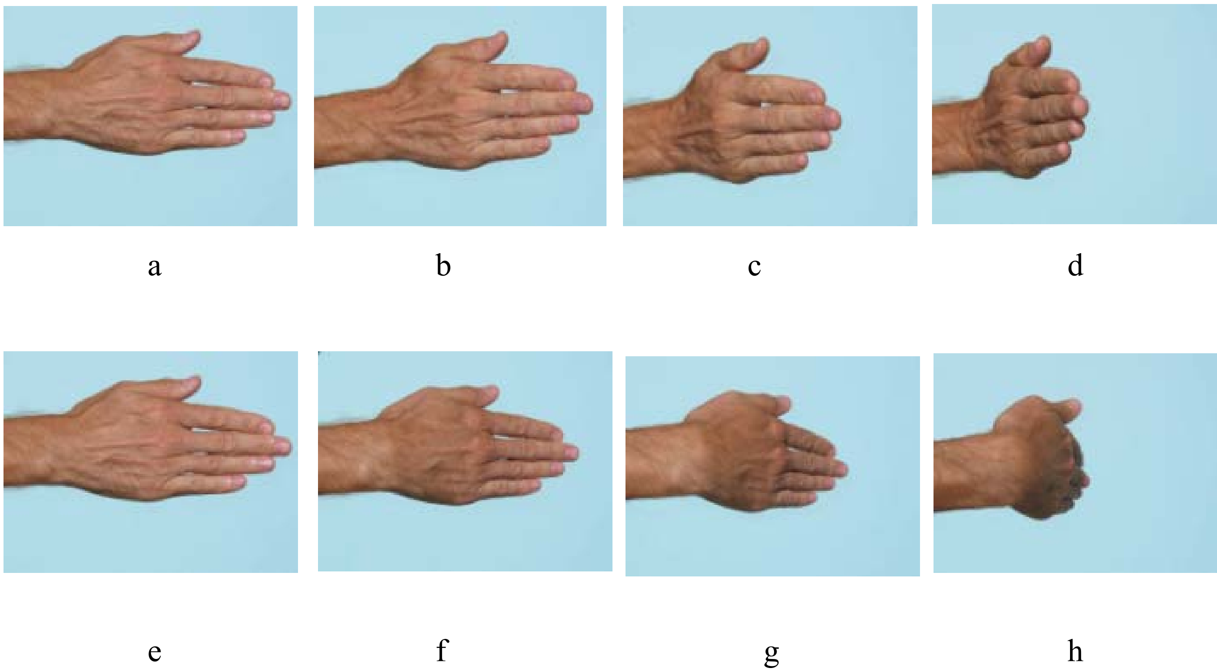
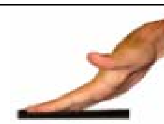


Figure 3: Comparison of wrist extension a-d and wrist extension e-h provide visual queues that indicate if the wrist is flexed or extended.

Measurement of hand posture: Hand posture requires measurement of at least 15 joint angles – some with multiple degrees of freedom. Often this level of detail is not needed. It may be sufficient to characterize hand posture as grip or pinch. Table II includes a simple taxonomy of grip and pinch positions. Generally the fingers joints will be more extended in pinch than in grip postures. Also the grip object will be between the palm and fingers in grip and between the fingers and thumb for power grip.

Table II: Hand postures can be classified in the above gross categories.

Posture	Description	Example
Idle	Hand is **not** actively performing a task. • e.g. midair, resting • *Hand Force* is automatically rated as 0.	
Grip – Power	Gip around an object where the hand surface is in full contact with the object. • e.g. in-line tool	
Grip – Hook	Grip with no thumb opposition where object rests in 'U' formed by semi-curled fingers. Object rests on pulp surface of middle phalanges. • Often used to oppose gravity. • e.g. briefcase handle	
Pinch – Tip	Pinch grasp between thumb, one or more tips of the fingers and the work object. • e.g. picking up a tiny screw or needle)	
Pinch – Pulp	Pinch grasp between the thumb, one or more of the pulps of the fingers and the work object. • e.g. picking up a pen	
Pinch – Lateral	Pinch grasp between thumb and lateral side of index finger. • e.g. turning key, holding a folder	
Press – Tip	Push against an object with tip(s) of finger(s). • e.g. pushing a key on a keyboard	
Press – Flat	Push against an object with palmar side of finger(s). • e.g. smoothing out a piece of paper	
Press – Palm	Push against an object with the palm contacting the entire surface.	

