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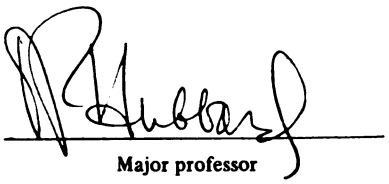
EXPERIMENTAL DETERMINATION
OF A SPINAL LINKAGE MODEL
FOR THE SEATED HUMAN TORSO

presented by

Melissa Sloan Gedraitis

has been accepted towards fulfillment
of the requirements for

Master's degree in Mechanics



Major professor

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EXPERIMENTAL DETERMINATION OF A SPINAL LINKAGE MODEL FOR THE SEATED HUMAN TORSO

By

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A THESIS

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ABSTRACT

EXPERIMENTAL DETERMINATION
OF A SPINAL LINKAGE MODEL
FOR THE SEATED HUMAN TORSO

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In this work, a model of the seated human torso was determined through postural analysis under a broad range of seated support conditions. Utilizing optical position measurement equipment and software, posture data were collected with ten mid-size male subjects in a laboratory seat under a wide range of torso support conditions. From these data, joint locations were determined for a three segment, two joint torso linkage model, which would satisfactorily simulate seated human torso motion. The allowable angle ranges through which adjacent segments should move relative to one another were determined and the coupling between motion at one joint and the other was evaluated. This seated human torso posture linkage was developed as a necessary step toward understanding the effects of seat support geometry on human posture.

I dedicate this work to my research partner, my friend, my husband, Chris.

ACKNOWLEDGEMENTS

I would like to thank the following individuals and entities for their help in making this research possible: Johnson Controls, Inc and the National Science Foundation for their financial support, Dr. Robert Hubbard for providing the environment in which this research could take place, Drs. Gary Cloud and Roger Haut for serving on my committee, and the consulting office of the statistics department for providing custom analysis methods for my research problem.

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NOMENCLATURE AND ABBREVIATIONS

ASIS	Anterior-Superior Iliac Spine
ANOVA	Analysis of Variance
C1-7	First through Seventh Cervical Vertebra
IR	Infrared
L1-5	First through Fifth Lumbar Vertebra
LL	Lower Lumbar
LP1	Lumbar Point 1
LP2	Lumbar Point 2
MSE	Mean Standard Error- ANOVA Output
MSTR	Mean Std. Error due to treatment- ANOVA Output
P_L	Pelvis relative to Lumbar
PSIS	Posterior-Superior Iliac Spine
S1	First Sacral Spine
SAE	Society of Automotive Engineers
T1-12	First through Twelfth Thoracic Vertebra
T_L	Thorax relative to Lumbar
T_P	Thorax relative to Pelvis
UMTRI	University of Michigan Transportation Research Institute

1. INTRODUCTION

1.1 Background

Seated tasks have become more and more prevalent in current times. Owing to travel in cars, planes, trains, and buses, and use of computers, the amount of time that people are seated has risen drastically over the last century.

To support this trend toward seated tasks, seating, from automotive to office, has also grown as an industry. What has lagged, however, is a method to evaluate seats from a human biomechanical perspective. Perhaps a good way to evaluate seats would be to understand the postures that result when people sit in them. Many people have seen the importance of data collection based on this type of seat performance. In the 1960's, SAE (Society of Automotive Engineers) developed an automotive seat evaluation tool that still is used today [1]. This tool is the 3D seating mannequin, shown with the 2D side view plastic design template in Figure 1.

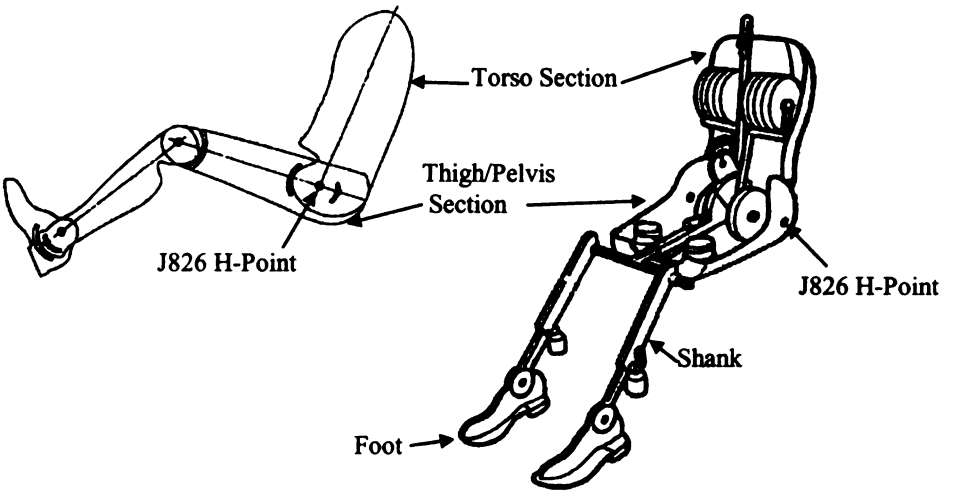

Figure 1: SAE 2-D Design Template and 3D Seating Mannequin [1]

The 3D mannequin consists of a single flat-backed torso section, connected via a pin joint to a thigh-pelvis section, to which shanks and feet are attached. To this shell, weights are added to simulate a seated average male, by weight and stature (height). The purpose of the mannequin has been to confirm that production automotive seating packages meet design specifications. Output parameters of the mannequin are limited to back, hip, knee and foot angles and H-Point location relative to the seat. However, when placed in a seat with large lumbar prominence, the mannequin does not fit. It cannot conform to the seat back contour, owing to its hard flat back, which makes it difficult, if not impossible, to take the standard angle readings repeatably from contoured seats. Also, the mannequin gives no feedback as to the effects on human posture that this contoured seatback would produce. There is a need for more output than that which this simple tool is designed to give. This need is for a tool that can quantify the effects of seatback contours on the

human torso. But what is torso posture and how should it be quantified?

In recent years, the issues of defining and measuring torso posture have begun to be addressed. Haas [2] began to evaluate the complex motion of the spine, based on postural data found in various publications. He assumed that by fitting a model to these few known postures, a posture linkage could be inferred. This gave good start to simulating torso posture. Haas developed a multi-joint computer model that represented the mobility of the lumbar spine and began to model possible human torso shapes. However, the few postures Haas found in his references were only samples of postures that had been attained by subjects in testing. Previous investigators had not made attempts to place the subjects in extreme torso postures; and, therefore, their test results did not provide sufficient data for understanding the total range of postures. Also, because Haas did not have measurement techniques available for investigation of the total range of postures, his model was able to represent only a series of possible postures, but not the entire range of attainable postures, as illustrated in Figure 2.

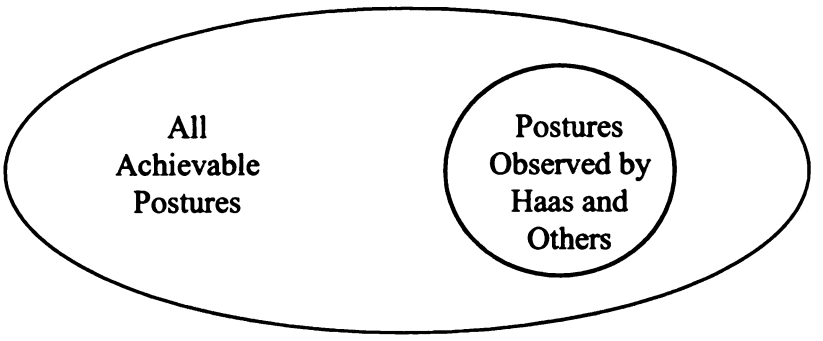

Figure 2: The Set of Achievable Postures and a Subset of Possible Postures.

From Haas's multi-joint computer model, Bush [3] made important simplifications. Bush reduced the complexity to a model of only three segments (a ribcage, lumbar, and pelvis) connected by pin joints. The upper joint of Bush's model was located at the anatomical joint center between the twelfth thoracic and first lumbar vertebrae, and the lower one was located at the anatomical joint center between the fifth lumbar and first sacral vertebrae. (See Section 1.2 for a better understanding of spinal anatomy.) Bush's three-segment model is shown in Figure 3. Bush's model was also given a motion pattern governed by a chain linkage, which directly coupled the motion of the thorax to that of the pelvis. For every clockwise rotation of the thorax relative to the lumbar, the pelvis rotated the same amount relative to the lumbar, in the counterclockwise direction. Refer to Figure 3. Bush found that his simplified model simulated Haas's six joint model to within 12.7 mm of back contour discrepancy, which was felt to be acceptable in automotive seat design. However, the locations of the joints for Bush's model were drawn from limited information. The motion patterns of Bush's model were confirmed using Haas's model, which itself had not been experimentally validated. No actual experiments were run to either confirm or discount the validity of Bush's model joint locations. Also, the coupling linkage Bush gave to his model imposed severe restrictions on the model's range of possible motion, excluding any thoracic rotation relative to the lumbar without pelvic rotation relative to the lumbar, or pelvic without thoracic rotation relative to the lumbar segment. This of the possible motions of Bush's torso model was also not tested for its accuracy in representing human torso motion. The joint locations and coupling linkage were adopted out of mere convenience.

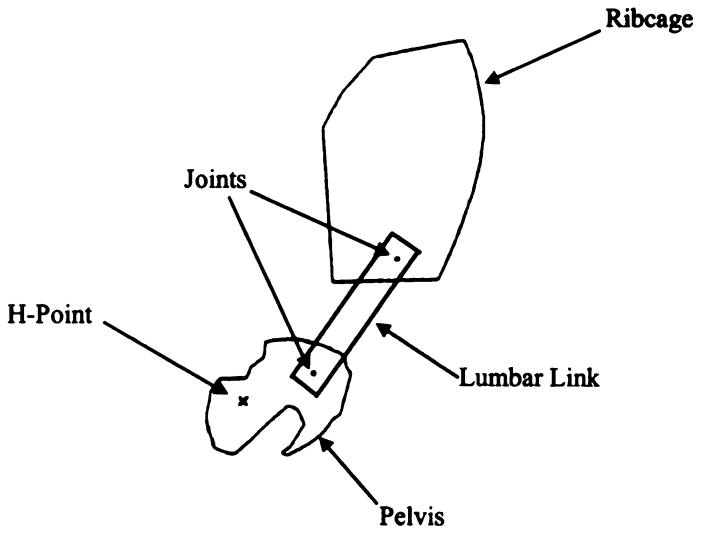

Figure 3: A Three Body, Two Joint Linkage Model

With this background, the current study aimed to expand on the work begun by Haas and Bush, by performing an in-depth study to lend insight to the entire range of possible seated postures. From the data produced by this study, a more complete understanding of seated human posture might be possible.

1.2 Anatomy Of The Human Torso And Posture Descriptors

1.2.1 Introduction

Anatomical information necessary to the understanding of spinal motion and attaining postures is given in this section.

1.2.2 Anatomical Directions

Special descriptive terms are used in anatomy to describe relative locations. For example, toward the top of the subject's head is referred to as the superior direction, rather than upward [4]. This is to avoid the confusion that may result from different

subject orientations, e.g., subject sitting versus lying down. Table 1 summarizes the anatomically comparative terms that will be necessary to the understanding of this document.

Table 1: Anatomical Prepositions [4]

PREPOSITION	DEFINITION
Superior	Toward the Top of Head
Inferior	Toward the Bottom of the Feet
Anterior	Toward the Front of the Body
Posterior	Toward the Back of the Body
Lateral	Away from the Left/Right Centerline of the Body

1.2.3 Spinal Anatomy

The base of the seated human torso is the pelvis (Figure 4). The pelvis has palpable skeletal landmarks, including the left and right anterior-superior iliac spine (ASIS), the pubic symphysis, and the sacrum, which are important for determining the position and orientation of the pelvis. The pelvis supports the spinal column, to which the ribcage is attached.

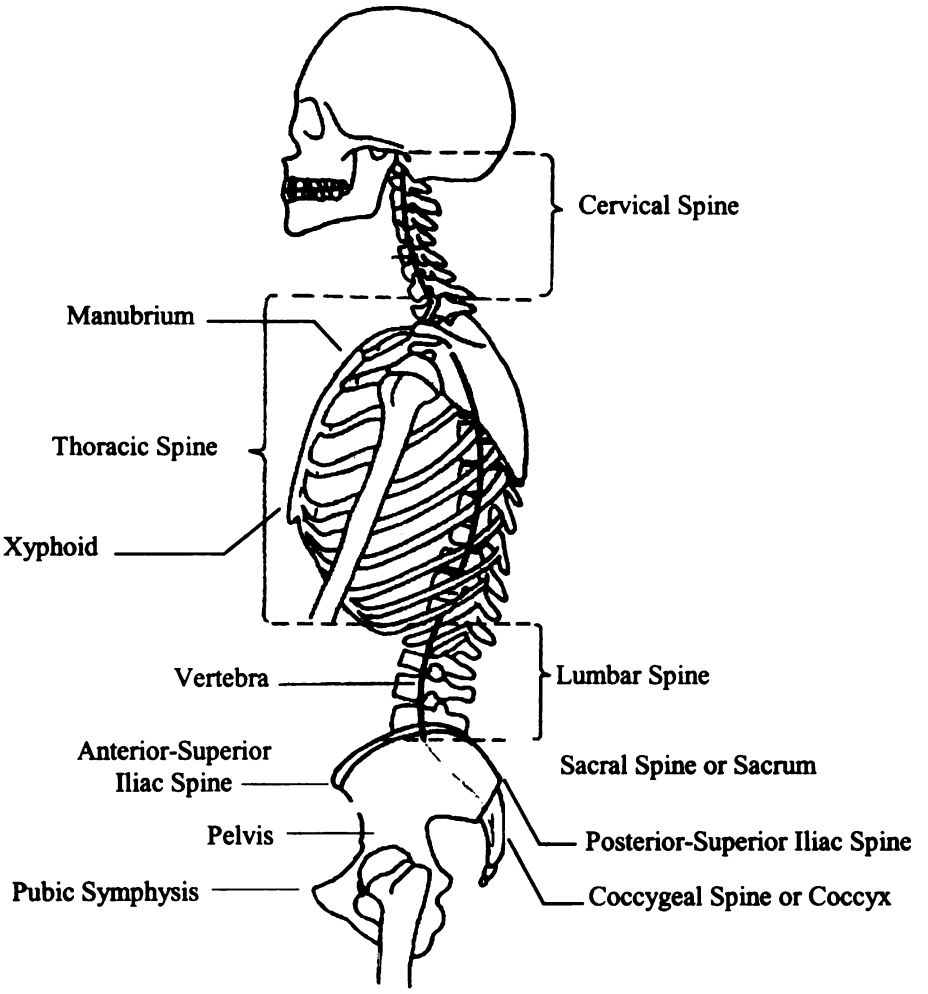

Figure 4: Spinal Regions, adapted from Chaffin, *et al.* [4]

The spinal column is divided into five sections: cervical, thoracic, lumbar, sacral, and coccygeal spine, which are labeled in Figure 4. But of the sections of the spine, not all are considered in defining torso posture. For example, the cervical spine is responsible for the motion of the head relative to the ribcage, and is therefore not considered in this study of torso articulation. Also, the sacral spine is composed of five fused vertebrae, which serve as an attachment to the pelvic girdle, but have no motion relative to one another, while the coccyx, or tail bone, plays no known functional role in humans [6]. These spinal sections are excluded from this motion study. The lumbar spine and, to a lesser degree, the thoracic spine are responsible for torso mobility.

The spine is composed of vertebrae, which move relative to one another, and give the human torso its wide range of mobility. The bony prominence on the posterior side of each vertebra is called the spinous process, and is the part of the bone that is palpable through the skin and tissue on a living human back. See Figure 5.

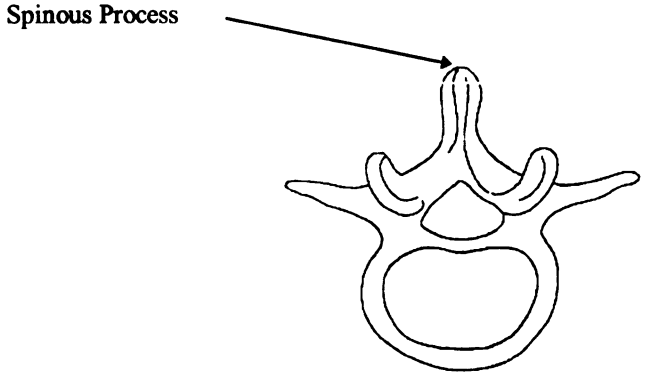

Figure 5: Vertebra- View from Superior Side

Each vertebra in the spinal column is given a name, consisting of a letter

followed by a number. The letter corresponds to the initial letter of the spinal segment name (cervical, thoracic, lumbar, or sacral), and the vertebrae are numbered within each section, superior toward inferior, such that the names of the vertebrae are: C1-C7, T1-T12, L1-L5, and S1-S5. See Figure 6.

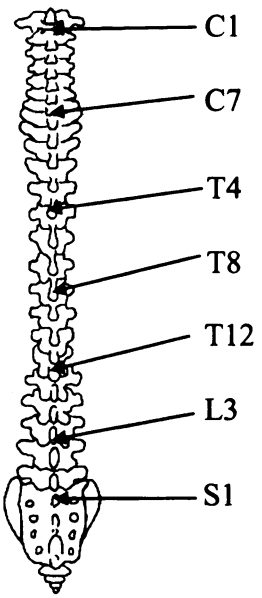

Figure 6: Vertebra Names, Examples

In describing the shape of the spine in different postures, it is often necessary to define the direction of curvature of the spine. For this purpose, the term lordotic (e.g., lumbar lordosis) is used to describe a lumbar spinal curvature that is concave posteriorly, and the term kyphotic (lumbar kyphosis) is used to describe an anteriorly concave spinal curvature. These are illustrated in Figure 7.

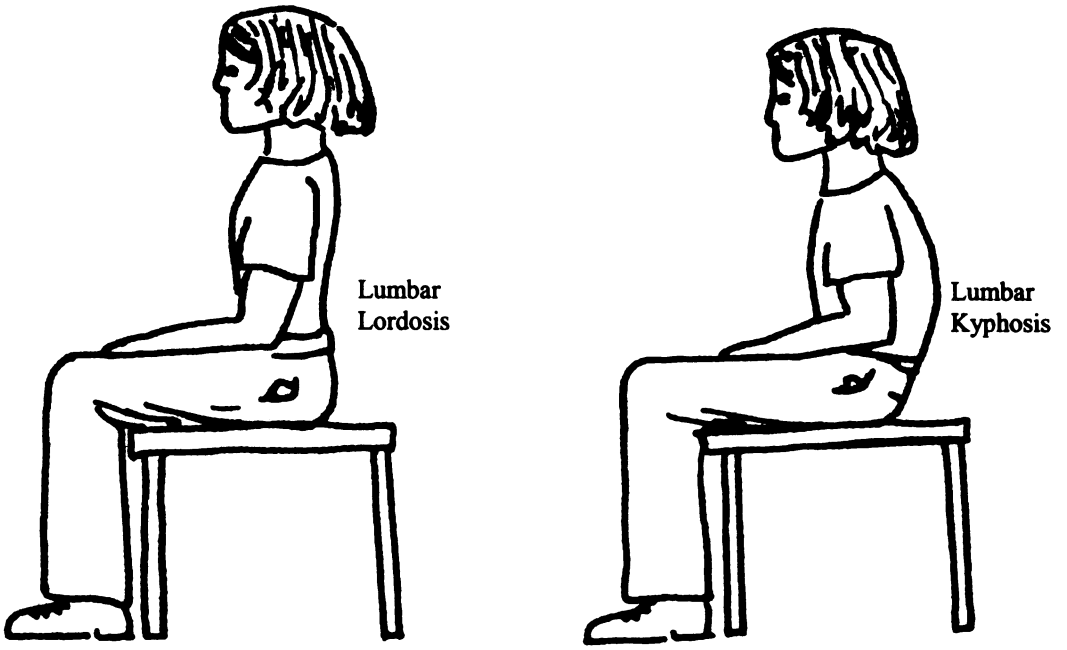

Figure 7: Lordotic and Kyphotic Postures

1.2.4 The Sternum

The sternum is the anterior intersection of the left and right ribs. The most superior region on the sternum is called the manubrium, while the most inferior part is called the xyphoid.

1.2.5 Limb Influence on Torso Posture

The positions of the limbs relative to the torso can influence the torso posture of an individual. For example, the hamstring muscle group has connections to the pelvis at the ischial tuberosity and to the leg inferior to the knee as shown in Figure 8.

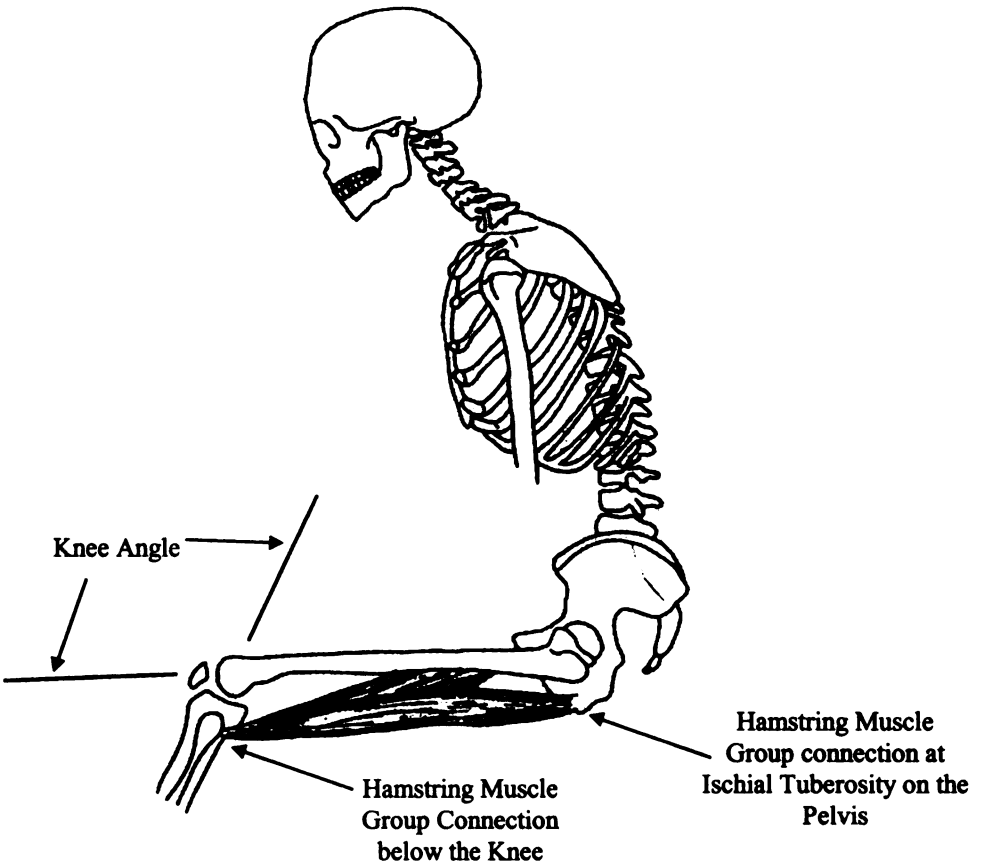

Figure 8: Hamstring Muscles, adapted from Chaffin, *et al.* [4]

The angle of extension of the knee therefore influences the tension of the hamstring, which in turn pulls on the bottom of the pelvis. Referring to Figure 8, should the knee be quite extended, perhaps beyond a knee angle of 120°, and should the pelvis want to rotate counter-clockwise, the hamstring would inhibit or limit this pelvic motion [4, 7].

Arm position is also able to influence torso posture. Arms extended out forward from a person must be held in this position using shoulder muscles, as shown in Figure 9. The resulting force and moment on the torso, shown in the free body diagram in Figure 9, cause the relaxed thorax to slump forward, if no counteracting muscle force is employed.

1.3 Research Objectives

The aim of this research was to design a three segment model to represent human torso motions in the sagittal plane, based on measured data and statistical analysis, to be valid over the entire range of seated postures, within known error limits. The resulting human torso posture description is to be reduced to two joint centers and three angles:

1. recline
2. thorax relative to lumbar
3. pelvis relative to lumbar

As shown in Figure 10, the recline angle is the angle of the lumbar segment relative to vertical. The thorax to lumbar angle (T_L) is zero in the flat-back configuration, as shown on the left. It becomes more positive, as the thorax rotates toward an erect posture (clockwise). Likewise, the pelvis to lumbar angle (P_L) is zero in the flat-back posture, and positive when the pelvis rotates toward a more erect posture (counter-clockwise).

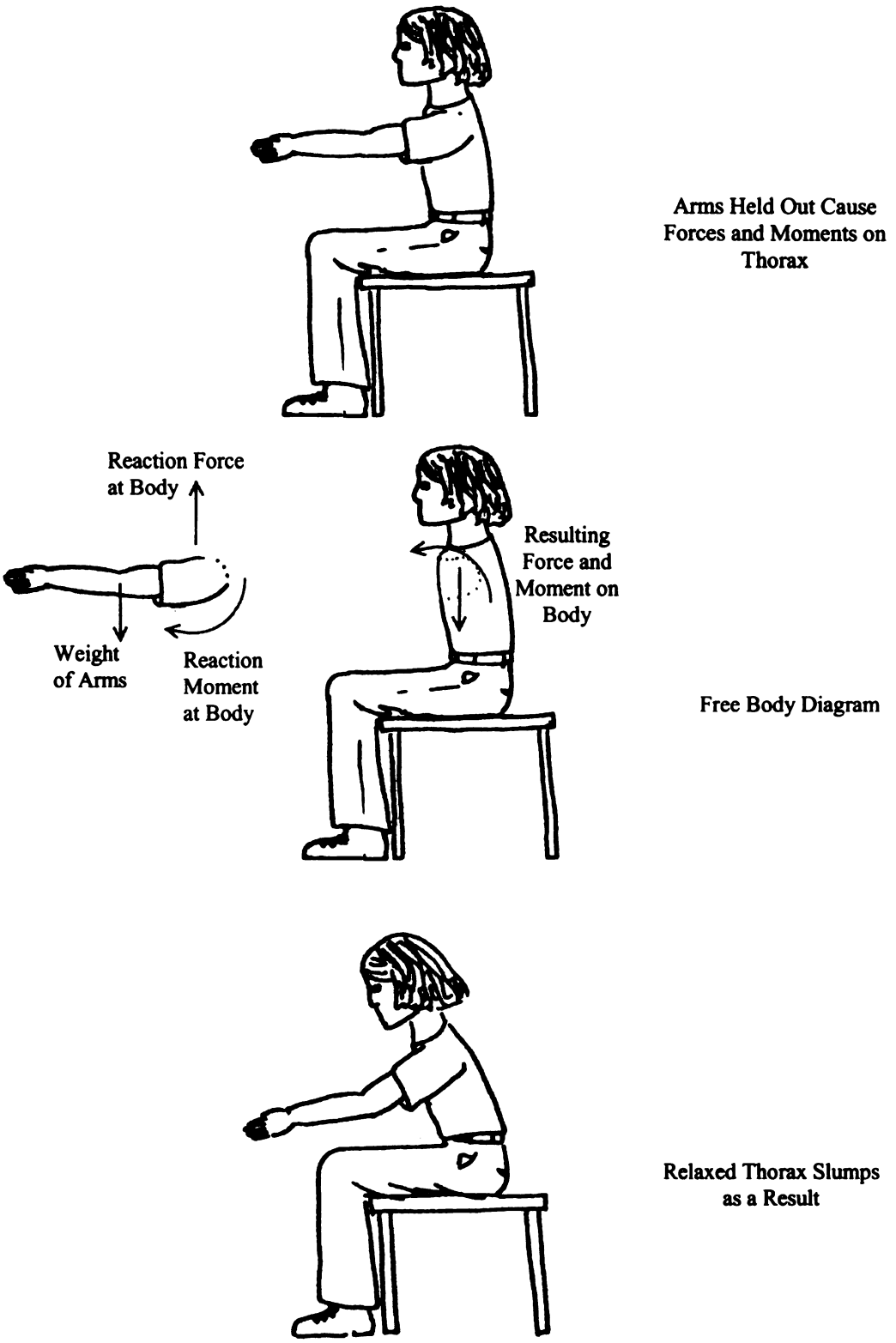

Figure 9: Arm Weight Influence on Thorax

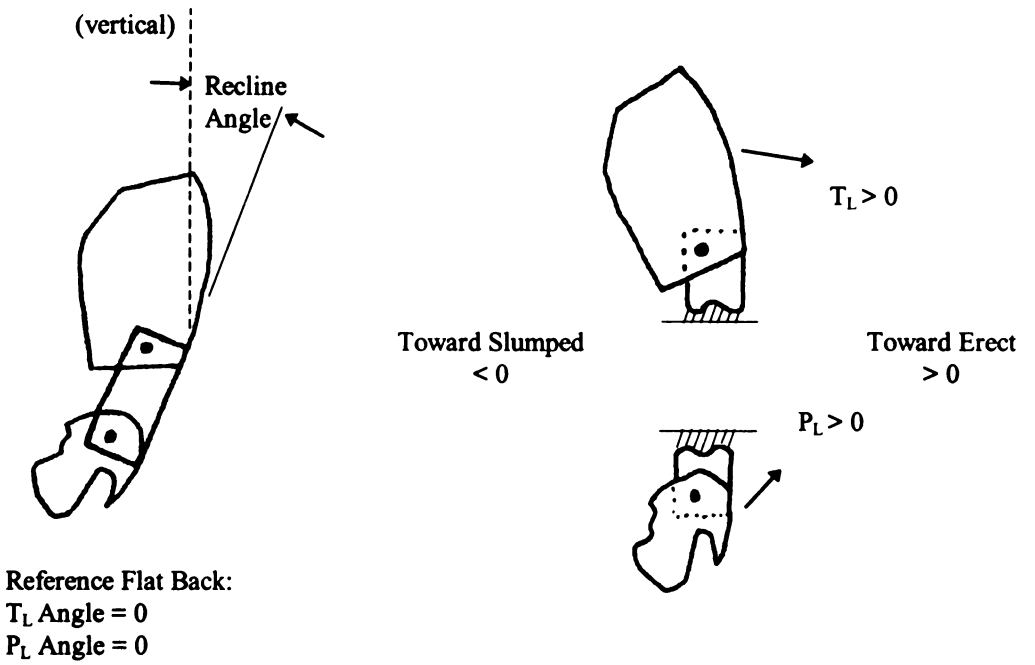

Figure 10: Posture Descriptors

The joint locations of the three segment model will be determined through analysis of postures resulting from different support configurations. Once the joint locations are determined, relative to the thorax and pelvis segments, the length of the segment connecting these joints will be calculated, and the angles through which the segments move relative to one another will be investigated. Coupling that might exist between the motions of the pelvis and thorax, as in Bush's model, will also be evaluated.

2. EXPERIMENTAL METHODS

2.1 Introduction

The goal of this research was to impose various geometric support conditions on the backs of seated mid-size males and to gather information about the postures attained by these subjects, resulting from these input support conditions. Analysis of the output was aimed at determining a three-segment torso model, first by locating centers of rotation between thorax and lumbar segments and between pelvis and lumbar segments, then by determining the ranges of motion about the joint centers.

This section describes methods that pertain to experimental set-up, data collection, and analysis techniques used in completing these tasks.

2.2 Test Setup

2.2.1 Data Acquisition

Data relating to the posture of each subject was collected using a five-camera Qualisys position and motion measurement system to locate targets placed over skeletal landmarks. The cameras were arranged to surround the test space, which was approximately 5.5 m x 5.5 m. The lenses of the measurement system cameras are surrounded by infrared (IR) light emitters, while the lenses themselves are equipped with IR filters. The camera apertures were closed sufficiently so that they would detect only the very brightly reflected IR light from test targets in the test space. (See Section 2.2.3 for details on targets.) MacReflex software, running on a Power Macintosh 7100/66AV

and connected to the Qualisys camera system, provided the coordinates of each target's location in three dimensional space, relative to the test space as output.

2.2.2 Test Space

The test space was calibrated such that each target would be seen by a minimum of two cameras for each trial of testing, as required by the camera system and software for three-dimensional target coordinate calculation. The coordinate system created by the calibration process determined the positive X-axis pointing toward the rear of the space, in accordance with standard SAE coordinates. A right-handed Cartesian coordinate system was created, with the Y-axis toward the subject's right, and the Z-axis upward (perpendicular to the plane of the floor.)

2.2.3 Measurement Targets

Spherical wooden beads of 16 mm diameter, to be used as measurement targets, were coated with a layer of 3M retro-reflective tape. This tape is imbedded with small glass spheres that make it highly reflective. Each target was then mounted with an adhesive to a 25 mm by 25 mm piece of vinyl backing material.

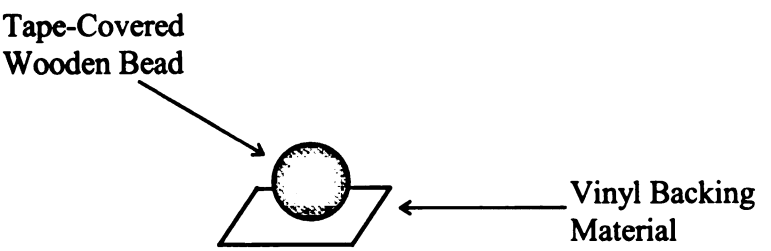

Figure 11: Measurment Target

These targets were taped to a subject's skin over palpated skeletal landmarks of interest,

as will be discussed in Section 2.4.2.

2.2.4 Measurement Probe

For applications in which the targets were not practical, i.e., if there was not good camera visibility or space for a target, as when locating points on the spine, a measurement probe was used to locate the skeletal landmark. Probe construction began by cutting 4 mm diameter steel drill rod to an arbitrary length (approximately 375 mm.) Two 25 mm diameter wooden beads were drilled down a centerline to receive the drill rod. The beads were then covered with reflective tape (as with the targets discussed in Section 2.2.3) and mounted on the drill rod, one at the end and one near the middle. The bead locations along the rod were fixed with epoxy. See Figure 12.

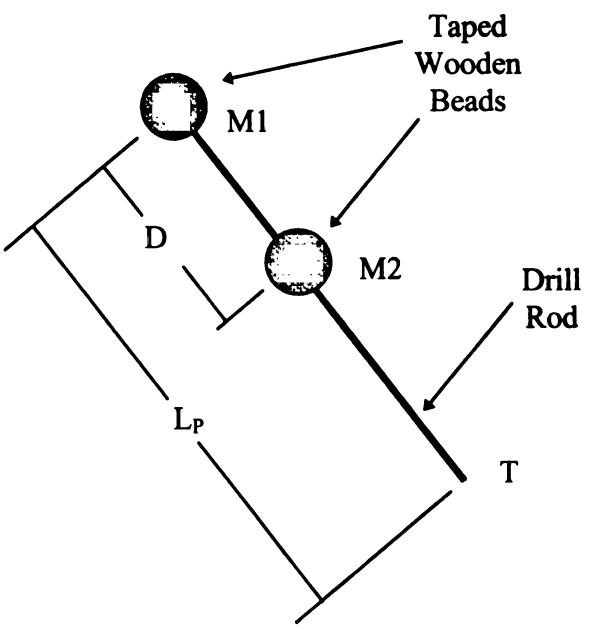

Figure 12: Measurement Probe

As labeled in Figure 12, the length (L_P) of the probe from the center of Marker 1 (**M1**) to

the Tip (**T**) was measured. The location of the probe tip could be calculated from measured positions in space of the centers of Marker 1 and Marker 2 (**M2**) using the principle of right triangles.

$$D = \sqrt{(M1_x - M2_x)^2 + (M1_y - M2_y)^2 + (M1_z - M2_z)^2} \qquad (1)$$

$$T_i = \frac{(L - D)\,M1_i - (L)M2_i}{(-D)} \qquad i = x, y, z \qquad (2)$$

$$\mathbf{T} = T_i\,\hat{\mathbf{e}}_i \qquad i = x, y, z \qquad (3)$$

In the event that a skeletal landmark location was physically inaccessible from being probed, a point superior and a point inferior to the actual location were probed and the two calculated tip locations were averaged.

2.2.5 Reference Seat

In order to gather posture data, it was first necessary to take a reference file, while the subject was seated in a reference seat. The reference file offered a consistent set of conditions under which to define locations of C7 and T4 spinous processes relative to the manubrium and xyphoid, and to get a reference foot angle of zero degrees.

The seating surfaces of the reference seat were constructed of plywood, with a seat pan angle of 15° (SAE L27 10° [8]) and a back angle of 23° (SAE L40 24° [8]). The back surface was made of two plywood sections, with an opening down the center, in order to provide access and visibility to the subject's spine. See Figure 13.

Two targets were affixed to the left lateral side of the reference seating surface.

The first target (T1) was aligned 120 mm forward of the seat back, so that it would be approximately lateral of a seated subject's ischial tuberosities. This target placement would allow superior/inferior scaling of the pelvis shape. The second target (T2) was 225 mm rearward of the first, along the seat pan, as shown. Because T2 was directly rearward of T1, in the X-Y plane, the pair of targets provided the necessary information to align the subjects' sagittal plane with the X-Z plane of the test space.

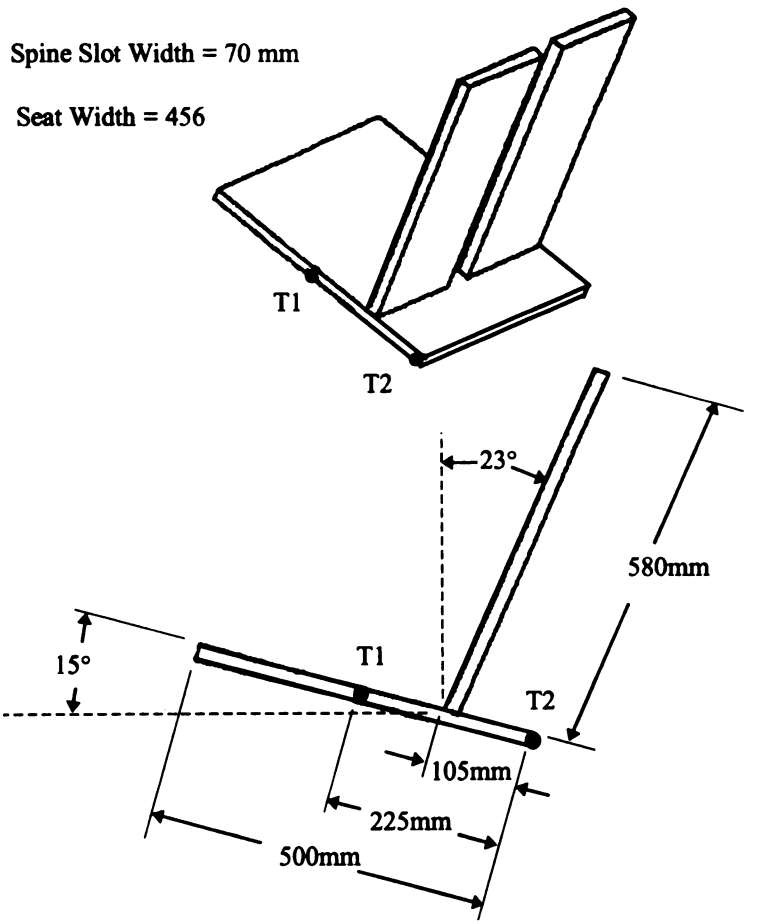

Figure 13: Reference Seat

2.2.6 Test Buck

In order to examine the postures of seated individuals in terms of a model, a laboratory seating buck was designed that would allow an adjustable seat back geometry. The buck is shown in Figure 14. The seating package was designed to produce a knee angle near 120°, using the SAE mannequin 50th percentile thigh and shank lengths [8]. This knee angle was chosen in order to minimize tension in the hamstring muscles that might restrict lordotic postures, as discussed in Section 1.2.5. The package was given an average vertical H-Point to Heel Point height of 398 mm, and a nominal horizontal H-Point to Ball of Foot distance of 885 mm [8]. This horizontal distance was adjustable, allowing the subject to choose an acceptable "pedal distance" at the beginning of the test.

A pair of vertical hand grips was provided for support of the arms, but not to require that the subject reach far forward. It was not desired that hand position be a major postural input, as described in Section 1.2. The hand grips were therefore much nearer the torso than an average steering wheel might be. These grips were centered on the buck in the Y-direction and were 305 mm apart. In the sagittal view, they were located approximately X = 150 mm and Z = 210 mm from the SAE H-Point location. The hand rests were adjustable ±20 mm vertically, in order to accommodate differences in subject torso and arm lengths.

The seat pan was constructed of flat plywood, and extended forward approximately 420 mm from the intersection with the back support plane in a flat configuration. The buck had a constant seat pan angle of 15° (SAE L27 = 10° [8].)

The seat back was comprised of four 30 mm diameter galvanized steel tubes. These were mounted horizontally and were adjustable in height as well as prominence

(distance from the back frame). A stop block was the lowermost seat back component and was used to provide consistent pelvis location. The seat back angle was 23° (SAE L30 = 24° [8]) in the flat contour configuration. See Figure 14.

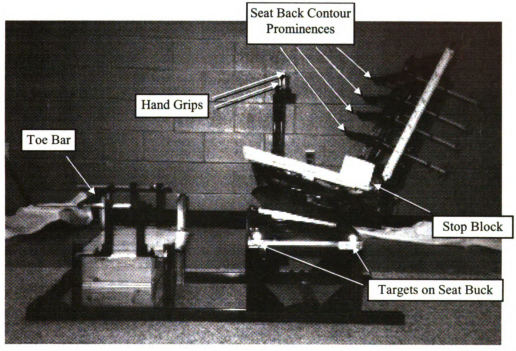

Figure 14: Test Buck

Two targets were affixed to the buck on the lower left side, along the fore-aft axis of the test buck. Note the bright spots in Figure 14. Because the targets were directly aligned with the test buck, they provided the necessary information to align each subject's sagittal plane with the X-Z plane of the test space.

Length scales were mounted on the left and right seat back members, for consistent measurement of support height. A similar scale was also attached to each support, allowing measurement of relative support prominence. These are shown in Figure 15.