3.2 Measurement of Dynamic Postures: Measurement of dynamic postures is an extension of static posture analysis in that it involves repeated or continuous measurements of posture over time. Dynamic postures are indicated using means, standard deviations, ranges, frequency distributions, time plots and time series analysis – among other methods. Instrumentation exists for continuous measurement of one or more joint postures. One of the most common examples is based on electromechanical goniometers that are attached directly to the workers and connected to an electronic data logger or computer. A second example is based on video tracking of markers on workers bodies. These systems show great promise.

Dynamic postures can be measured with the method described above for analyzing static postures. The posture measurements are simply repeated at selected times until the entire job or task has been characterized. The times can be scheduled a fixed intervals, at random intervals or to correspond with specific events. These methods are referred to as fixed interval, random interval and event based sampling. Fixed interval sampling is generally used for tasks that are cyclical in nature. The time interval should be smaller that the time between significant posture changes. 0.25 seconds should be adequate form most hand tasks. Random interval sample is well suited for jobs that entail irregular work activities – asynchronous occurrence of multiple work tasks and elements. Task based sampling is best suited for cases where the analyst is interested in specific tasks or work elements. Task based sampling may be combined with fixed interval sampling to characterize movement patterns of specific work tasks or elements.

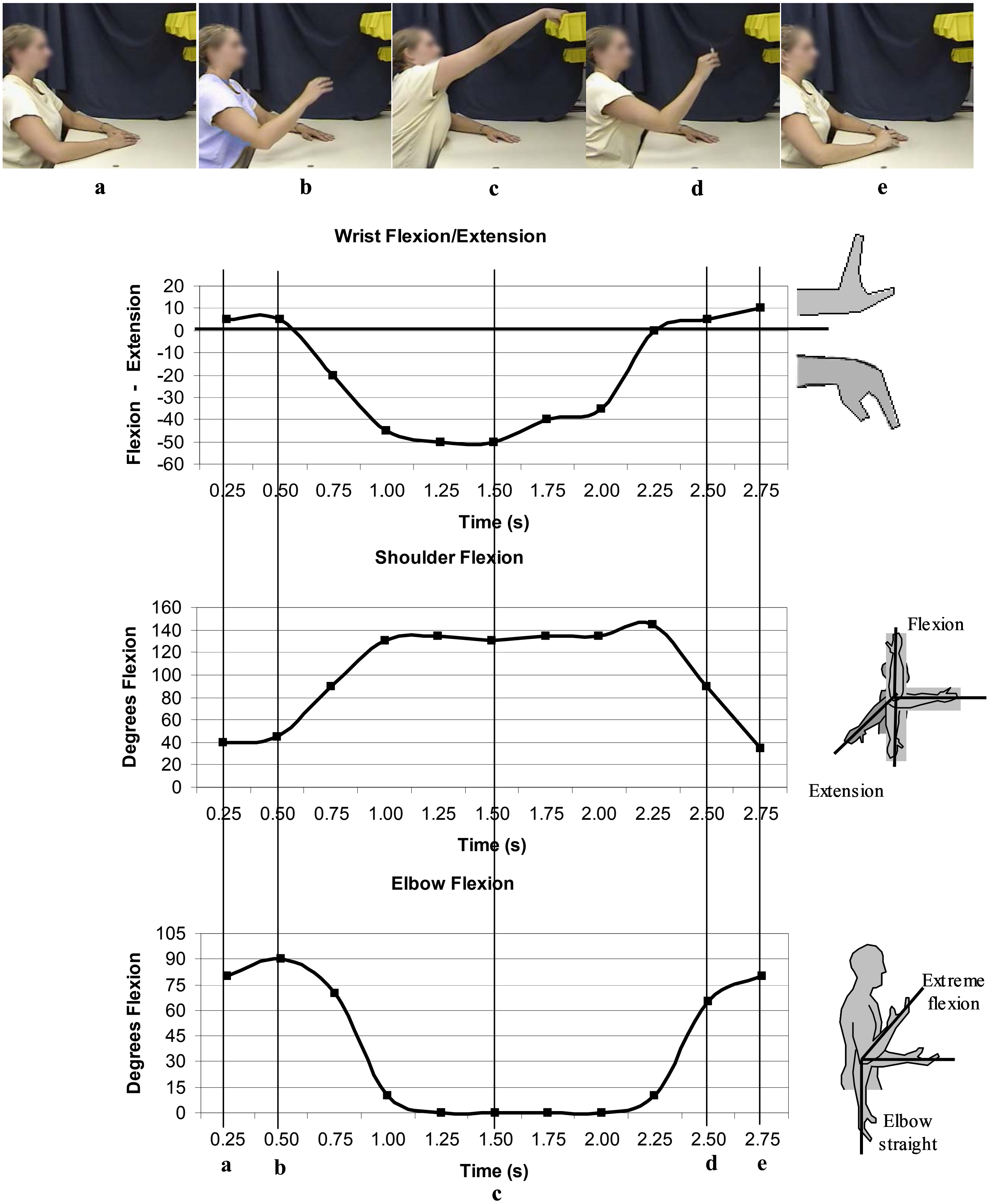
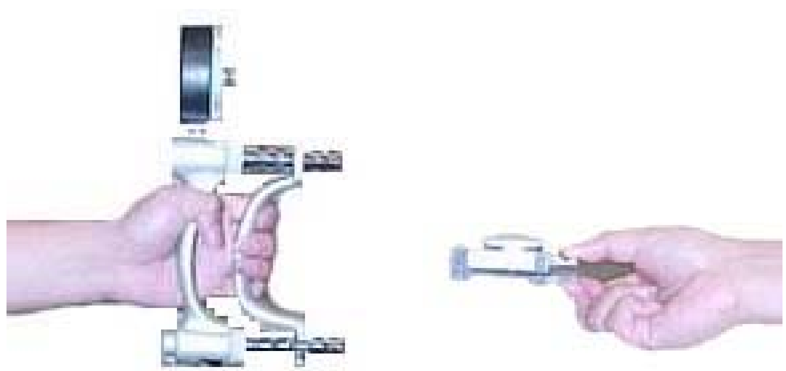