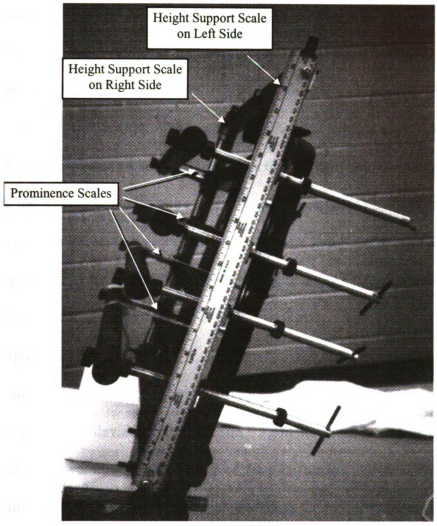

Figure 15: Height and Prominence Scales

2.2.7 Test Clothing

Clothing was provided to the test subjects for use during testing. It was necessary that targets be attached to the subjects' skin at various locations, and that these targets be readily visible by the cameras. The test clothing therefore consisted of tight-fitting garments (a tank top and a pair of running style shorts), with holes in necessary areas. The tank top was cut in the front to allow affixing of a target to the xyphoid and cut down the back to allow access to the spinous processes. The shorts were cut in the back to allow access to the sacrum and cut on the front left to allow a target to be affixed to the skin at the left ASIS.

2.3 Subject Selection

Subjects were selected to be mid-size males, based on the 1974 HANES U.S. population study [9], deviating plus or minus 5 kg in mass and 25 mm in stature (height). The upper and lower limits for the ranges of mass and stature indicated by these specifications are given in Table 2. Appendix A lists the height and mass for each of the ten tested subjects.

Table 2: Subject Specifications

	MINIMUM	**MAXIMUM**
Stature	1727 mm	1778 mm
Mass	73 kg	82 kg

2.4 Testing Protocol

2.4.1 Introduction

A testing protocol was followed, allowing posture data to be gathered in each of the test conditions. These data pertained to the limbs as well as the torso, to document the total posture of each subject in each test condition.

2.4.2 Test Preparation

1. Prior to subject arrival, the test space was calibrated as described in Section 2.2.2.
2. Double sided medical tape was adhered to each of thirteen targets. (See Section 2.2.3.)
3. The reference seat was brought into the space, facing the negative X-direction.
4. Upon subject arrival, the experiment was explained in detail to the subject.
5. The subject was asked to sign a UCRIHS (IRB 96-054) approved subject consent form. (Appendix B contains a sample copy.)
6. The subject was asked to change into prepared test clothing (as described in Section 2.2.7), leaving shoes on.
7. Medical tape was placed on palpated spinous processes T10, T12, L3, and S1 on the subject's back.
8. A single dot was made on each tape over the spinous processes. This would be the point to be probed in each test condition.
9. The subject was asked to sit upright on a hard surface and the heights from this surface of the following landmarks were recorded: T6, T12, L3, PSIS.
10. The test buck's back supports were then adjusted to the heights from the previous step, as measured from the test seat surface.
11. Prepared targets were fixed to the subject, at the following palpated skeletal landmarks:
    a) manubrium
    b) xyphoid
    c) left ASIS
    d) left lateral femoral condyle
    e) left lateral malleolus
    f) left lateral ball of foot
    g) spinous process levels of C7, T4, and S1
12. Three measurements were then taken and recorded,
    a) The lateral distance between the subject's ASIS's
    b) The lateral distance between the subject's PSIS's
    c) The distance from the posterior heel of the shoe, to the location of the foot target, measured anteriorly.
13. The subject was then asked to sit in the reference seat, as described in Section 2.2.5, keeping his feet on a flat level surface, and hands beside his thighs, resting on the

seat pan. See Figure 16.

14. Target location data was gathered in this reference configuration, using the Qualisys system.
15. The subject got out of the reference seat.
16. The targets were then removed from the C7, T4 and S1 locations.
17. A target was affixed to the subject's left lateral humoral condyle and another to the back of the subject's left wrist, between the radial and ulnar condyles.
18. The reference seat was removed from the space and the test buck brought into the space.
19. The subject was asked to sit in the test buck.
20. The subject was instructed to sit in the seat with as extreme a lordotic posture as possible. He was encouraged to attempt to tilt his pelvis forward and push his shoulders back, bringing his lumbar spine away from the support surface as much as possible.
21. The test buck's back supports were adjusted to meet the back contour produced by this intentional lordosis. The values were read from the prominence support scales and were recorded.
22. The subject was then asked to slump into a kyphotic posture as much as possible.
23. The supports were again adjusted to meet this posture and the prominence values were recorded.
24. The subject was asked to exit the test buck.
25. The test buck's seatback was set at test condition 1. (Test conditions are described in Section 2.4.4.)

2.4.3 Testing Procedure

1. The subject was asked to enter the test buck, sliding his pelvis rearward until it contacted the stop block, then leaning back to contact the remaining back supports. (See Figure 17.)
2. The subject was asked to focus on a designated spot on the wall, which was straight ahead and approximately at eye level, and which produced a typical driving head angle.
3. The subject was asked to inhale and completely exhale.
4. When the subject had expired his air, target location data was gathered while the following five points were probed:
   a) the acromion*
   b) taped spinous processl levels: T10, T12, L3 and S1
5. The subject was asked to exit the test buck.
6. The buck's seatback contour was adjusted for the next condition.

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* The acromion is the most prominent bone on the top of the shoulder joint, and was probed at the most anterior, lateral point.

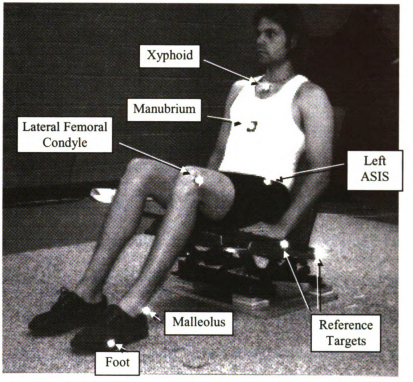

Figure 16: Subject in Reference Seat

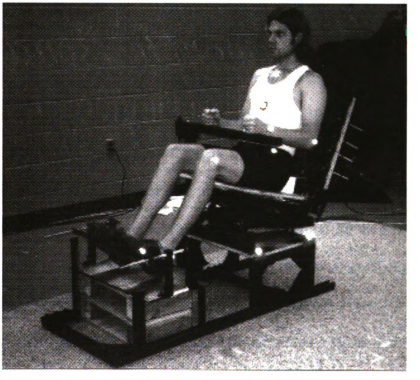

Figure 17: Subject in Test Buck

The Testing Procedure was repeated for each test condition, as discussed in the next section.

2.4.4 Test Conditions

Each test condition consisted of an amount of support applied to the thorax through the two uppermost seatback supports (T6 and T12 spinous process levels), and an amount of support applied to the pelvis by the lowest support (PSIS level). The support at the L3 level was used only to relieve any load concentrations caused by the other supports, but was not intended to initiate input contour control. The settings for the back support prominences for each test condition were computed separately for each subject. The extreme values for the lordotic and kyphotic range, as found in Steps 20-23 of the test preparation, were used to calculate the list of test conditions.

The flat seat back was defined as the configuration in which all of the supports were in line with the pelvis stop block. Thorax Flat was the case in which the thorax supports (at the T6 and T12 spinal levels) were still in line with the pelvic stop block. Pelvis Flat was the configuration in which the pelvis support (PSIS level) was even with the stop block.

The intentional lordotic extreme posture of test preparation Step 20 gave the values for extremely erect thoracic and pelvic support conditions for the test subject. These were Thorax Erect posture of degree 2 and Pelvis Erect posture of degree 2. Halfway between Thorax Erect degree 2 and Thorax Flat was designated Thorax Erect degree 1. Likewise, Pelvis Erect degree 1 was halfway between Pelvis Erect degree 2 and Pelvis Flat. Thorax Erect degree 3 was the same as Thorax Erect degree 2, but with the topmost support relieved by five millimeters, allowing the subject's shoulders to fall back

even more.

The slumped conditions were determined in much the same way. The intentional extreme kyphotic posture of Test Preparation Step 22 gave the values for extremely slumped thoracic and pelvic support conditions. These were Thorax Slumped posture degree 2 and Pelvis Slumped posture degree 2. Just as above, halfway between Thorax Slumped posture degree 2 and Thorax Flat was Thorax Slumped posture degree 1, and halfway between Pelvis Slumped posture degree 2 and Pelvis Flat was Pelvis Slumped posture degree 1.

The test conditions provided all combinations of various degrees of thorax support with degrees of pelvic support. A description of the order of support conditions follows. From a flat support condition (condition number 1), first the pelvis was given support at the PSIS level in two increments (conditions 2 and 3) until it was extremely supported, all the while the thorax supports remained in the original flat configuration. With the pelvic support at the full extreme, the thorax was brought to full support at the T12 level in two increments (4, 5) and then relieved of support at the T6 level (6). At this point, the subject was supported in a fully lordotic posture. The pelvis support was then relieved at the PSIS level in two increments back to its flat configuration position (7, 8), while the thorax remained supported at T12. The support of the thorax was then relieved by half (9). At this point, half of the most extreme pelvic support was brought back, to pair with the analogous support of the thorax (10). Then both the pelvis and thorax were relieved of support, just to the other side of flat (11). Then back to all flat. (12). The same procedure of combining pelvic and thoracic support conditions was followed in the slumped postures. The complete list of test conditions is shown in Table 3.

Table 3: Test Conditions

CONDITION NUMBER	THORAX SUPPORT CONDITION	PELVIS SUPPORT CONDITION
1	FLAT	FLAT
2	FLAT	ERECT 1
3	FLAT	ERECT 2
4	ERECT 1	ERECT 2
5	ERECT 2	ERECT 2
6	ERECT 3	ERECT 2
7	ERECT 2	ERECT 1
8	ERECT 2	FLAT
9	ERECT 1	FLAT
10	ERECT 1	ERECT 1
11	SLUMPED 1	SLUMPED 1
12	FLAT	FLAT
13	FLAT	SLUMPED 1
14	FLAT	SLUMPED 2
15	SLUMPED 1	SLUMPED 2
16	SLUMPED 2	SLUMPED 2
17	SLUMPED 2	SLUMPED 1
18	SLUMPED 2	FLAT
19	SLUMPED 1	FLAT
20	ERECT 1	ERECT 1
21	SLUMPED 1	SLUMPED 1
22	FLAT	FLAT

These conditions were chosen in order to characterize the centers of rotation as well as to examine the possible existence of a coupling linkage, as suggested by Bush. If Bush's model were correct, supporting only the pelvis would increase not only the P_L angle (see Figure 10), but also the T_L angle by the same amount. The unbalanced support conditions, brought to extremes in conditions 3, 8, 14, and 18, were designed to bring out the details of this linkage.

2.5 Analysis Approaches

2.5.1 Simplifying Modeling Assumptions

Because each thoracic and lumbar vertebra is able, to some degree, to rotate relative to its neighboring vertebra, as discussed in Section 1.2.3, the anatomical spinal linkage is of 16 joints. This system is very complex for explicit description in each given posture. To create a usable and understandable human torso linkage model, several simplifying assumptions have been made in an attempt to represent this complex system in some simpler terms.

The first simplifying assumption was to consider only postures taking place symmetric to the mid-sagittal* plane, in keeping with the previous works of Haas [2] and Bush [3], since vehicle packaging and many other seated environments are designed symmetrically. The implication is that the model described in this research will be a two dimensional side view of a person.

Th next simplifying strategy followed Bush's work, discussed in Section 1.1, which was to lump the torso into three rigid segments, simply connected with only two

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* The mid-sagittal plane divides the body into mirror image, left and right halves.

joints. However, the three rigid segments need not be assumed to be the same ones used by Bush. To the contrary, the aim of the current research was to define joint locations between rigid segments that matched experimental data over the total range of support conditions.

2.5.2 Raw Data Treatment

The raw target data for each subject were rotated to align the sagittal plane with the X-Z plane, such that positive X was rearward, and positive Y toward the subject's right. For details on this rotation, see Appendix C.

Because the test data were then aligned with the coordinate system of the test space, and because of the assumption of symmetry about the sagittal plane, only the X and Z coordinates of the data were considered from this point on.

2.5.3 Thorax Shape

In the reference file, the locations of the targets over the manubrium, xyphoid, and spinal levels C7 and T4 were all known. From these measured target locations, actual skeletal landmark locations had to be calculated. Calculation from the target center to the actual landmark was achieved by construction of the appropriate vector from the target center to the landmark. The length of this calculation vector (L_{cv}) was defined to be half the target diameter (d_t) plus the thickness of the target backing (t_b) plus the thickness of the tissue at that point (t_t).

$$L_{cv} = \frac{1}{2} d_t + t_b + t_t \qquad (4)$$

The vectors' directions were considered individually by landmark, and will be discussed now. For the manubrium and xyphoid target pair, the calculation vector for both targets was chosen to be perpendicular to the line connecting these two target locations, toward the posterior of the body. See Figure 18.

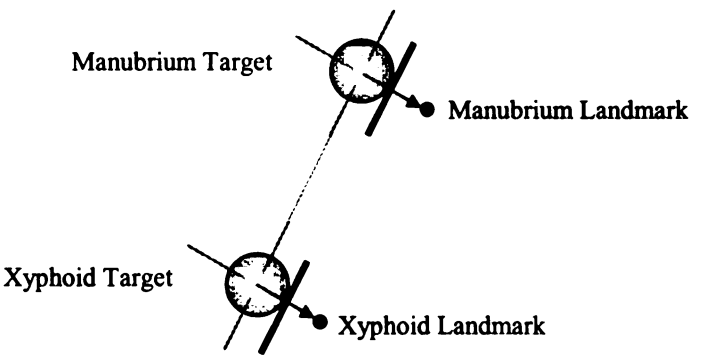

Figure 18: Calculation Directions for Locating Sternum from Targets

For the spinous process levels C7 and T4, the calculation direction was perpendicular to the line between the C7 and T4 targets, anteriorly. These directions are summarized in Table 4.

Table 4: Target to Landmark Directions- Thorax

LANDMARK	⊥ TO LINE: FROM	TO
Manubrium	**Manubrium**	**Xyphoid**
Xyphoid	**Manubrium**	**Xyphoid**
C7	**C7**	**T4**
T4	**C7**	**T4**

Mathematically, let there be a pair of target locations (**J**″ and **K**″) for which the landmarks lie a certain distance from the target, in a direction perpendicular to the line

between these two target. Let **J″** be the more superior target, when the landmarks are more anterior than the targets. Or let **K″** be the more superior target, in the case that the landmarks are posterior to the target locations. Under either of these circumstances, the skeletal landmark locations (**J** and **K**) are calculated from the target locations (**J″** and **K″**) as follows:

$$\mathbf{J} = \left[J_x'' + L_{cv}(\sin\theta)\right]\hat{\mathbf{e}}_x + \left[J_z'' + L_{cv}(\cos\theta)\right]\hat{\mathbf{e}}_z \tag{5}$$

$$\mathbf{K} = \left[K_x'' + L_{cv}(\sin\theta)\right]\hat{\mathbf{e}}_x + \left[K_z'' + L_{cv}(\cos\theta)\right]\hat{\mathbf{e}}_z \tag{6}$$

$$\theta = \sin^{-1}\left[\frac{(J_X'' - K_X'')}{\sqrt{(J_X'' - K_X'')^2 + (J_Z'' - K_Z'')^2}}\right] \tag{7}$$

To complete a rigid thorax shape for the subject, the locations of the probed skeletal landmarks T10 and T12 relative to the manubrium and xyphoid were taken from the flat input configuration of test condition 12. Since posture influences thorax shape in the lower thoracic region[*], a neutral posture was chosen for locating the T10 and T12 spinous processes relative to the rest of the ribcage. From these probed points, the T10 and T12 skeletal landmarks were located beneath the tissue. Analogous to the above description of calculating landmark locations from target positions, the T10 and T12 spinal landmark locations were extracted from the probed point data by creating a vector from the probed points to the landmarks. The vectors, in this case, were created

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[*] influence of postural change on thorax shape has been experienced in previous laboratory investigation.

perpendicular to the vector connecting the probed points for T10 and T12, and had a length equal to the estimated tissue thickness (3 mm). The T10 and T12 landmarks, relative to the xyphoid and manubrium, were included with the xyphoid, manubrium, C7 and T4 landmarks from the reference file. These were all of the points necessary for creation of a rigid thorax shape. A sample thorax shape for a subject is shown in Figure 19.

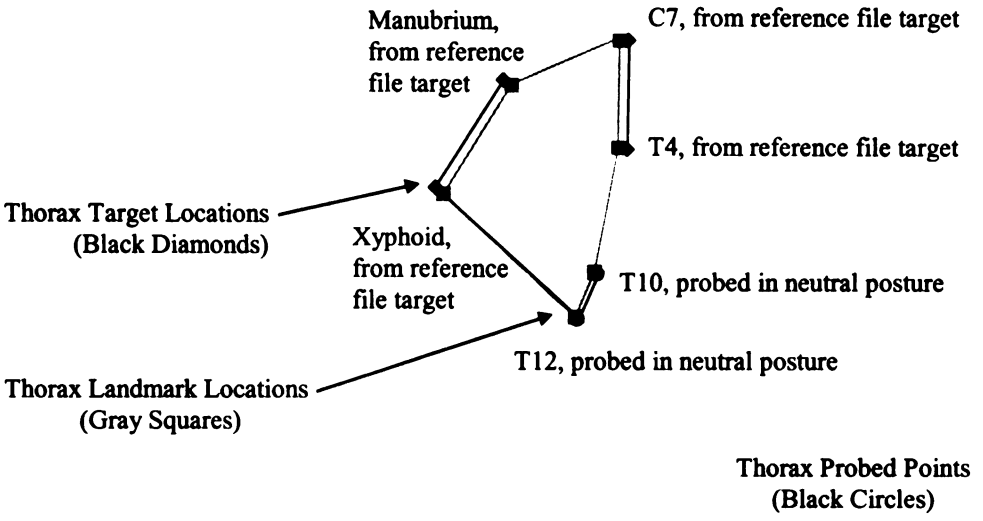

Figure 19: Example of Thorax Target Locations with Calculated Landmark Locations

Once this reference thorax shape was established for a subject, it was rotated for each test condition to match the same xyphoid location and xyphoid-to-manubrium vector orientation as that found in the test condition. This transformation was performed to provide visual representation of the thorax segment during analysis and to document rigid C7, T4, T10, and T12 locations for ech test condition.

Mathematically, the first step in this transformation was to locate the manubrium

and xyphoid landmarks relative to the target locations, repeating the procedure used for this task in the reference file. Refer again to Figure 19. The following transformation equation was then used:

$$\{\mathbf{T}'\} = \begin{bmatrix} \cos\theta_T & \sin\theta_T & 0 \\ -\sin\theta_T & \cos\theta_T & 0 \\ 0 & 0 & 1 \end{bmatrix} \{\mathbf{T} - \mathbf{Xy}\} + \{\mathbf{Xy}'\} \tag{8}$$

where

$$\begin{aligned} & i = x, z \\ & \mathbf{T}' = T_i' \, \hat{\mathbf{e}}_i \\ & \mathbf{T} = T_i \, \hat{\mathbf{e}}_i \\ & \mathbf{Xy}' = Xy_i' \, \hat{\mathbf{e}}_i \\ & \mathbf{Xy} = Xy_i \, \hat{\mathbf{e}}_i \\ & \theta_T = \phi_T' - \phi_T \\ & \phi_T' = \sin^{-1}\left(Man_x' - Xy_x'\right) \\ & \phi_T = \sin^{-1}\left(Man_x - Xy_x\right) \\ & \mathbf{Man}' = Man_i' \, \hat{\mathbf{e}}_i \\ & \mathbf{Man} = Man_i \, \hat{\mathbf{e}}_i \end{aligned} \tag{9}$$

$\mathbf{T}'$ is the test location of any rigid thorax shape point (C7, T4, T10, or T12), $\mathbf{T}$. $\mathbf{Xy}'$ is the test condition location of the xyphoid and $\mathbf{Xy}$ is the rigid thorax shape location of the xyphoid. θ_T the difference in thorax orientation between the test condition orientation (ϕ_T') and the rigid shape orientation (ϕ_T). $\mathbf{Man}'$ is the test location of the manubrium and $\mathbf{Man}$ is the rigid shape manubrium location. The matrix is the transformation matrix [10].

2.5.4 Thoracic Coordinate System

A thoracic coordinate system was necessary for locating points on the rigid thorax

and also for comparison between subjects' thoraces. The thoracic coordinate system is shown in Figure 20, with the origin at the rigid thorax T12 and the Z_T-axis through C7.