Figure 4: Time based analysis of wrist, elbow and shoulder postures for worker getting part.

4.0 Hand force Analysis:

Force is exerted to grasp, hold, move or manipulate work objects. It also may be exerted to resist reaction forces of power tools and to support the body. Forces may be distributed over one or more digits (fingers and thumb) or the palm. Forces are vector quantities that are they have properties of magnitude and direction. As a practical mater, force is most commonly characterized as a single number that corresponds to measurements using a grip or pinch dynamometer and is expressed in pounds, kilograms or newtons. Force can also be characterized on a relative scale of 0 to 10 or 0 to 100%. A relative value of force can be calculated by dividing the actual force value by the corresponding strength value and multiplying by 10 (for a 0 to 10 value) or by 100% (for a 0 to 100% value). Relative values are often estimated using perceived rating estimates by workers or by using EMG methods. They also can be estimated from observations for example, picking up a hand tool might require only a small fraction of workers strength and be rated as a 1 (on a 10 point scale) while using the tool to loosen a rusted nut might require all of a workers effort and be rated as a 10 (on a 10 point scale). Some of the considerations in rating force are listed in Table 3.

Fixed interval, random interval and event based sampling methods apply to force estimates.



a b

Figure 5: Power grip strength, a, is 5-6 times greater than pinch strength, b.

5.0 Posture/force Analysis Program:

The posture/force analysis program is a VisualBasic™ program that displays enables the user to view an electronic video file at fixed intervals and to enter task, work element, work object, posture estimates and force estimates into a Microsoft Excel™ spreadsheet. Subsequent analyses can be performed using the spreadsheet using standard functions in the spreadsheet. Important program features include:

1) The ability find and open desired video files, e.g., *.avi, *.mpg or *.mov. Note: video may use a special algorithm – "codecs" -- to compress and decompress the video file and save disk space. If the codex used to create the video file is not available on your computer, you will not be able to play it.

2) The ability to advance the video at specified intervals, e.g., 0.25s, 0.50s, 1.0s, etc.

3) A user form for recording information about what the worker is doing, the work object, upper limb posture and estimated posture and entering (see figure 6). Data are stored in an Excel™ spread sheet for subsequent plotting and analysis.

4) Information can be recorded for the right side and left side separately or both at the same time.