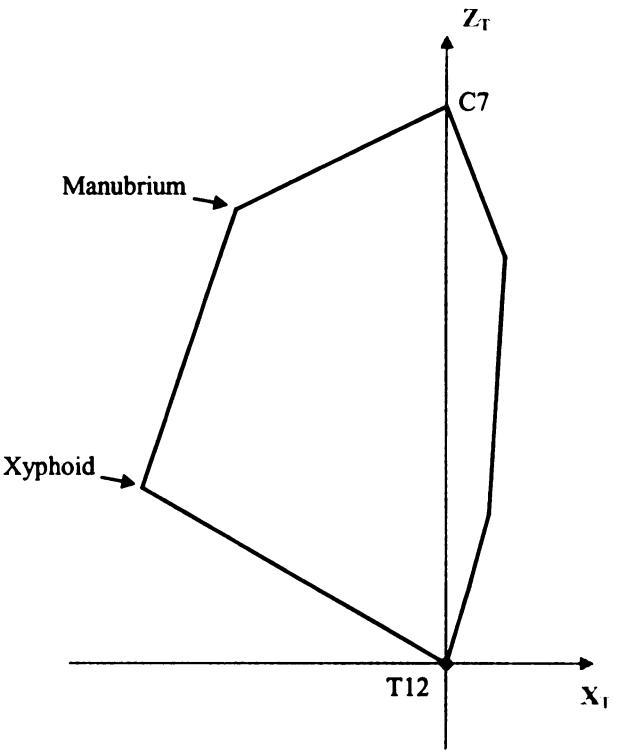

Figure 20: Thoracic Coordinate System

This coordinate system was chosen on the back of the body, as the back is expected to be what contacts a seating surface, and should be held consistent between subjects.

2.5.5 Pelvis Shape

Analogous to the creation of the thorax shape, a pelvis shape was also constructed. In the reference file, the locations of the left ASIS and the sacrum were measured with targets. To compute the locations of the skeletal landmarks from these target locations, a vector was again constructed from the target centroid to the landmark.

The length of the calculation vector was again L_{cv}, as above. The direction used for calculating from the target center to the landmark for the ASIS was in the direction from the ASIS target toward the sacral target, in the sagittal view. For the sacrum, it was toward the ASIS target from the sacral target, in the sagittal view. See Figure 21.

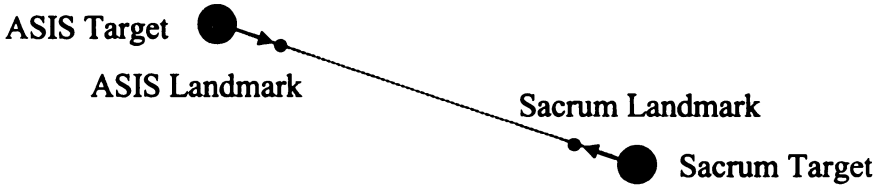

Figure 21: ASIS and Sacral Landmark Locations from Target Data

Mathematically, similar to Equations 5, 6, and 7 on page 33, the ASIS and sacrum landmark locations (**A** and **S**) are calculated from the target locations (**A**″ and **S**″) as follows:

$$\mathbf{A} = \left[A_x'' + L_{cv}(\cos\theta)\right]\hat{\mathbf{e}}_x + \left[A_z'' - L_{cv}(\sin\theta)\right]\hat{\mathbf{e}}_z \qquad (10)$$

$$\mathbf{S} = \left[S_x'' - L_{cv}(\cos\theta)\right]\hat{\mathbf{e}}_x + \left[S_z'' + L_{cv}(\sin\theta)\right]\hat{\mathbf{e}}_z \qquad (11)$$

$$\theta = \sin^{-1}\left[\frac{(A_Z'' - S_Z'')}{\sqrt{(A_X'' - S_X'')^2 + (A_Z'' - S_Z'')^2}}\right] \qquad (12)$$

A general pelvis shape was then created from data contained in a report by Reynolds, *et al.* [11]. Figure 22 shows the sagittal view pelvic shape resulting from the

location of points on the outline of Reynolds' pelvis shape relative to the ASIS and S1 landmarks.

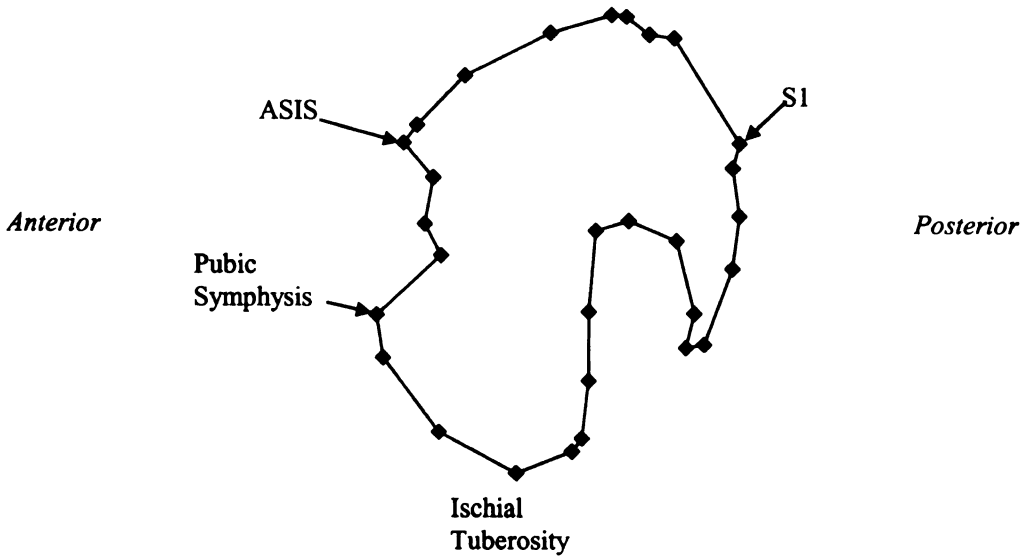

Figure 22: General Pelvis Shape

This pelvis shape was only used as a visual representation and to estimate hip joint center location, which will be discussed in Section 2.5.21. Overall pelvis scaling was based on the subject's S1 to ASIS distance in the sagittal view. Additional scaling was performed based on knowledge of the pelvis bottom location. Since the location of the bottom of the pelvis was known in the reference file to rest upon the seat pan of the reference seat, level with the origin target of the reference seat, this known location of the bottom of the subject's pelvis was used for superior-inferior scaling. See Appendix D for details of pelvis shape creation, as well as scaling methods.

For every test condition, data gathered on the location of the pelvis consisted of the left ASIS target location and the location of a probed point at S1. (See Section 2.2.4

for details on calculating point location from probe data.) The locations of the ASIS and S1 skeletal landmarks were calculated exactly as described for the reference condition, except that the length of the vector from the S1 probed point to the skeletal landmark in the test conditions was only the clothing thickness plus the estimated tissue thickness (5 mm), since there was no target diameter to consider.

The reference pelvis shape was then manipulated in the same manner as was the thorax reference file shape. It was rotated to match the S1 skeletal landmark location and the S1-to-ASIS orientation of the test condition.

$$\{\mathbf{P}'\} = \begin{bmatrix} \cos\theta_P & \sin\theta_P & 0 \\ -\sin\theta_P & \cos\theta_P & 0 \\ 0 & 0 & 1 \end{bmatrix} \{\mathbf{P} - \mathbf{S}\} + \{\mathbf{S}'\} \qquad (13)$$

where

$$\begin{aligned} &i = x, z \\ &\mathbf{P}' = P_i' \hat{\mathbf{e}}_i \\ &\mathbf{P} = P_i \hat{\mathbf{e}}_i \\ &\mathbf{S1}' = S1_i' \hat{\mathbf{e}}_i \\ &\mathbf{S} = S1_i \hat{\mathbf{e}}_i \\ &\theta_P = \phi_P' - \phi \\ &\phi_P' = \sin^{-1}\left(A_z' - S_z'\right) \\ &\phi_P = \sin^{-1}\left(A_z - S_z\right) \\ &\mathbf{A}' = A_i' \hat{\mathbf{e}}_i \\ &\mathbf{A} = A_i \hat{\mathbf{e}}_i \end{aligned} \qquad (14)$$

P′ is the test location of any rigid pelvis shape point, **P**. **S1′** is the test condition location of S1 and **S1** is the rigid pelvis shape location of S1. θ_P the difference in pelvis orientation between the test condition orientation (ϕ_P') and the rigid shape orientation

(ϕ_P). **A′** is the test location of the ASIS and **A** is the rigid shape ASIS location.

2.5.6 Pelvic Coordinate System

A pelvic coordinate system was created for locating points on the pelvis and comparing these points between subjects. The chosen coordinate system is shown in Figure 23, with the origin at the sacral skeletal landmark and the negative X-axis through the ASIS.

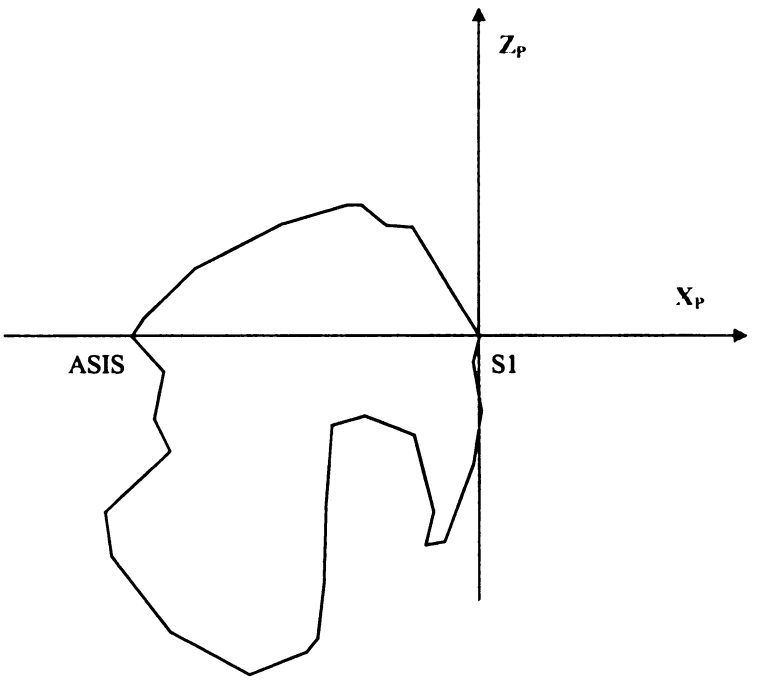

Figure 23: Pelvic Coordinate System

Just as with the thoracic coordinate system, this pelvic coordinate system was chosen with its origin at the back of the body. Since the model's back would be expected to interact with a seat, the subjects' backs should be documented consistently between subjects.

2.5.7 Spinal Data

During testing, the use of targets to locate landmarks on the subjects' backs would have been impractical, due to visual blockage and physical interference by the test buck. Therefore, during test trials, spinous process levels of interest (T10, T12, L3, and S1) were probed instead of targeted. Locations of the spinous process skeletal landmarks were calculated from the probe target data, as discussed in Section 2.2.4. In order to determine the locations of the skeletal landmarks below the tissue, it was assumed that the tissue thickness over these spinous processes was three millimeters. In an analogous manner to the methods described for the thorax and pelvis in Sections 2.5.3 and 2.5.5, calculation directions from probed points to skeletal landmarks were determined for probed points in the sagittal view. The direction for calculation from the T10 probed point to the location of the T10 spinous process was the direction perpendicular to the line between the T10 and T12 point locations, anteriorly. The direction for calculation from the T12 probed point to the location of the T12 spinous process was the direction perpendicular to the line between the T10 and L3 point locations, anteriorly. The direction for calculation from the L3 probed point to the location of the L3 spinous process was the direction perpendicular to the line between the T12 and S1 point locations, anteriorly. The direction for calculation from the S1 probed point to the location of the S1 spinous process was the direction perpendicular to the line between the L3 and S1 point locations, anteriorly. For mathematical details, please refer to the equations on page 33, where L_{cv}, in this case, is the estimated tissue thickness (3 mm), and $\mathbf{J}^{\blacksquare}$ is the more superior of the probed points used in calculation.

2.5.8 Creating Spinal Points- "Upper Lumbar" and "Lower Lumbar"

Lumbar segments were to be determined as reference segments against which to compare thoracic and pelvic orientations. In order to define more reference lumbar segments, an additional spinal point was interpolated. (Lumbar segment definition will be discussed in Section 2.5.9.) A "lower lumbar point" (**LL**) was created by averaging the locations of the L3 and S1 bony landmark locations.

$$LL_i = \frac{1}{2}(L3_i + SI_i) \qquad i = x,z \tag{15}$$

Figure 24 shows a set of actual lumbar data points (filled diamonds) with the interpolated **LL** point (empty diamond). Although the **LL** point certainly varied slightly from representing an actual spinal point, the variation was taken to be negligible, as supported by the smooth shape created by the points in Figure 24.

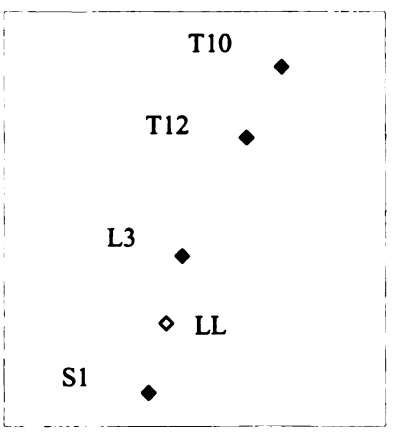

Figure 24: Actual Spinal Data Points with Interpolated Spinal Point, **LL**

2.5.9 Defining Lumbar Segments

While choosing the ribcage to represent the rigid thorax segment and the pelvic bones to represent the rigid thorax segment was fairly intuitive, because of their relatively rigid natures, the definition of the lumbar was not obvious. The human torso is not, in fact, comprised of three rigid sections. The lumbar spine, which anatomically connects the thorax and pelvis, changes shape with posture change. Because there was not obvious definition of a lumbar segment, five different lumbar definitions were used. The probed spinal points used to create each lumbar segment are listed in Table 5.

Table 5: Lumbar Segments

LUMBAR SEGMENT	LUMBAR PT. 2 (LP2)	LUMBAR PT. 1 (LP1)
1	S1	T12
2	LL	T12
3	S1	T10
4	LL	T10
5	L3	T10

Because of the dependence of the lumbar spine shape on posture, the spinous processes also move relative to one another as posture changes. The origin for each lumbar segment was chosen as the midpoint between **LP1** and **LP2**, because this midpoint would remain constant as the length of the vector between the pair of points changed with the change of spinal shape between postures. The coordinate system for each lumbar segment was as shown in Figure 25.

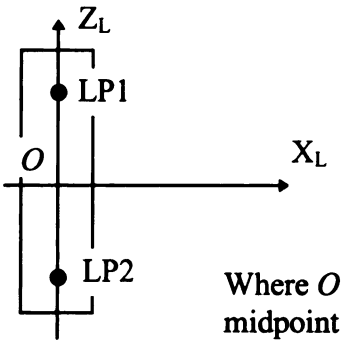

Figure 25: Lumbar Coordinate System

2.5.10 Thoracic and Pelvic Positions in the Lumbar Coordinate System

Thoracic and pelvic segments were transformed into the lumbar coordinate system so that positions and orientations of the thoracic and pelvic segments could be easily compared between test conditions, relative to the lumbar segment. For each lumbar segment, the coordinate transformation was carried out as follows:

$$\mathbf{L}' = \begin{bmatrix} \cos\theta_L & \sin\theta_L & 0 \\ -\sin\theta_L & \cos\theta_L & 0 \\ 0 & 0 & 1 \end{bmatrix} \{\mathbf{L}\} + \{\mathbf{O_L}\} \qquad (16)$$

$$\begin{aligned} & i = x, z \\ & \mathbf{L}' = L_i' \, \hat{\mathbf{e}}_i \\ & \mathbf{L} = L_i \, \hat{\mathbf{e}}_i \\ & \mathbf{O_L} = O_i \, \hat{\mathbf{e}}_i \\ & \theta_L = \sin^{-1}(\hat{\mathbf{z}}_\mathbf{L} \cdot \hat{\mathbf{e}}_z) \end{aligned} \qquad (17)$$

where $\mathbf{L}'$ is the position in lumbar coordinates of any thoracic or pelvic point that had position $\mathbf{L}$ in test space coordinates. $\mathbf{O_L}$ is the origin of the lumbar coordinate system and

θ_L is the angle of orientation of the lumbar segment in the test space: the angle between the lumbar's Z-axis and the Z-axis of the test space. The matrix is the transformation matrix [10].

2.5.11 Locating Model Joints, Introduction

The goal was to determine joint locations, or centers of rotation between adjacent segments (thorax and lumbar, and pelvis and lumbar), for the model.

2.5.12 Calculation of Rotation Centers in Lumbar Coordinates

Treating the sets of data from each lumbar reference separately, centers of rotation were calculated for the thorax and pelvis in each lumbar coordinate system, between every two orientations of either the thorax or the pelvis. The center of rotation, assuming no pure translation, was determined using the following procedure: First, a two-dimensional vector was created from the initial location of a point on the body in one orientation (**A**) to the position of this same point in the other orientation (**A′**). This was repeated for a second point (**B** to **B′**). Vectors **D** and **E** were constructed with their origins at the midpoints of vectors **AA′** and **BB′**, respectively, and their directions perpendicular to these vectors. The intersection of vectors **D** and **E** was the calculated center of rotation (**C**). Figure 26 shows an example of two thoracic orientations and the associated center of rotation.

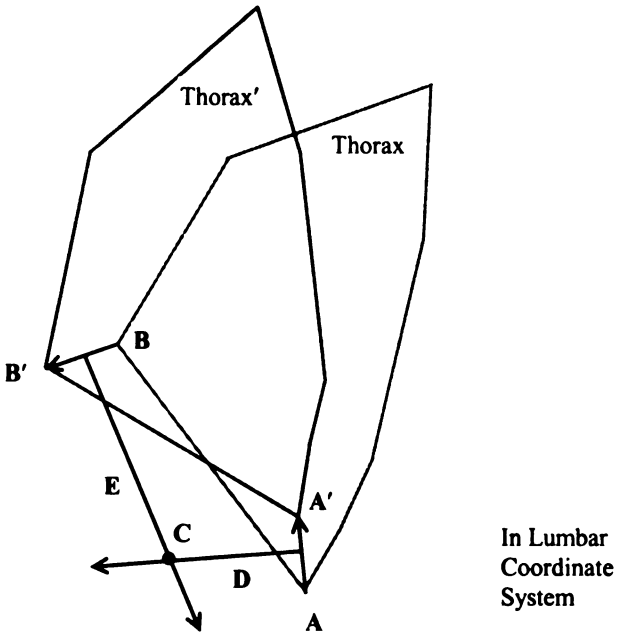

Figure 26: Diagram for Center of Rotation Calculation

The details of the rotation center calculations are given below.

Creation of vectors **AA′** and **BB′** :

$$\mathbf{AA'} = (A'_X - A_X)\,\hat{\mathbf{e}}_\mathbf{X} + (A'_Z - A_Z)\,\hat{\mathbf{e}}_\mathbf{Z} \qquad (18)$$

$$\mathbf{BB'} = (B'_X - B_X)\;\hat{\mathbf{e}}_\mathbf{X} + (B'_Z - B_Z)\;\hat{\mathbf{e}}_\mathbf{Z} \qquad (19)$$

Midpoint ($\mathbf{M_A}$) of vector **AA′**:

$$M_{AX} = \frac{1}{2}(A_X + A'_X) \qquad (20)$$

$$M_{AZ} = \frac{1}{2}(A_Z + A'_Z) \tag{21}$$

Midpoint ($\mathbf{M_B}$) of vector **BB′**:

$$M_{BX} = \frac{1}{2}(B_X + B'_X) \tag{22}$$

$$M_{BZ} = \frac{1}{2}(A_Z + A'_Z) \tag{23}$$

Location of rotation center **C**:

$$C_X = \frac{(B_Z + B'_Z - A_Z - A'_Z)}{2\left(\frac{A_X - A'_X}{A'_Z - A_Z} + \frac{B'_X - B_X}{B'_Z - B_Z}\right)} \tag{24}$$

$$C_Z = -\left(\frac{A'_X - A_X}{B'_Z - B_Z}\right)C_X + \frac{1}{2}(A_Z + A'_Z) \tag{25}$$

Note: In an attempt to minimize noise in the data, orientation differences of less than 7º between the thoraces or pelves in the lumbar coordinate system were not considered in computing rotation center locations. Seven degrees was chosen as the cutoff angle difference, because by trial and error this was found to give few erratic rotation center locations, which may have resulted from small rotation angles combined with pure translations.

2.5.13 Rotation Centers in Thoracic/Pelvic Coordinates

The centers of rotation as computed in the previous section were in the lumbar coordinate system. The set of thoracic or pelvic rotation center points was transformed into the thoracic or pelvic coordinate systems described in Sections 2.5.4 and 2.5.6.

Mathematically, this transformation was carried out as follows:

$$\mathbf{L}'' = \begin{bmatrix} \cos\theta_K & \sin\theta_K & 0 \\ -\sin\theta_K & \cos\theta_K & 0 \\ 0 & 0 & 1 \end{bmatrix} \{\mathbf{L}' - \mathbf{O}_\mathbf{L}\} + \{\mathbf{O}'\} \tag{26}$$

$$\begin{aligned} & i = x, z \\ & \mathbf{L}'' = L_i'' \hat{\mathbf{e}}_i \\ & \mathbf{L}' = L_i' \hat{\mathbf{e}}_i \\ & \mathbf{O}' = O_i' \hat{\mathbf{e}}_i \\ & \mathbf{O}_\mathbf{L} = O_{Li} \hat{\mathbf{e}}_i \\ & \theta_K = \sin^{-1}(\hat{\mathbf{z}}_\mathbf{L} \cdot \hat{\mathbf{z}}_\mathbf{K}) \end{aligned} \tag{27}$$

where $\mathbf{L}''$ is the position of the rotation center in thoracic or pelvic coordinates, and $\mathbf{L}'$ is the position in lumbar coordinates. $\mathbf{O}_\mathbf{L}$ is the origin of the lumbar coordinate system. $\mathbf{O}'$ is the origin of the thoracic or pelvic coordinate system to which the rotation center is being transformed. θ_K is the angle of orientation of the thoracic or pelvic segment in the lumbar coordinate system, where $\hat{\mathbf{z}}_\mathbf{K}$ is the orientation vector of the thoracic or pelvic coordinate system with respect to the lumbar coordinate system. The matrix is the transformation matrix [10].

2.5.14 Averaging Subject Data

For each subject, the rotation center locations of the thorax segment in thoracic

coordinates were averaged to yield a mean location. ($\overline{X}_{T1}, \overline{Z}_{T1}; ... \overline{X}_{T5}, \overline{Z}_{T5}$). The mean thoracic rotation center locations for each subject, for each lumbar, are given in Table 6 on page 63. Identically for the pelvis, the rotation center locations were averaged for each subject for each of the five lumbar segments. This gave an average pelvic rotation center location for each subject($\overline{X}_{P1}, \overline{Z}_{P1}; ... \overline{X}_{P5}, \overline{Z}_{P5}$), for each lumbar. These values are given in Table 8 on page 67.

2.5.15 Generalizing Subject Results

To locate the pin joints connecting the thorax to the lumbar and the pelvis to the lumbar, the averages computed in Section 2.5.14 of the thorax and pelvis rotation center locations were averaged over the subjects tested for each lumbar. These final values for the rotation centers with respect to each lumbar section ($\hat{X}_{T1}, \hat{Z}_{T1}, \hat{X}_{P1}, \hat{Z}_{P1}; ... \hat{X}_{T5}, \hat{Z}_{T5}, \hat{X}_{P5}, \hat{Z}_{P5}$) were then designated as joint centers between the model segments. These values are given in Section 3.3.2, Table 6 and Table 8.

The following sections discuss criteria for choosing the most appropriate lumbar segment based on error, length, and angle ranges, so that only one pair of the points determined by the methods in this section would be chosen for inclusion in the model.

2.5.16 Error in Joint Center Location

All the values with respect to a given lumbar segment for each subject were analyzed together, to determine the error associated with the calculations in Sections 2.5.14 and 2.5.15. The data for the rotation centers were grouped by subject. Recall that there is not necessarily an equal number of rotation centers determined for each subject, due to the filtration described in Section 2.5.13, (comparing only relative orientations of

greater than seven degrees difference.)

For both the thoracic and pelvic joint center estimations, the problem was treated as two separate univariate estimation tasks. A rectangle of at least 95% confidence was obtained by taking the (X, Z) pairings where X's belong to a 97.5% confidence interval for $\hat{X}$ and the Z's belong to a 97.5% confidence interval for $\hat{Z}$. This provided a rectangle estimate for $(\hat{X}, \hat{Z})$ of at least 95% confidence.

Since it was desired that an inference be made about the mean joint center location of all mid-sized males, not merely the mean for the males tested (I = 10), it was reasonable to use a "random-effects" model, which treats the individual systematic differences away from $(\hat{X}, \hat{Z})$ as a sample from a large population of all such differences, i.e. the population of such systematic differences for each mid-size male conceivable.

Symbolically, the X and Z coordinates of the rotation center location (thoracic or pelvic) were denoted (X_{ij}, Z_{ij}) where this is the j^{th} observation on the i^{th} subject, for i = 1...I (I is the total number of subjects), j = $1...n_i$ (n_i is the number of rotation centers determined for subject i). The random-effects models are:

$$X_{ij} = a_i + e_{ij} \tag{28}$$

$$Z_{ij} = b_i + f_{ij} \tag{29}$$

where $a_1...a_I$ are independent and identically distributed (i.i.d.) with a normal distribution of mean μ_a and standard deviation σ_a, [denoted, $N(\mu_a, \sigma_a)$] and e_{ij} $1 \le i \le I$, $1 \le j \le n_i$ are i.i.d. $N(0, \sigma_x)$ with $\{a_1...a_I\}$ independent of $\{e_{ij}, 1 \le i \le I, 1 \le j \le n_i\}$. And where $b_1 ...b_I$

are independent and identically distributed (i.i.d.) with a normal distribution of mean μ_b and standard deviation σ_b, [denoted, $N(\mu_b, \sigma_b)$] and f_{ij} $1 \le i \le I$, $1 \le j \le n_i$ are i.i.d. $N(0, \sigma_z)$ with $\{b_1 \ldots b_I\}$ independent of $\{f_{ij}, 1 \le i \le I, 1 \le j \le n_i\}$. ($a_i$ is the systematic deviation from μ_x for the i^{th} subject; e_{ij} is the random error of the j^{th} observation on the i^{th} subject in the X direction representing measurement error, etc. b_i is the systematic deviation from μ_z for the i^{th} subject; f_{ij} is the random error of the j^{th} observation on the i^{th} subject in the Z direction representing measurement error, etc.) From this model, the following 97.5% confidence interval formulas arise:

$$\text{For } \mu_x : \hat{X} \pm 2.24 * S(\hat{X}) \tag{30}$$

$$\text{For } \mu_Z : \hat{Z} \pm 2.24 * S(\hat{Z}) \tag{31}$$

where 2.24 is the confidence multiplier since $P(-2.24 < N(0,1) < 2.24) = 0.975$ and

$$\hat{X} = \frac{1}{I}\sum_{i=1}^{I} \overline{X}_i \tag{32}$$

$$\overline{X}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} X_{ij} \tag{33}$$

$$\hat{Z} = \frac{1}{I}\sum_{i=1}^{I} \overline{Z}_i \tag{34}$$

$$\overline{Z}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} X_{ij} \tag{35}$$

$$S(\hat{X}) = \frac{1}{I}\sqrt{\sum_{i=1}^{I} S^2(\overline{X}_i)} \tag{36}$$

$$S(\hat{Z}) = \frac{1}{I}\sqrt{\sum_{i=1}^{I} S^2(\overline{Z}_i)} \tag{37}$$

To obtain the values for $S^2(X_i)$ and $S^2(Z_i)$, an ANOVA (analysis of variance) was performed on the X and Z data separately. The MSE and MSTR values for both X and Z (MSE_x, $MSTR_x$, and MSE_z, $MSTR_z$) were output from this ANOVA. Then,

$$S^2(X_i) = \frac{1}{k}\left(\frac{(k-n_i)}{n_i} MSE_x + MSTR_x\right) \tag{38}$$

$$S^2(Z_i) = \frac{1}{k}\left(\frac{(k-n_i)}{n_i} MSE_z + MSTR_z\right) \tag{39}$$

where

$$k = \frac{1}{I-1}\left(N - \frac{\sum_{i=1}^{I} n_i^2}{N}\right) \tag{40}$$

[12] The above was performed identically for both thoracic and pelvic rotation centers, to obtain 97.5% confidence error estimations in both the X and Z directions for joint locations relative to each lumbar segment. The error estimations are given on page 70, in Table 9.

2.5.17 Length of Lumbar Segment

Once the overall averaged rotation center locations on the thorax and pelvis rigid

segments ($\hat{X}_T, \hat{Z}_T$ and $\hat{X}_P, \hat{Z}_P$) were calculated, the length of the member that would connect these two joint centers for each lumbar segment was to be determined. The location of the thoracic rotation center was attached as a feature to the rigid thorax and the pelvic joint center was attached to the rigid pelvis. The segment orientations for each subject were then observed in various test conditions, with the joint center traveling with the segments. (This process of calculating test condition point locations was previously discussed in Sections 2.5.3 and 2.5.5.) In each condition, the distance between the thoracic and pelvic joint centers was computed, using the Pythagorean theorem.

$$L_{ij} = \sqrt{(T_{Xij} - P_{Xij})^2 + (T_{Zij} - P_{Zij})^2} \qquad (41)$$

where L_{ij} is the distance between the rotation centers for subject i in test condition j. **T** is the location of the thoracic joint center for the test condition, and **P** is the location for the pelvic joint center for the same test condition.

These inter-joint distances were averaged for each subject over the various test conditions. The average lumbar length for each subject ($\overline{L}_i$) from these distance calculations and the averages over the subjects ($\hat{L}$) for each lumbar are given in Table 10 on page 72. Mathematically, this is expressed,

$$\hat{L} = \frac{1}{I}\sum_{i=1}^{I} \overline{L}_i \qquad (42)$$

$$\overline{L}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} L_{ij} \qquad (43)$$

2.5.18 Error in Lumbar Length

The estimated error in the distance between the two joints ($S(\hat{L})$) was computed using the same methods as those discussed above with respect to the error in the joint center locations. For each subject, the mean of the entire population was expected to lie within calculated interval with 95% confidence. The calculation of this confidence interval follows:

$$\text{For } \mu_L : \hat{L} \pm 1.96 * S(\hat{L}) \qquad (44)$$

$$S(\hat{L}) = \frac{1}{I}\sqrt{\sum_{i=1}^{I} S^2(\overline{L}_i)} \qquad (45)$$

$$S^2(L_i) = \frac{1}{k}\left(\frac{(k-n_i)}{n_i} MSE_L + MSTR_L\right) \qquad (46)$$

2.5.19 Thoracic and Pelvic Angles Relative to the Lumbar Segment

The angles of the thorax and pelvis relative to each lumbar segment were calculated for each test condition, in order to compare the amount of motion found between the thorax and the lumbar to the amount of motion between the pelvis and lumbar. In the local lumbar coordinate system, with $\hat{\mathbf{e}}_x$ and $\hat{\mathbf{e}}_z$ along the directions of $\mathbf{X_L}$ and $\mathbf{Z_L}$ of Figure 25, respectively, a thoracic orientation unit vector was created on the thorax from xyphoid toward manubrium as follows, where ˆ indicates unit vector:

$$\hat{\mathbf{T}}_{\text{orient}} = \left(\frac{Man_X - Xy_X}{L_{Man-Xy}} \right) \hat{\mathbf{e}}_x + \left(\frac{Man_Z - Xy_Z}{L_{Man-Xy}} \right) \hat{\mathbf{e}}_z \tag{47}$$

where

$$\begin{aligned} & i = x, z \\ & \mathbf{Man} = Man_i \hat{\mathbf{e}}_i \\ & \mathbf{Xy} = Xy_i \hat{\mathbf{e}}_i \\ & L_{Man-Xy} = \sqrt{(Man_X - Xy_X)^2 + (Man_Z - Xy_Z)^2} \end{aligned} \tag{48}$$

Man is the location of the manubrium and **Xy** is the location of the xyphoid. $L_{Man\text{-}Xy}$ is the length of the vector from manubrium to xyphoid. The angle of the thorax relative to the lumbar (T_L angle) was the angle of the sternum in this coordinate system, or

$$T_L = \sin^{-1}\left(\hat{\mathbf{T}}_{\text{orient}} \cdot \hat{\mathbf{e}}_x\right) \qquad -\frac{\pi}{2} < \theta < \frac{\pi}{2} \tag{49}$$

Likewise for the pelvis, a unit vector was created from the sacrum toward the ASIS

$$\hat{\mathbf{P}}_{\text{orient}} = \left(\frac{A_X - SI_X}{L_{A-SI}} \right) \hat{\mathbf{e}}_x + \left(\frac{A_Z - SI_Z}{L_{A-SI}} \right) \hat{\mathbf{e}}_z \tag{50}$$

where $L_{A\text{-}SI}$ is the length of the vector from the ASIS to the sacrum,

$$L_{A-SI} = \sqrt{(A_X - SI_X)^2 + (A_Z - SI_Z)^2} \tag{51}$$

The P_L angle is determined as follows:

$$P_L = \cos^{-1}(\hat{\mathbf{P}}_{\mathbf{orient}} \cdot \hat{\mathbf{e}}_x) \qquad 0 < \theta < \pi \qquad (52)$$

The total range of T_L for each subject was compared to the total P_L range relative to each lumbar. The results of this comparison are discussed in Section 3.7. The following section describes methods for determining a consistent reference for T_L and P_L angles between subjects.

2.5.20 Flat-Back Reference Posture

Once the T_L and P_L angles were established for each test, the reference posture was defined to a flat-backed posture, to which the T_L and P_L angles would be referenced for each subject. Any angle more slumped than the reference angle would be negative, and any angle more erect than the reference angle would be positive. Refer to Figure 10, page 14. This flat-backed posture was to be defined as the posture in which the L3 bony landmark lay on a line between the T12 and S1 bony landmarks, or in which the lumbar spine formed a straight line in the sagittal view.

For each test condition, in which the thorax and pelvis were both supported in the same degree (test conditions 1, 5, 6, 10, 11, 12, 22, 21, 20, 16), the spinal shape data (locations of the T12, L3 and S1 spinous process landmark locations, as calculated from the probed spinal points) were transformed so S1 was at the origin, and the Z-axis passed through the T12 point.

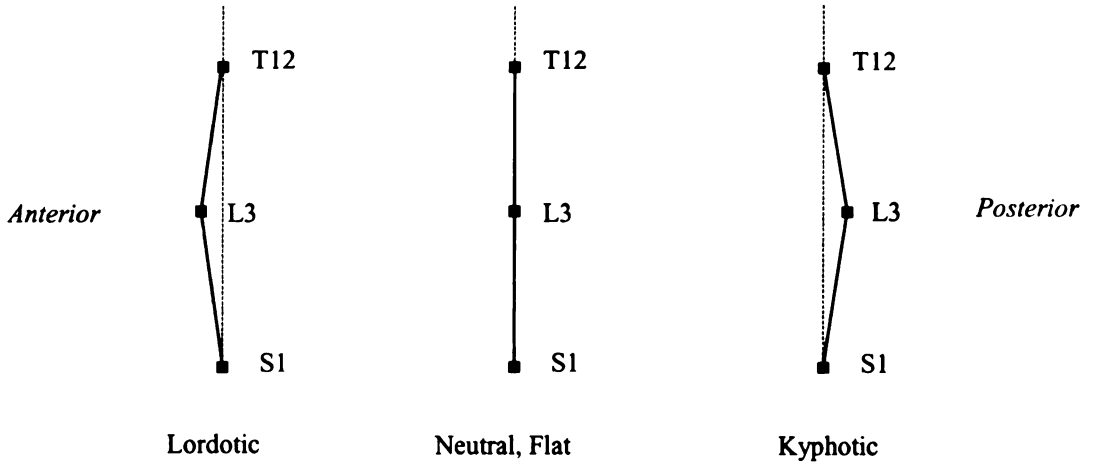

Figure 27: L3 Deviation from Flat Back

In this configuration, a flat back would have a zero L3 X coordinate. Any deviation of L3 from the Z-axis (non-zero X coordinate) would imply a non-flat back, and the amount of L3 deviation from the Z-axis indicated the extent the posture deviated from the flat-back posture.

The deviation of L3 from the Z-axis was plotted versus the T_L angle for each symmetrically supported posture. A linear regression line of the form

$$y = mx + b \tag{53}$$

was calculated to pass through these points. See Figure 28.

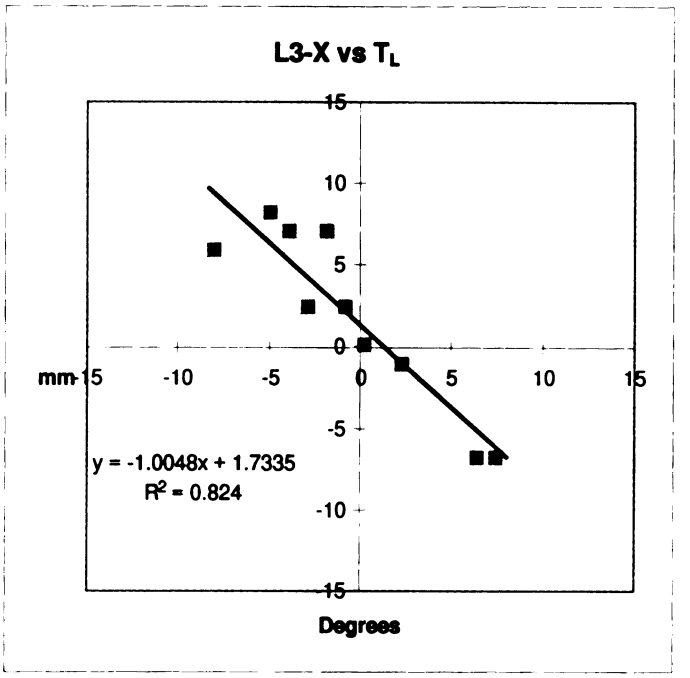

Figure 28: Regresssion Line on Graph of L3 Deviation from Flat

In order to adjust the T_L values, so that a zero T_L was representative of a flat-back posture, the T_L values were adjusted so that the regression line passed through zero L3 deflection at zero T_L. The adjustment amount, which would be added to each current T_L value, was calculated as

$$\text{Adjust} = \frac{-b}{m} \tag{54}$$

In the graphical example of Figure 28 above,

$$\text{Adjust} = \frac{-1.7335mm}{-1.0048\,mm/^{\circ}} = 1.7^{\circ} \qquad (55)$$

This process was identically repeated for the L3 deviations versus P_L angle and the associated linear regression line. The adjustment offsets for each subject were added to the T_L and P_L angles computed in the previous section, rendering T_L and P_L angles relative to a flat-back zero, more positive with lordosis, and more negative with kyphosis.

2.5.21 Limb Data

Data were collected pertaining to the positions of the limbs (left arm and leg) to document the subject's overall posture. Data were gathered on the leg and foot during reference data and test data collection. Arm data were collected only during testing.

Targets were placed on the left lateral femoral condyle, left lateral malleolus, and lateral toe of left shoe. In the reference file, the subjects' foot rested flat on the floor, so that subsequent orientations of the foot target relative to the lateral malleolus target had a reference. The left ASIS was targeted, and the sacrum probed in the test conditions to document pelvis location. The inter-ASIS and inter-PSIS distances were measured for femoral head (hip joint center) location estimation, using methods of Seidel *el al.* [13]

For the upper extremity, targets were located at the lateral humoral condyle of the elbow and between the radial and ulnar condyles, on the dorsal (back or posterior) side of the wrist. The acromion was also probed, giving a reference point for locating the shoulder joint. These data, sufficient for documentation of the limb posture, using methods of Robbins [14], are included in the raw data given in Appendix E.

3. RESULTS AND DISCUSSION

3.1 Introduction

This study of seated postures was conducted for modeling the seated human torso. Subjects' seated postures were evaluated under a broad range of geometric support conditions. These postures were compared in terms of a three segment model, connected by two joints. The two joint locations that best distributed the torso were computed. The ranges of angles through which the model should be allowed to move on either side of a flat-back condition at each joint were determined. The possibility of a linkage coupling the motion at one joint to the motion at the other was investigated. Trends in the shape of the lumbar segment with changes in relative segment orientations were also evaluated.

3.2 Raw Output Data

Posture data was collected on subjects in a reference seat and in a test buck with various geometric seat back configurations. (See Section 2.4.) Raw data for each subject consisted of

1. measurement values taken during test preparation
   a) inter-ASIS distance
   b) inter-PSIS distance
   c) heel to foot target distance
2. and, for the reference file
   a) nine skeletal landmark target locations
   b) two reference seat target locations
3. and, for each test condition
   a) eight skeletal landmark target locations
   b) two test frame target locations
   c) coordinates of the probe, when probing

i) acromion
ii) T10
iii) T12
iv) L3
v) S1

See Appendix E for a complete list of the raw data for each subject.

3.3 Thorax

3.3.1 Shape

The shape used for the thorax was taken from an anthropometric study conducted by the University of Michigan Transportation Institute (UMTRI). Anatomical landmarks of 50 mid-size males seated in an automotive environment were measured [14]. Skeletal landmark locations from this UMTRI study were used to create the shape shown in Figure 29. For details, see Appendix F. The UMTRI thorax shape overlays the subject thorax shapes from this research.