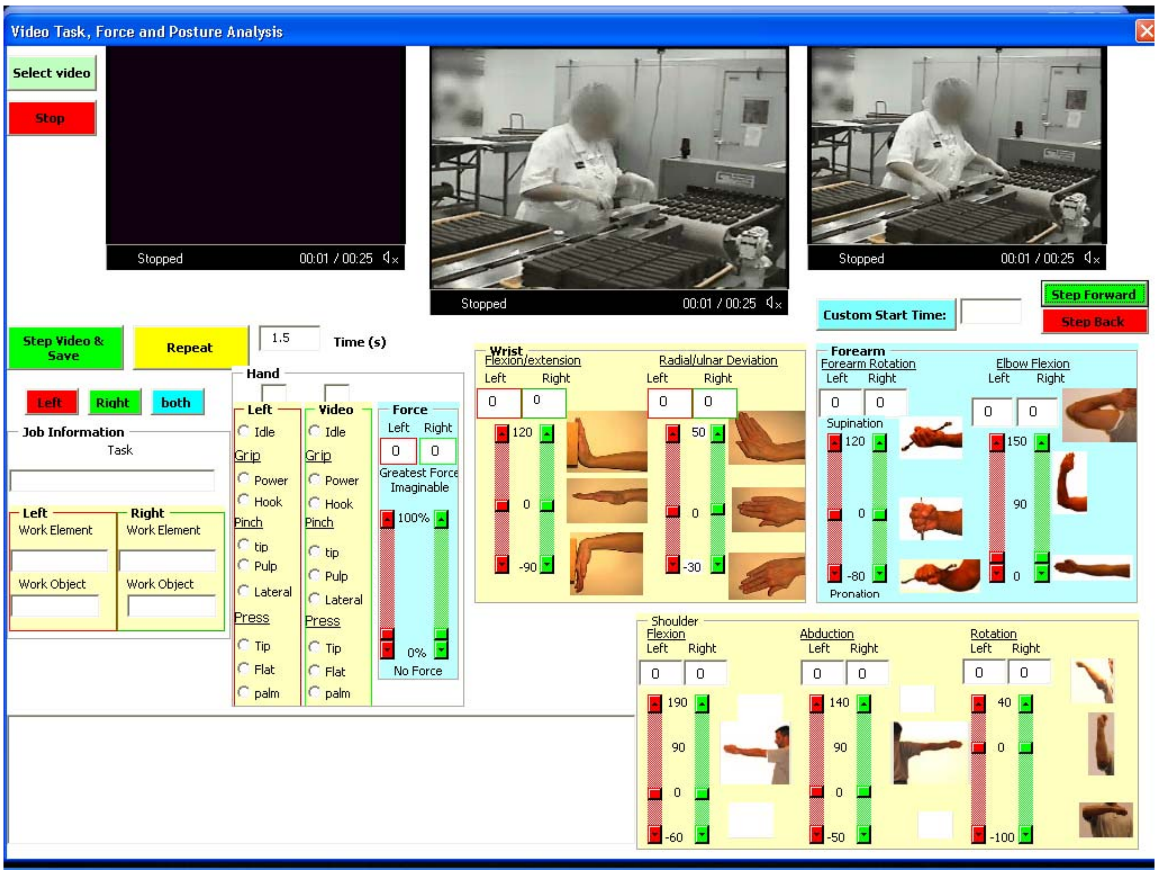


Figure 6: User form for posture and force analysis.

6.0 Exercise:

1) Open the assigned video clip

2) Enter your initials

3) Enter an inter-sample time, e.g., 0.25m.

4) Analyze the assigned clip

5) Plot the results for wrist posture, shoulder posture, and hand force versus time.

6) Identify the work elements that correspond to the stressful actions.

7) What are the causes of the identified stresses?

8) How could you reduce these stresses?

6.1 Using Excel to Create Scatterplots

1) Open the spreadsheet of interest and select the data that needs to be plotted.
2) Under the "Insert" menu, select the "Chart" option.
3) Select the XY (Scatter) type of graph and press the "Next" button.
4) If the graph appears in the manner that you would like it to be displayed, click "Next". Otherwise, select the "Series" tab.
    a. Remove the series that are listed.
    b. Click "Add" series.
    c. Select the X and Y values as well as the series name by pressing the small spreadsheet icon next to the text boxes.
    d. When the graph appears as you would like it to, press "Next".
5) Label the chart axes and title.
6) Click "Finish" and your chart will appear in the spreadsheet.
7) To create a curved line connecting your points, right click on one of the data points and select "Format Data Series".
8) Under the "Patterns" tab, select a custom line and check the box "Smoothed Line".