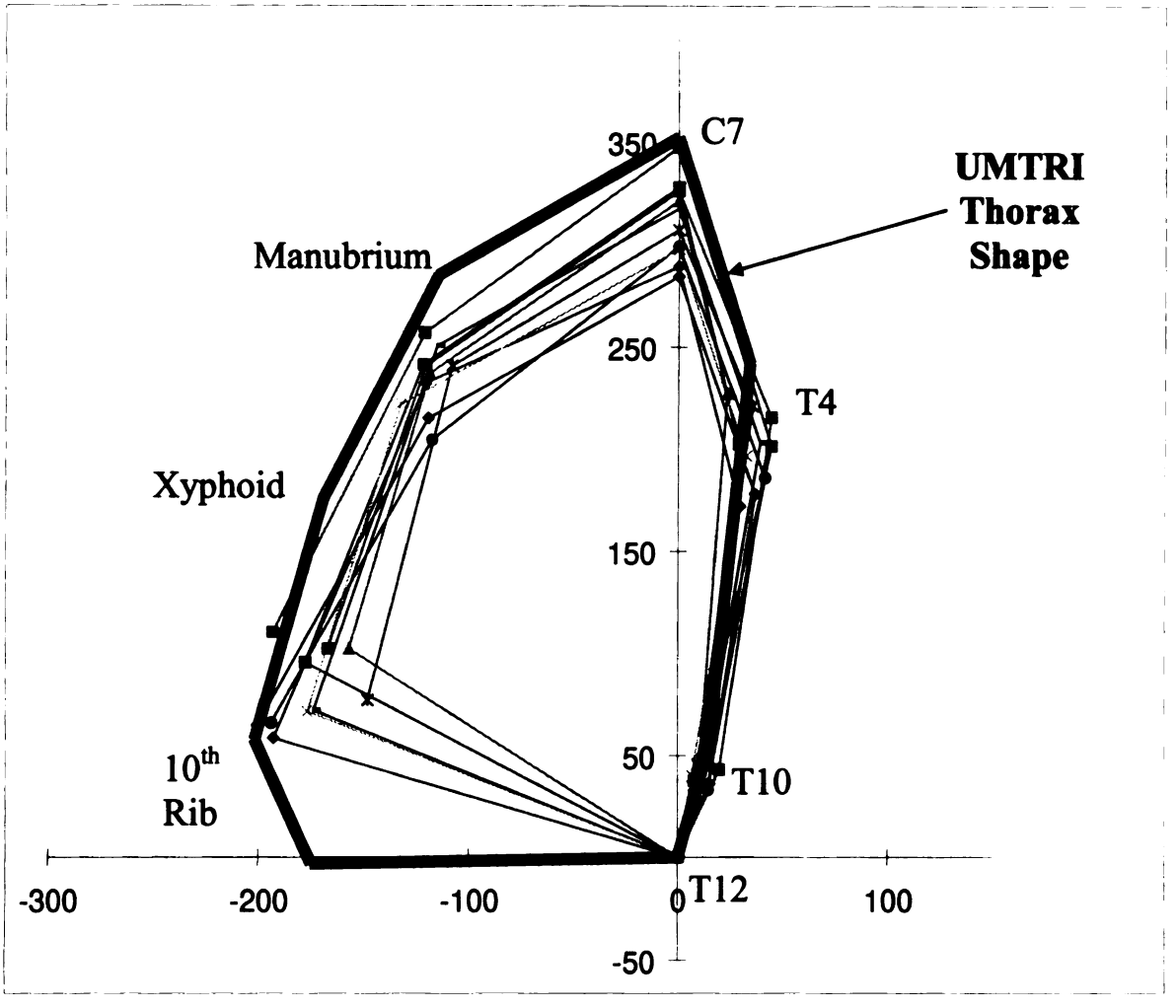

Figure 29: UMTRI Average Thorax Shape with Subject Shapes (axes in mm)

This UMTRI thorax shape was chosen for use as the rigid thorax segment for this model, because it was based on an in-depth anthropometry study and therefore represents the mean anthropometric shape of a large sample of mid-size males. The back shape of the UMTRI thorax was consistent with the shapes of the subjects from this study within 10 mm in the X direction, up to the T4 level, confirming its compatibility with the data of this study.

3.3.2 Joint Center Locations

As described in Sections 2.5.11 and 2.5.12, rotation centers between the thorax and lumbar sections were computed for each subject using five different lumbar definitions. The instant center locations (X, Z) between test conditions can be found in Appendix G. For each joint, each subject, the X coordinates for each lumbar definition were averaged over all computed rotation centers, as were the Z coordinates, as discussed in Section 2.5.14. The thorax to lumbar rotation center location in thoracic coordinates [in the notation of Section 2.5.14, ($\overline{X}_{P1}, \overline{Z}_{P1}; ... \overline{X}_{P5}, \overline{Z}_{P5}$)] is given for each subject in Table 6.

Table 6: Average Thoracic Joint Center Locations in Thoracic Coordinates (mm)

LUMBAR:	S1 to T12		LL to T12		S1 to T10		LL to T10		L3 to T10	
SUBJECTS	X_{T1}	Z_{T1}	X_{T2}	Z_{T2}	X_{T3}	Z_{T3}	X_{T4}	Z_{T4}	X_{T5}	Z_{T5}
01	-66	-7	-66	-35	-26	2	-33	-3	-57	1
02	-72	11	-60	-39	-57	-17	-61	-13	-75	-6
03	-87	-17	-45	-52	-28	-18	-36	-9	-39	17
04	-39	-17	-31	-42	-5	7	-17	6	-36	15
05	-68	-9	-43	-56	-45	-26	-44	-29	-32	-24
06	-84	-5	-33	-64	-54	-31	-42	-26	-30	-19
07	-62	-9	-51	-40	-42	4	-55	-5	-60	-9
08	-44	11	-52	-14	-47	29	-59	21	-78	10
09	-55	-28	-41	-43	-39	-17	-32	-25	-23	-28
10	-67	-26	-52	-66	-52	-35	-72	-65	-134	-66
MEAN	**-64**	**-10**	**-47**	**-45**	**-40**	**-10**	**-45**	**-15**	**-56**	**-11**

Of these thoracic joint center locations for all subjects, the mean was taken, to yield the thoracic rotation centers for the model, relative to each lumbar definition, $(\hat{X}_{T1}, \hat{Z}_{T1}; \ldots \hat{X}_{T5}, \hat{Z}_{T5})$. These mean rotation center coordinates are given in the last row of Table 6 and are plotted relative to the rigid UMTRI thorax in Figure 30. The T12 - L1 joint center [(-54, 17) in the thorax coordinate system, from [15]] is also shown in Figure 30 as an anatomical reference.

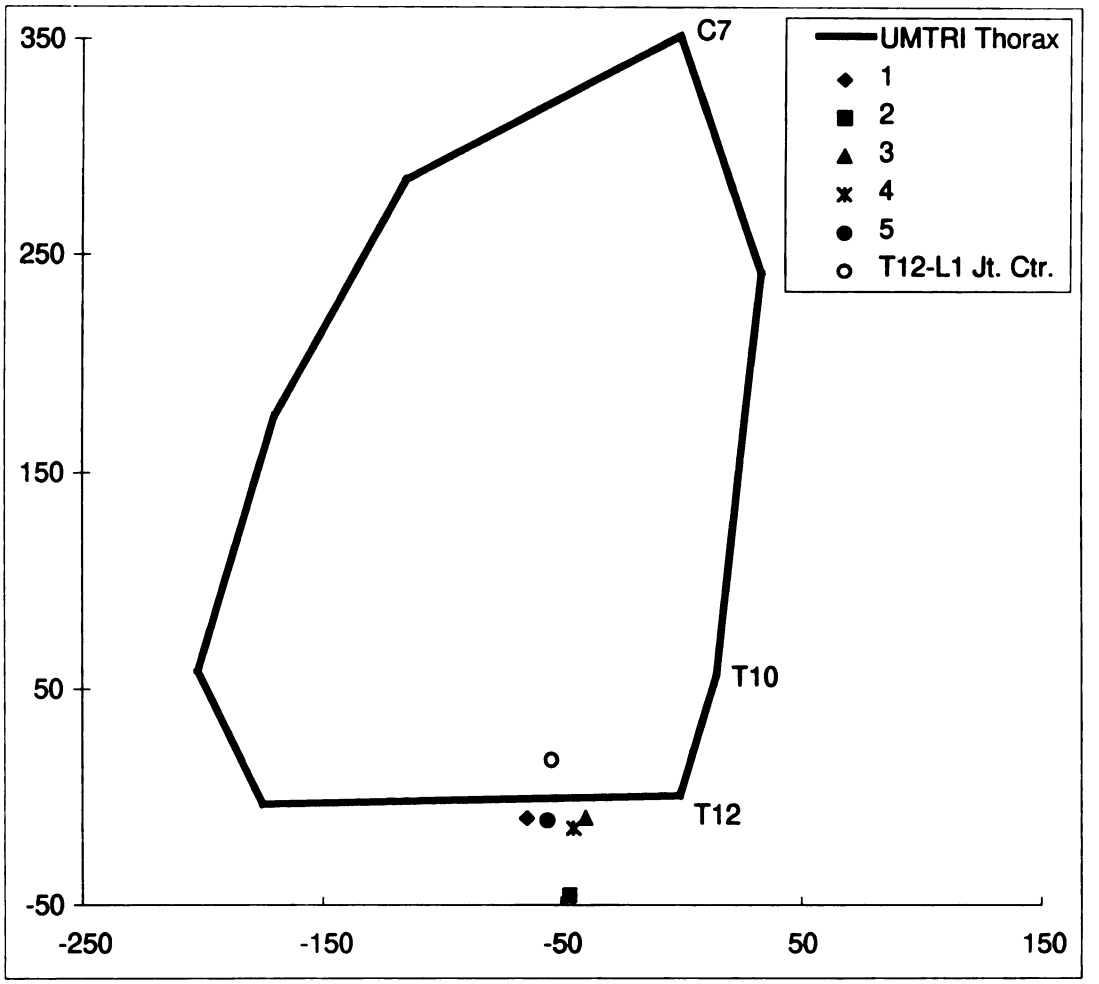

Figure 30: Thoracic Joint Centers on UMTRI Thorax (axes in mm)

3.3.3 Error in Joint Center Location

For each of the five final joint locations given in the last row of Table 6, an associated error margin was calculated, within which the mean joint location of the entire population of mid-size males would lie, with 95% confidence, as determined by the statistical methods described in Section 2.5.16. The estimated error associated with the X and Z coordinates [$S(\hat{X}_T)$ and $S(\hat{Z}_T)$] for each of the five lumbar segments is given in Table 9.

Table 7: Error in Model Joint Locations (plus or minus)

Coordinate / Lumbar	$S(\hat{X}_T)$ (mm)	$S(\hat{Z}_T)$ (mm)
1	9.9	10.2
2	7.8	10.5
3	10.6	14.2
4	11.5	15.8
5	19.5	14.1

Lumbar definitions 1 and 2 showed the lowest average error. Lumbar 3 had slightly larger error in the Z coordinate, and lumbar 4 had slightly greater error in both X and Z coordinates. The error margin associated with the X coordinate of lumbar 5 was substantially higher than the other four.

3.4 Pelvis

3.4.1 Shape

The rigid pelvis segment shape was taken from an anthropometric study of the pelvis performed by Reynolds, *et al.* [11]. This shape was used because it was derived

from an in-depth study of pelvic anatomy, based on 80 male pelves. See Appendix D for tabulated coordinates of points along the outside of the pelvis.

3.4.2 Joint Center Locations

As described in Section 2.5.11 and 2.5.12, rotation centers between the pelvis and lumbar segments were computed for each subject using five different lumbar definitions. The calculated rotation center locations, (X, Z) between test conditions can be found in Appendix G. For each subject, the X coordinates for each lumbar definition were averaged over all computed rotation centers, as were the Z coordinates, as discussed in Section 2.5.14. The average pelvis to lumbar rotation centers for each subject in pelvic coordinates ($\overline{X}_{P1}, \overline{Z}_{P1}; \ldots \overline{X}_{P5}, \overline{Z}_{P5}$) are given for each subject in Table 8.

Table 8: Average Pelvic Joint Center Locations in Pelvic Coordinates (mm)

LUMBAR:	S1 to T12		LL to T12		S1 to T10		LL to T10		L3 to T10	
SUBJECTS	$\overline{X}_{P1}$	$\overline{Z}_{P1}$	$\overline{X}_{P2}$	$\overline{Z}_{P2}$	$\overline{X}_{P3}$	$\overline{Z}_{P3}$	$\overline{X}_{P4}$	$\overline{Z}_{P4}$	$\overline{X}_{P5}$	$\overline{Z}_{P5}$
01	-54	-3	-71	23	-75	-6	-93	22	-99	63
02	-54	-8	-66	13	-62	-9	-72	17	-78	60
03	-70	1	-84	17	-72	-1	-86	16	-95	37
04	-72	-15	-90	26	-77	-17	-95	28	-96	95
05	-65	3	-85	19	-78	3	-89	24	-93	54
06	-61	-6	-85	15	-46	-4	-69	22	-81	71
07	-16	-2	*	14	-60	-7	*	16	-80	29
08	-59	-10	-89	-1	-64	-12	-106	35	-64	131
09	-42	-2	-49	39	-44	-1	-42	41	-38	90
10	-62	-2	-68	40	-58	-1	-51	44	-38	102
MEAN	-57	-4	-77	20	-63	-5	-79	25	-78	70

(Where * indicates a large variance in data. These data were not used.)

The final pelvic joint location relative to each lumbar segment was found by averaging

the subjects' rotation center locations. [In the notation of Section 2.5.15, these are $(\hat{X}_{P1}, \hat{Z}_{P1}; \ldots \hat{X}_{P5}, \hat{Z}_{P5})$.] The mean pelvic rotation center locations are given in the last row of Table 8 and are plotted relative to the Reynolds rigid pelvis shape in Figure 31. The anatomical L5 - S1 joint center [(-47, 15) in the pelvis coordinate system, from [11]] is shown in Figure 31 for reference.

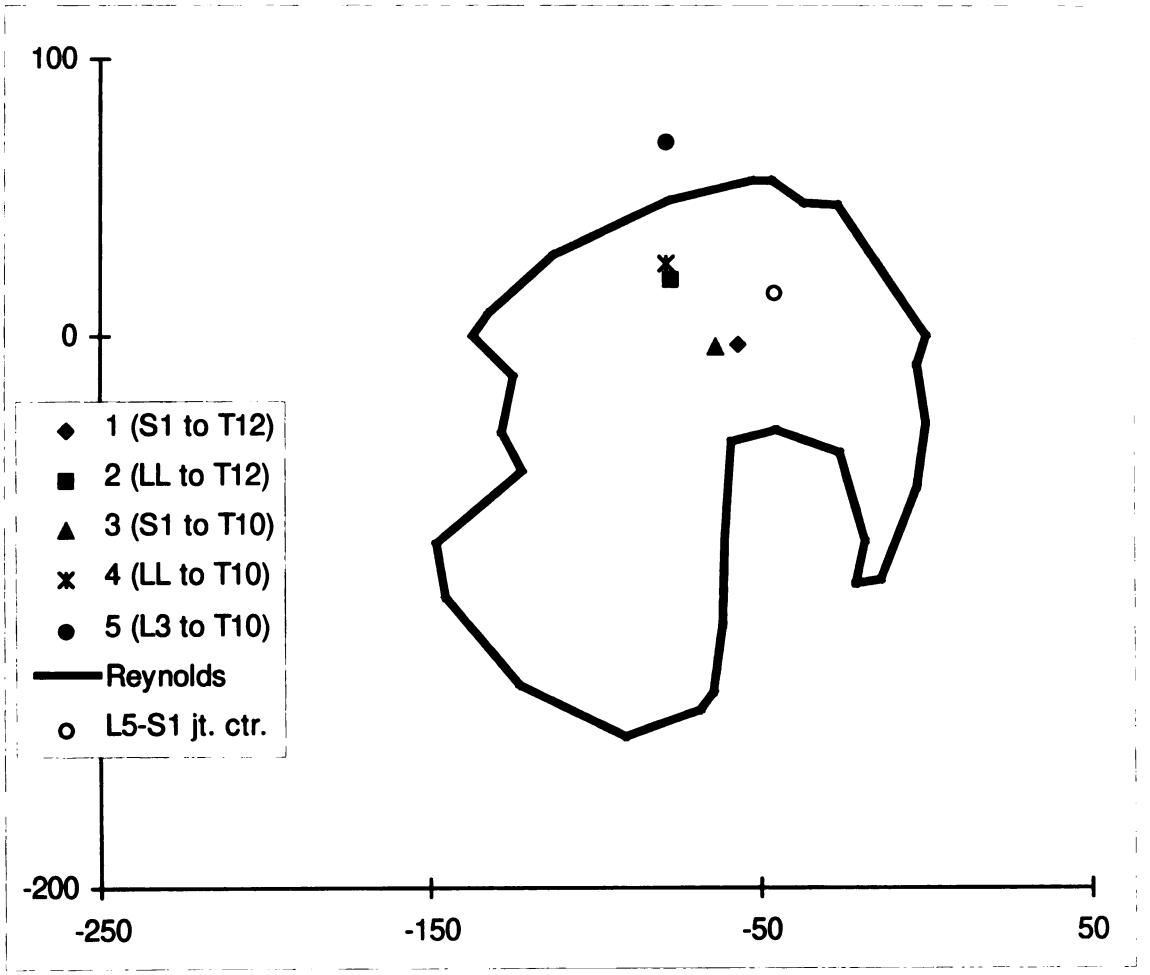

Figure 31: Pelvic Rotation Center Relative to Rigid Pelvis Shape (axes in mm)

3.4.3 Error in Joint Center Location

For each final pelvis joint location given in the last rows of Table 8, an associated error margin was calculated, within which the mean joint location of the entire population of mid-size males would lie, with 95% confidence, as determined by the statistical methods described in Section 2.5.16. The estimated error associated with the X and Z coordinates ($S(\hat{X}_P)$ and $S(\hat{Z}_P)$) for each of the five lumbar segments is given in Table 9.

Table 9: Error in Model Joint Locations (plus or minus)

Coordinate / Lumbar	$S(\hat{X}_P)$ (mm)	$S(\hat{Z}_P)$ (mm)
1	10.9	3.7
2	9.4	5.9
3	9.3	3.9
4	11.5	7.0
5	16.1	20.3

Lumbar definitions 2 and 3 showed the least error in the X direction, while lumbar 1 had only slightly higher error in the X direction. Lumbars 1 and 3 showed the least error in the Z direction, while lumbar 2 had only slightly higher error in the Z direction. Lumbar 4 showed higher error in both the X and Z directions, and the error margin associated with lumbar 5 was substantially (3.5 to 6.8 mm in the X direction and 16.6 to 13.3 mm in the Z direction) higher than the other four.

3.5 Summary of Joint Center Locations

Both thorax and pelvic centers tended to cluster (with the exception of the pelvic center associated with lumbar segment definition 5. Refer again to Figure 31.) This clustering of the mean rotation centers indicates that the behavior of a model generated

from the use of one of these pairs of centers would not vary significantly from the behavior of a model generated from one of the other pairs of centers. Choosing one pair, using some selection criteria, would therefore be reasonable, although, as stated, any of the five pairs of centers (thorax and pelvis) could be used to represent the postures of the seated human torso, since they were calculated from actual human torso postures.

Although five pairs of centers were found that would represent seated postures, due to differences in the magnitudes of the 95% confidence error margins, the centers determined by using lumbar definitions 1-4 would be better choices for the model than lumbar definition 5.

3.6 Lumbar

3.6.1 Length

Having defined locations for joint centers on the thorax and pelvis segments, the length of the link connecting the thorax and pelvis joints was determined, as discussed in Section 2.5.17. For each subject, an inter-joint length was found corresponding to each test condition. These lengths, which can be found in Appendix H, were averaged to yield a lumbar length ($\overline{L}$) for each subject. These subject averages are given, along with the overall mean lumbar length ($\hat{L}$), in Table 10.

Table 10: Lumbar Length (mm) Each Subject ($\bar{L}$) and Mean ($\hat{L}$)

LUMBAR / SUBJECT	1 S1 to T12	2 LL to T12	3 S1 to T10	4 LL to T10	5 L3 to T10
01	190	128	188	152	109
02	189	123	183	147	106
03	207	145	205	170	128
04	221	155	218	180	138
05	148	91	149	115	70
06	208	142	202	166	124
07	169	*	168	*	88
08	167	102	163	126	84
09	179	117	177	141	98
10	210	146	204	170	128
MEAN:	189	126	186	150	107

where * indicates large varience in pelvic center location, and data were not used in mean lumbar length calculations

3.6.2 Error in Length Calculation

Note that the lumbar length for each subject listed in Table 10 is the average length for that subject over different postures. Since the human torso is not actually composed of three rigid segments, there is some difference in the distance between the joints, which are located relative to the thorax and pelvis rigid segments, in different postures. In other words, posture change causes the distance between the joints (or the lumbar length) to change. Therefore there is some error, even in representing one single human torso with a simplified model. The error within subject, for the lumbar segment length was found to be small; the standard deviations of the inter-joint, or lumbar segment, lengths of Table 10 for each subject were all between 2.0 and 8.7 millimeters.

The average lengths for each subject were averaged, to yield a lumbar length to be used for the model. The estimated 95% confidence error margin associated with each inter-joint (lumbar) length, as it represented the mean of the entire population of mid-size

males, was calculated, as discussed in Section 2.5.18. These are given in Table 11.

Table 11: Error in Lumbar Length (mm)

Lumbar Segment Definition	$\hat{S}_L$
1	14.4
2	13.3
3	13.5
4	13.3
5	13.8

An error in the length of the lumbar segment implies that while the pelvis segment of the model would be on the seating surface, the thorax segment could be up to 14.4 mm too high or too low. This error is acceptable here, as the small influence that this error would have on a contour design or evaluation would be insignificant relative to differences in anthropometric measurements between people.

3.7 Ranges of Relative Rotation Angles

For each joint, as discussed in Section 2.5.19, the minimum (most kyphotic) angle found in the testing for each subject was subtracted from the maximum (most lordotic) angle, to yield the angle range. These angles ranges are given, for each lumbar segment definition, in Table 12.

Table 12: Range of Angles (°)

LUMBAR:	1 S1 to T12		2 LL to T12		3 S1 to T10		4 LL to T10		5 L3 to T10	
SUBJECT	T_L	P_L	T_L	P_L	T_L	P_L	T_L	P_L	T_L	P_L
01	18	20	16	23	16	21	14	24	12	28
02	35	16	34	18	31	18	29	19	26	21
03	15	28	14	30	12	27	10	28	12	31
04	21	12	20	15	19	13	17	15	15	19
05	21	17	20	17	18	16	16	18	14	23
06	19	19	18	20	16	20	15	21	13	23
07	18	14	20	12	14	15	14	14	12	15
08	22	9	20	10	19	8	16	9	12	14
09	26	12	24	15	23	16	21	20	18	26
10	22	13	19	15	18	16	15	19	11	24
MEAN:	**22**	**16**	**21**	**18**	**19**	**17**	**17**	**19**	**14**	**22**

The angle ranges varied considerably between subjects, as some torsos were more mobile than others. Some torsos exhibited more motion in the lower lumbar, and therefore had a greater P_L than T_L angle, such as subjects 01, and 03. Other subjects' torsos exhibited the opposite bias, such as subjects 02 and 09. However, the average amount of motion at each joint was computed for all of the subjects, to render the mean motion range at each joint. This is given in the last row of Table 12.

The ratio of the mean T_L angle range to the mean P_L angle range was taken for each lumbar segment definition, in order to understand the distribution of motion found at the upper joint compared to the lower joint, using the different lumbar definitions. These are given in Table 13.

Table 13: Ratio of Average T_L Angle to P_L Angle

LUMBAR	T_L:P_L
1	1.3
2	1.2
3	1.1
4	0.9
5	0.7

An unequal distribution of the range of motion between the joints indicates more torso motion range at one joint than the other. In the most extreme of unequally distributed cases, all the range would be at one joint and none at the other, which would be a one joint linkage. This would not allow the decoupling of rotation from translation of the thorax relative to the pelvis, and may be too simple to represent the complexity of the torso. Two joints allow decoupling of rotation from translation, and an equal distribution of motion between that upper and lower joints (1.0) takes greatest advantage of the degree of complexity allowed by having two joints, over having just one, allowing the most decoupling. Lumbars 3 and 4 come closest to the 1.0 ratio, and might, based only on this criterion, be the best choices of lumbar definitions.

3.8 Maximum and Minimum Relative Angles

The flat-back posture, to be used as the reference zero posture ($P_L = 0$ and $T_L = 0$) was discussed in Section 2.5.20. The amounts of angle change from this reference in the positive (more erect and lordotic) and negative (more slumped and kyphotic) directions were determined at both joints. These are given for the thorax in Table 14 and for the pelvis in Table 15.

Table 14: Max and Min T_L Angles (°)

LUMBAR:	1		2		3		4		5	
	S1 to T12		LL to T12		S1 to T10		LL to T10		L3 to T10	
SUBJECT	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
01	13	-6	11	-5	12	-4	10	-4	8	-4
02	33	-1	32	-1	31	0	30	1	28	2
03	9	-7	8	-6	7	-4	7	-3	8	-4
04	14	-8	12	-8	13	-6	11	-6	8	-7
05	18	-3	17	-3	17	-1	16	0	15	1
06	2	-16	2	-16	3	-14	3	-12	4	-9
07	21	0	22	-1	15	-2	13	-4	10	-5
08	17	-5	15	-5	14	-5	11	-5	6	-6
09	20	-6	19	-4	20	-3	19	-2	19	1
10	18	-4	15	-4	15	-3	12	-3	8	-3
MEAN:	17	-5	16	-5	15	-4	13	-4	11	-3

Table 15: Max and Min P_L Angles (°)

LUMBAR:	1		2		3		4		5	
	S1 to T12		LL to T12		S1 to T10		LL to T10		L3 to T10	
SUBJECT	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
01	10	-10	12	-11	10	-11	11	-13	12	-15
02	13	-3	15	-3	14	-3	15	-3	18	-3
03	25	-4	26	-4	23	-4	24	-4	25	-6
04	9	-3	12	-3	10	-3	12	-3	15	-4
05	11	-7	11	-6	8	-7	10	-9	12	-11
06	10	-9	11	-9	10	-9	11	-10	12	-11
07	3	-11	1	-11	9	-6	8	-5	11	-5
08	5	-5	5	-5	5	-3	6	-3	10	-3
09	7	-5	9	-6	10	-6	12	-8	16	-10
10	7	-6	10	-6	10	-7	13	-7	17	-7
MEAN:	10	-6	11	-7	11	-6	12	-6	15	-7

It should be noted that at both joints, the torsos were able to move farther in lordosis than kyphosis, from the flat-back. Looking, for example at the mean maximum and minimum angles associated with lumbar segment definition five, the thorax, on average, articulated 15° in the positive (kyphotic) direction relative to the lumbar and only 4° in the negative (lordotic) direction. Likewise, the pelvis articulated, relative to the lumbar, on average 11° toward lordosis and 6° degrees toward kyphosis.

Although SAE J826 tools [1] (refer to Figure 1, page 2) use the flat-back as the nominal posture, this may not be ideal. Because of the higher mobility of torsos in flexion (lordosis) than extension (kyphosis) relative to the flat-back, the flat-back is perhaps not the best nominal position around which to design and evaluate seat back contours. A more lordotic posture, such as 5.5° T_L and 2.5° P_L, would be more in the center of the average range of mid-size male postures and would be a better nominal posture for seat design and evaluation than the flat-back.

For model design, it might be reasonable to limit the amount of angular motion at the joints to these average amounts. Or it may serve better to allow a model to flex and extend to the extreme ranges of motion found, depending on the application.

3.9 Lumbar Shape

While the pelvis shape is easily defined as a rigid shape, because the pelvis bones articulate relative to one another only slightly, and the thorax rigid shape is easily defined because the thorax is nearly rigid, having only some appreciable mobility in the lower thoracic spine* and during breathing, the lumbar shape is not so easily defined. The shape

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* from previous experience, examining laboratory postures and thorax shape change with changing posture

of the lumbar spine changes considerably with posture changes, from kyphotic in the slumped postures to lordotic in the more erect postures. Lumbar shape change varies for each individual, but there are trends that should be documented.

To begin to understand the shape of the lumbar segment in different postures, the position of L3 relative to a line between T12 and S1 in various postures was observed. As discussed in Section 2.5.20, the L3 landmark lies on a line between the T12 and S1 spinal points in a flat-back posture. In more kyphotic postures, the L3 landmark lies more posterior of this line (more positive), and in more lordotic postures the L3 landmark lies more anterior (more negative). Refer again to Figure 27, on page 57. The deviation of the L3 landmark from the S1 to T12 line was plotted versus P_L angle in order to understand the shape of the lumbar segment in different pelvis to lumbar configurations. This plot is shown in Figure 32.

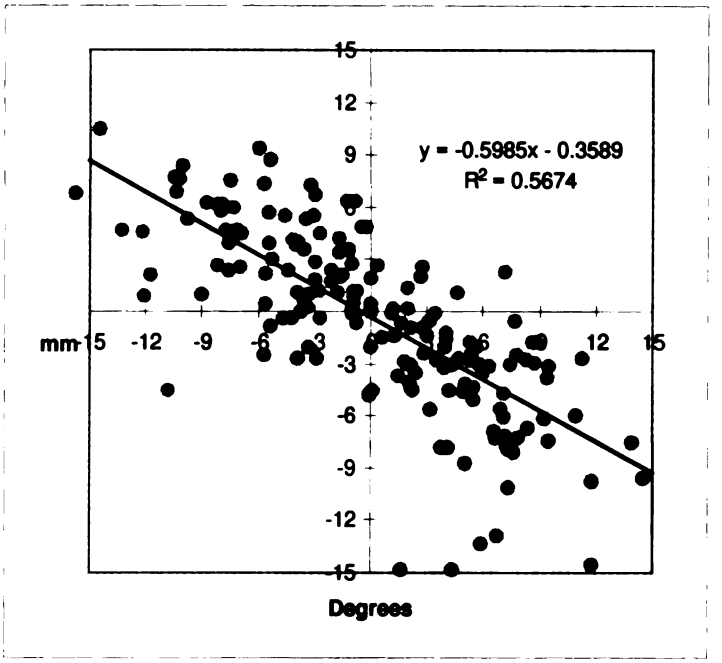


Figure 32: L3 Deviation from Flat vs. P_L Angle

The slope of the linear regression line shows that the trend in deviation was approximately -0.60 mm per degree P_L. (The minus sign indicates L3's moving toward the front of the body, which is in the negative direction, for an increase in P_L angle, meaning toward a more lordotic posture.) The R^2 correlation is 0.57, which indicates that the L3 deviation is influenced by the P_L angle, but that there are also other influences on lumbar shape.

Figure 33 shows the L3 deviation from the T12 to S1 line versus the T_L angle, which was plotted to show the influence of thorax segment to lumbar segment orientation on lumbar shape. In this case, the slope of the linear regression line shows that L3 moves anteriorly 0.46 mm per degree T_L (more lordotic) angle.

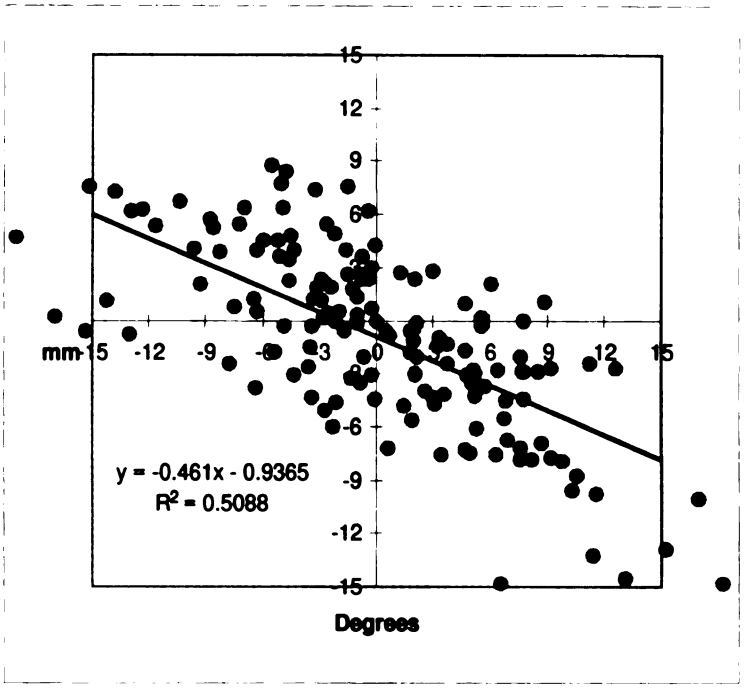


Figure 33: L3 Deviation from Flat vs. T_L Angle

The R^2 correlation of 0.51 shows a trend, but again, that there are influences, other than T_L angle (such as P_L angle), on lumbar shape.

Summing the P_L and T_L angles produces a thorax angle relative to the pelvis, or T_P angle. The influence of the overall T_P angle on L3 deviation from the S1 to T12 line is shown in Figure 34.

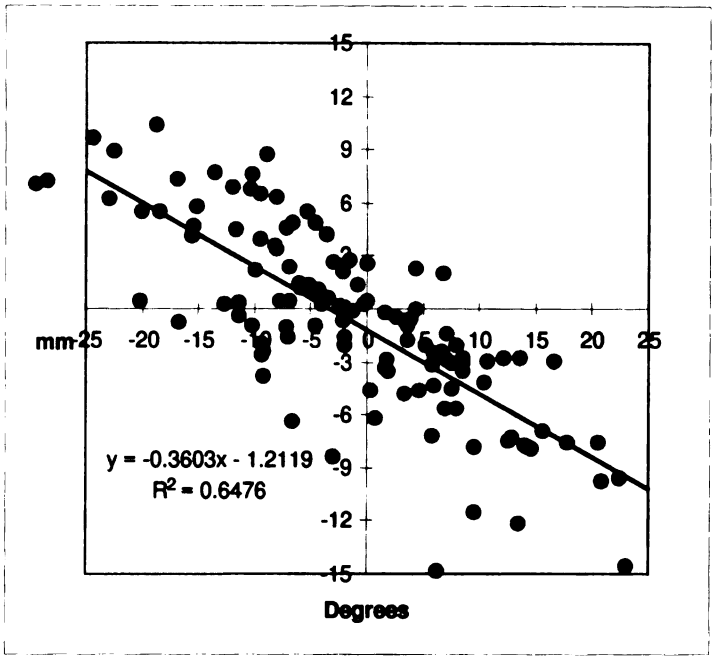


Figure 34: L3 Deviation from Flat vs. T_P Angle

The slope of the regression line indicates that there is a trend of 0.36 mm anterior L3 deviation per degree T_P (toward flexion), with an R^2 correlation of 0.64. Note that this is greater than the correlations of T_L (0.51) or P_L (0.56) alone.

One would expect, perhaps, that the sum of the influences of the P_L and T_L angles on the L3 deviation, might add up to the T_P influence, but this is not necessarily the case. If it were true, for a five degree P_L and five degree T_L,

$$(\text{L3 dev.})_{P_L} + (\text{L3 dev.})_{T_L} \stackrel{?}{=} (\text{L3 dev.})_{T_P} \quad (56)$$

$$0.60 * (P_L) + 0.46 * (T_L) \stackrel{?}{=} 0.36(P_L + T_L) \quad (57)$$

$$0.60 * 5 + 0.46 * 5 \stackrel{?}{=} 0.36(5 + 5) \quad (58)$$

$$3.0 + 2.3 \neq 3.6 \quad (59)$$

As shown, the influences of the P_L and T_L angles on deviation from the flat-back configuration are linearly dependent (not summable). The dependency is not immediately quantifiable, but the trends provide a qualitative understanding of lumbar shape change as a result of posture change.

Understanding the shape of the lumbar spine is important, especially in designing a structure that will support the back. The support structure should contact and support the whole back in order to avoid load concentrations and to achieve an even pressure distribution. An understanding of the trends in lumbar shape makes the design of conforming (comfortable) seat back contours possible.

3.10 Coupling Evaluation

In the case that the orientation change of the pelvis relative to the lumbar and the orientation change of the thorax relative to lumbar were coupled, support of the pelvis would induce not only an increase in the P_L angle, but also in the T_L angle, while support of the thorax would induce not only an increase in the T_L angle, but also in the P_L angle. For evaluation of the orientation change coupling between motion at the joints, the postures resulting from fully supporting only the pelvis or only the thorax were examined.

Table 16 shows the subjects' average posture (P_L and T_L angles) over the subjects for the cases of only fully supporting the pelvis (from test condition 3) and only fully supporting the thorax (from test condition 8).

Table 16: Average T_L and P_L angles (°) for Thorax or Pelvis Support Only

	T_L	P_L
Pelvis Support Only	-2	6
Thorax Support Only	9	-2

These T_L and P_L values show that on average, when only the pelvis was supported (by a prominence at the PSIS level,) the P_L angle increased from flat to six degrees lordotic, while the T_L angle did not increase, but decreased slightly. And with support of the thorax only, the T_L angle increased by nine degrees from the flat-back, but the P_L angle decreased slightly.

These results imply that the orientation changes are not coupled. Support of the pelvis and support of the thorax do not produce equivalent postures, as they do using Bush's coupled model [3]. Differences in the shape of the seat back, such as height of the support prominence, have a major effect on posture, whether the change in segment orientation takes place between the pelvis and lumbar or between the thorax and lumbar, or a combination of both. The T_L and P_L angles must be evaluated separately, for a complete understanding of the effects of a seat on posture. The thorax can and will remain in its flat-back configuration relative to the lumbar or will even slump, if not supported, although there may be support at the pelvis. Likewise, the pelvis must be

supported, or it will also remain in its flat-back configuration relative to the lumbar or will slump, in spite of support of the thorax.

Table 17 shows average results of supporting both the pelvis and thorax simultaneously (toward lordosis in test condition 6) and relieving both pelvis and thorax support (toward kyphosis in test condition 16).

Table 17: Average T_L and P_L angles (°) for Even Support

	T_L	P_L
Pelvis and Thorax Supported	8	6
Pelvis and Thorax Unsupported	-7	-5

Supporting both upper pelvis and lower thorax produced average increases of 8° in T_L and 6° in P_L. Providing no support of the upper pelvis of lower ribcage produced on average, a 7° decrease in T_L and a 5° decrease in P_L. It should be noted that the amount of support applied to each subject in these conditions varied based on the flexibility of the subject's torso, as described in the Testing Procedure (Section 2.4.3). However, support at T12 and support at the PSIS tended to produce lordosis, which was nearly evenly distributed between the upper and lower joints, and unsupported PSIS and T12 levels tended to produce almost evenly distributed kyphotic postures.

3.11 Final Model

From the five definitions of the lumbar segment used in calculation, five pairs of joints (thorax and pelvis) were found to represent the human torso postures. Due the clustering of the five calculated joint locations for the thorax and the pelvis, the five models resulting from the five pairs of points would be expected to behave quite similarly

to one another. Therefore, it is not unreasonable to choose one of these pairs to represent the torso, based on some selection criteria. As, due their similarity in location. Because the error in the locations of the joint centers associated with lumbar 5 were high, relative to the other four segment definitions, the joint locations associated with lumbar definition number 5 were not chosen.

There were no considerable differences between lumbar segment definitions in lumbar length error.

Because it is perhaps most desirable to have an equal distribution of the torso motion between the two joints, as opposed to having more motion at one joint or the other (as discussed in Section 3.7), the joint locations associated with lumbar definitions 3 and 4 were considered the best behaved pairs of joints based on distribution.

In order to decide between the joint locations associated with lumbar segment definitions 3 and 4, a second look at joint center location error was taken. Lumbar 3 showed smaller error margins, by 0.9 mm in the X direction and 4.9 mm in the Z direction. For this reason, the joint locations associated with lumbar segment definition 3 were chosen for the model.

The three-body, two-joint model in a flat-back posture, with the joint centers of lumbar segment 3, is shown in Figure 35.

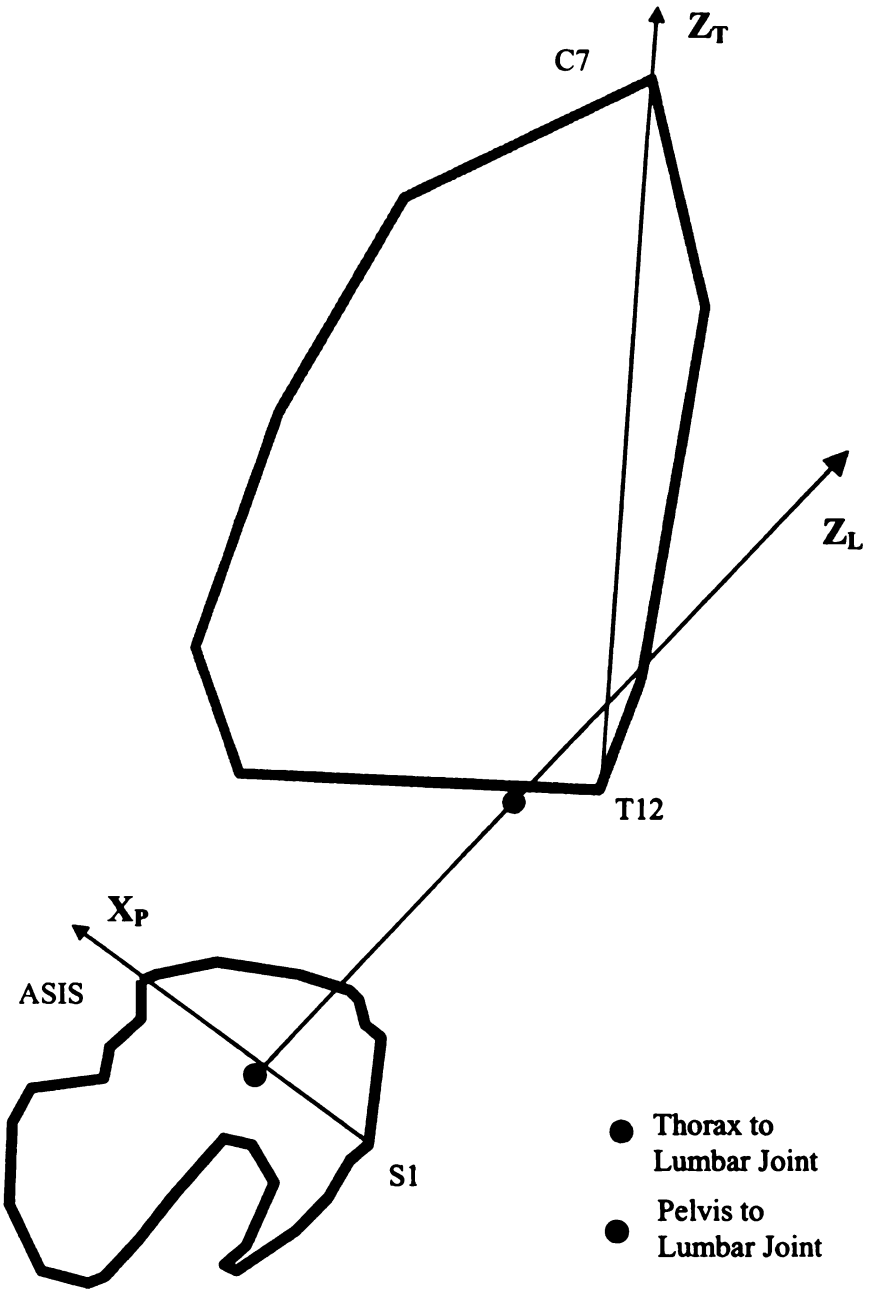


Figure 35: Resulting Three-Segment, Two-Joint Model

The segments were oriented relative to one another sing the UMTRI drawing of the seated mid-size male [15] in the flat-back posture. Orientation vectors, as defined by this research, for each segment are shown in Figure 35. The relative angles of the adjacent segments' orientation vectors document the flat-back posture ($T_L = P_L = 0$) of this model. For the flat-back posture, the angle between the thorax and lumbar orientation vectors ($\mathbf{Z_T}$ and $\mathbf{Z_L}$) must be 39° and the angle between the pelvis and lumbar orientation vectors ($\mathbf{X_P}$ and $\mathbf{Z_L}$) must be 96°. From this flat-back configuration, the model can be adjusted to any desired posture, as defined by T_L and P_L angles. By the sign convention defined in Figure 10, rotation of the thorax in the clockwise direction relative to the lumbar segment is an increase in T_L and a counterclockwise rotation of the pelvis relative to the lumbar segment is an increase in P_L.

3.12 Repeatability

Since this research was only to investigate the nature of attainable seated postures, but was not to draw a correlation between input (support condition) and output (posture), the issue of repeatability was not a major factor in the success of this experiment. However, because great variations in output from like inputs would have initiated curiosity as to the cause, the repeatability of the postural response to input conditions was investigated.

Two of the test support conditions were visited twice (in Steps 10 and 21, 11 and 20) and the flat input condition three times (in Steps 1,12, and 22) during the data gathering procedure. The T_L and P_L angles determined at each like input would be expected to yield a similar result each time the same subject was subjected to the identical condition. The T_L and P_L angles relative to the third lumbar segment are given in Table

18, where TC1, TC12 and TC22 were identical inputs, TC10 and TC21 were identical inputs, and TC11 and TC20 were identical inputs.

Table 18: Repeatability Angles (°) for Third Lumbar Segment

SUBJECT	01		02		03		04		05		06		07		08		09		10	
Test Condition	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL	TL	PL
TC1	-3	-1	-13	-7	0	-9	-2	1	2	-1	3	3	3	0	no data		0	-10	-5	-7
TC12	-2	1	-9	-10	-3	-5	0	-2	-3	0	5	4	3	0	2	4	-3	-2	-1	0
TC22	-1	-3	-9	-3	-3	-6	-1	0	-2	0	6	6	7	-5	3	7	-1	-4	-1	1
TC10	2	5	-8	-3	-5	7	4	2	4	3	9	5	8	3	5	7	2	0	5	3
TC21	4	6	-6	-3	-8	10	1	3	0	3	8	5	10	-2	5	5	1	1	3	0
TC11	-6	-4	-13	-10	-3	-10	-4	2	-3	-4	0	5	2	-5	2	9	-7	-3	-5	-3
TC20	-3	-4	-19	-9	-7	-13	-2	-4	-5	-5	4	3	2	-6	3	1	-10	-5	-2	-2

The T_L and P_L angles did not vary more than 3° between trials of identical input, in 42 cases out of 60 total. Of the 18 cases where the difference between the angles was more than 3°, in 6 of these cases the difference was less than 4°. This error was considered small, in the scope of this experiment.

3.13 Error sources

There are always sources of error in experimentation. In this study, there may have been error in the measurement equipment, the experimenters' accuracy in targeting, or in the nature of collecting data on humans.

The target location measurement cameras need to have visibility of complete targets. Viewing targets only partially would result in an offset in the target location readout compared to the actual target location. Since all the body landmark locations used in the calculations are derived from target location data, such an offset would reduce the integrity of the data. Every effort was made to ensure conditions were favorable for

full target visibility, but the possibility that target blockage may have occurred must be considered.

The targets were attached to the skin over palpated skeletal landmarks. It was up to the tester to make decisions about what prominence corresponded to which skeletal landmark. Many methods of locating spinal process levels were used: palpating from the C7 spinous process (which is nearly always easily identifiable by palpation as the most superior of the prominent spinous processes) and counting inferiorly to the desired level; palpating the most inferior lumbar vertebra (L5) and counting superiorly to the desired level; and using estimation of the T7 level as being at about the level of the bottom of the shoulder blades, and using this as a reference. However, even combining these methods of spinous process location, it is not always possible to feel the prominences through the skin and some educated guessing was involved. Not only was location of skeletal landmarks affected by the skin and tissue overlying the landmarks, but through movement into different postures, the tissue shifted relative to the skeleton. This was especially apparent with the tissue over the ASIS of the pelvis. The experimenter attempted to ensure that the ASIS target always remained in place above the ASIS, but there may have been some error in the extremely lordotic or kyphotic postures.

3.14 Other Considerations

It should be brought to light that the age distribution of the subjects ranged only from 19 to 40 years of age. The data presented in this document can only be assumed valid over this age range, since no data were gathered outside this range.

4. CONCLUSIONS AND FUTURE WORK

A postural model of the seated human torso was developed to be valid over a broad range of seated postures. Utilizing optical position measurement equipment and software, posture data were collected with ten mid-size male subjects in a laboratory seat under a wide range of torso support conditions. From these data, joint locations for a three-segment, two-joint torso linkage model were determined, which would satisfactorily simulate seated human torso motion. The allowable angle ranges through which the model should move at each joint were determined and the linkage between motion at one joint and the other was evaluated. This seated human torso posture linkage was developed as a necessary step toward understanding the effects of seat support geometry on human posture.

The rigid shapes for the model were taken from previous research. The thorax shape of the 1983 UMTRI anthropometry study [14] was used along with the pelvis geometry found by Reynolds [11]. The lumbar shape will be discussed below. Each shape was given a local coordinate system, based on palpated anthropometric landmarks. See Figure 36 and Figure 37.

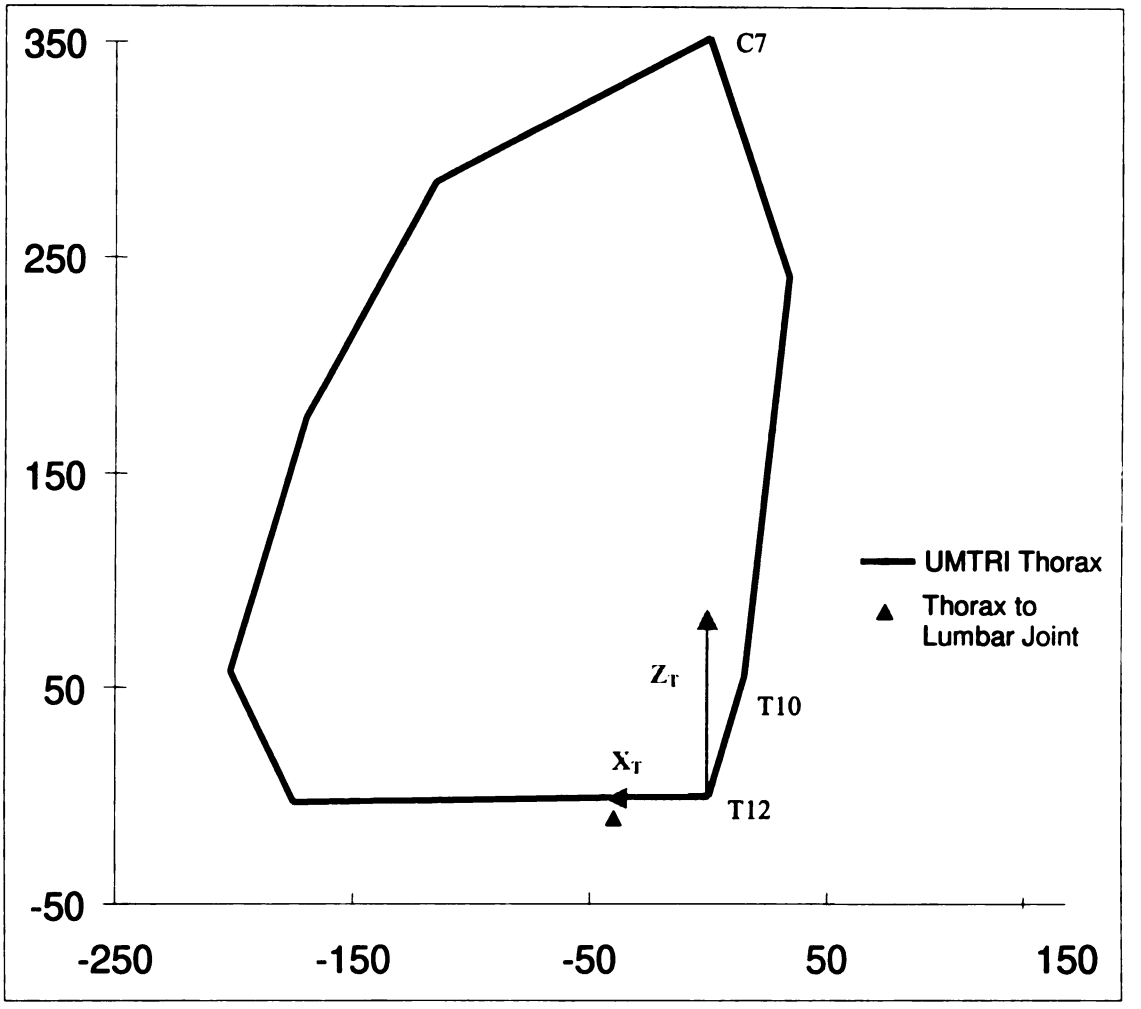


Figure 36: Thorax Rigid Shape (axes in mm)

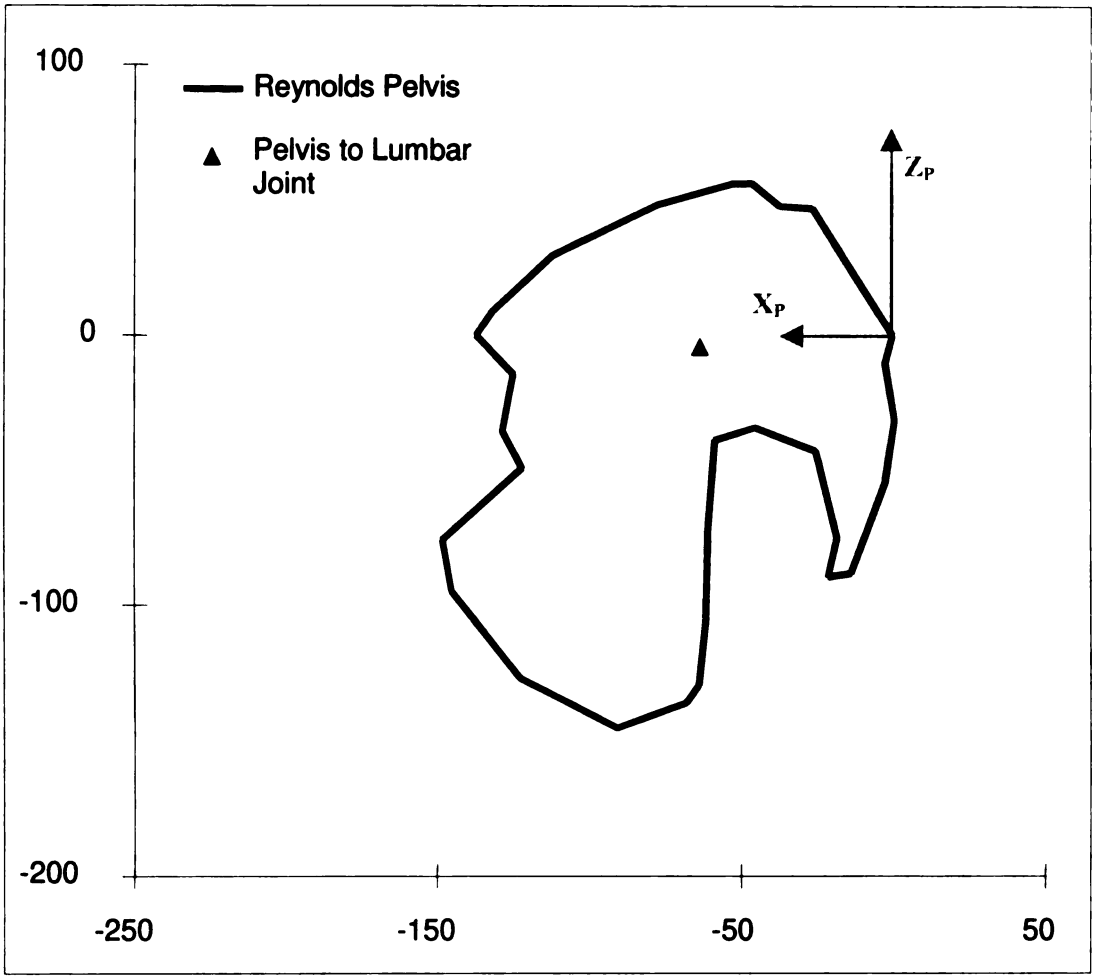


Figure 37: Rigid Pelvis Shape (axes in mm)

After gathering posture data on the seated subjects under 18 different support conditions, locations for joints between adjacent segments were calculated to best represent the postures of the seated torsos. The final joint locations are shown in Figure 36 and Figure 37 for the thorax to lumbar and the pelvis to lumbar, respectively. The error associated with the calculated joint center locations was computed using an analysis of variance, to obtain the 95% confidence margin, within which the mean location of the joint would lie for the whole population of mid-size males within the 19 to 40 year old age range. The error of both coordinates of both joints are listed with the joint locations in their respective local coordinate systems in Table 19.

Table 19: Final Joint Locations and Error

	X (mm)	$\pm\hat{S}(X)$ (mm)	Z (mm)	$\pm\hat{S}(X)$ (mm)
Thorax to Lumbar Joint (In thoracic coordinate system)	-40	10.6	-10	14.2
Pelvis to Lumbar Joint (In pelvic coordinate system)	-63	9.3	-5	3.9

The length of the link connecting the thoracic and pelvic joints, or the length of the lumbar segment, was computed to be 186 mm. The 95% error margin, within which the mean lumbar length for the whole population of mid-size males lies is ± 12.7 mm.

The zero reference position for the model was a flat-backed posture. Angles at each joint more lordotic than this were considered positive and more kyphotic postures were considered negative. The average range of postural mobility attributed to each joint is given in Table 20.

Table 20: Angle Ranges (°)

	Maximum (most lordotic)	Minimum (most kyphotic)
T_L	15	-4
P_L	11	-6

Because of the tendency of the torso to be more flexible in lordosis than kyphosis relative to a flat back, the flat-back configuration is not the best nominal posture around which to design and evaluate seats. A more extended or lordotic posture should be used.

The shape of the lumbar segment was defined by the deviation of the L3 spinous process from the line between the S1 and T12 spinous processes. This deviation, as compared to different measured postures (T_L, P_L, and T_P angles) resulted in the following trends:

- L3 deviated 0.60 mm from the flat-back line toward the front of the body for every positive degree change in P_L angle (toward lordosis). The R^2 correlation for this trend was 0.57.
- L3 deviated 0.46 mm from the flat-back line toward the front of the body for every positive degree change in T_L angle (toward lordosis). The R^2 correlation for this trend was 0.51.
- L3 deviated 0.36 mm from the flat-back line toward the front of the body for every positive degree change in T_P angle (toward lordosis). The R^2 correlation for this trend was 0.65.

Note that although T_P angle is defined a the sum of T_L and P_L angles, the trends in lumbar shape due to T_L and P_L do not sum to the trend in lumbar shape due to T_P. This is because T_L and P_L influences on L3 deviation are not independent. However, the trends provide a starting point for understanding the impact of posture on lumbar shape.

Coupling between orientation change of the thorax relative to the lumbar to orientation change between the pelvis and lumbar was not found. Support of the pelvis was shown to yield relative orientation change between the pelvis and lumbar, but not corresponding orientation change between the thorax and lumbar. Support of the ribcage resulted in thorax orientation change relative to the lumbar segment, but did not cause relative orientation change between the pelvis and lumbar.

Because no coupled linkage was found, it was concluded that evaluating seats with a linked model, such as Bush's model, would provide insufficient information for describing the total posture. Using a coupled model, many different heights of a prominence would yield identical postural outputs; however, when using an uncoupled model, more like the human torso, change in thorax to lumbar orientation could be evaluated separately from change in orientation between the pelvis and lumbar segments, to reflect the height of the lumbar prominence.

Support of both the thorax and pelvis, creating a convex seat back contour, showed, on average, nearly even increases in T_L and P_L from flat-back (lordosis). Unsupported lower thorax and upper pelvis seatback configurations (concave seat back) caused evenly distributed decreases in T_L and P_L from flat-back (kyphosis).

Future work should include testing more mid-size male subjects. This would increase the level of confidence in the final joint locations and angle ranges. It would

also be fitting to test subjects in other size groups, i.e. large males and small females, in order to understand the differences size and gender make on a model. Perhaps also warranting investigation would be a posture study in an office environment. Although it is possible to use the model developed here in an office environment, there is no documentation to support the fact that the range and type of motion represented by this model would necessarily model subjects seated in an office environment.

Values of and locations for masses of the segments should also be determined, to provide a true human-like computer model for computer modeled seat prototypes. This would be the next step in creating the needed seat design tool, which incorporates evaluation feedback, in the form of seated posture, in the design process. Having a means of testing seat ideas with such a computer model would be a great advantage over expensive and time-consuming physical prototyping.

APPENDICES

APPENDIX A

Height and Mass of Tested Subjects

Table 21: Height and Mass of Tested Subjects

SUBJECT	HEIGHT (mm)	MASS (kg)
01	1778	73
02	1759	73
03	1765	73
04	1778	74
05	1753	82
06	1759	73
07	1740	73
08	1702	76
09	1740	82
10	1734	79

APPENDIX B

UCRIHS Approved (IRB 96-054) Consent Forms

BIOMECHANICAL DESIGN RESEARCH LABORATORY

A423 East Fee Hall
Michigan State University
East Lansing, MI 48824

I,_____, consent to serve as an experimental subject in the research project "Position, Force, and Muscle Activity Measurements of the Body in Various Seats". I understand that I am to participate in a non-invasive experiment conducted in various instrumented seats, and that data will be gathered concerning my position, muscle activity and force on the seat. The time that I will spend participating in this experiment will be approximately two hours. My height, weight and some physical measurements will be taken prior to testing. Certain areas of my skin will be cleaned with alcohol swab and gauze pad. Hypo-allergenic tape or adhesive collars may be used to attach reflective targets and EMG electrodes to the surface of my skin. A material band may be used to attach reflective targets to my head or pelvis. I may be asked to move through a range of typical positions. Motion and muscle activity data will be transferred to a personal computer along with force information gathered by force plates in the seats. I have been advised that all work will be conducted under the supervision of individuals who are expert with the involved techniques. I have been assured that my participation remains confidential and that published experimental results will not reveal my identity. My consent to serve as a subject is given freely and without coercion. Further, I understand that I may choose not to participate in any portion of the experiment, that I may refuse to answer any question, and that I may withdraw from the experiment at any time and for any reason without penalty. Should I have questions, I may contact Tammy Bush at 353-9544 or Robert Hubbard at 353-5013.

Signature:_____Date:_____
Address: _____
_____
_____
Phone: _____

Witness:_____Date:_____

UCRIHS APPROVAL FOR THIS project EXPIRES:

JAN 2 9 1998

SUBMIT RENEWAL APPLICATION ONE MONTH PRIOR TO

BIOMECHANICAL DESIGN RESEARCH LABORATORY
A423 East Fee Hall
Michigan State University
East Lansing, MI 48824

CONSENT TO PHOTOGRAPH AND/OR INTERVIEW

I,_____,do hereby give my consent
(subject name, parent, legal guardian)

for_____, to be:
(name of subject/ other interviewee)

_____videotaped
_____filmed
_____photographed
_____interviewed and/or audiotaped

by_____, for the purpose of:
(name of photographer and/or interviewer)

_____
_____
_____

I also consent to the use or publication of such photographs and/or interviews for the purpose stated above. I relinquish any claim to said photographs, films, videotapes, audio tapes and/or interviews and acknowledge that they are the property of and to be used only by Michigan State University.

_____
Signed Date

_____
Witness Relationship to Subject/ Interviewee

UCRIHS APPROVAL FOR
THIS project EXPIRES:

JAN 2 9 1998

SUBMIT RENEWAL APPLICATION

APPENDIX C

Data Transformation into Sagittal Plane

In order to transform all of the observed data into the coordinate system defined by the reference targets, O and R (Origin and Reference), the data was first translated to the origin at O and then rotated such that the vector from target O through target R created the positive x axis.

Locations of targets were defined as vector locations, where **O** is the origin target location, **R** is the x-axis reference target location, and **P** is the location of any other target in the space.

$$\mathbf{O} = O_i\,\hat{\mathbf{e}}_i \qquad i = x, y, z \tag{60}$$

$$\mathbf{R} = R_i\,\hat{\mathbf{e}}_i \qquad i = x, y, z \tag{61}$$

$$\mathbf{P} = P_i\,\hat{\mathbf{e}}_i \qquad i = x, y, z \tag{62}$$

The translation was carried out, such that

$$O_i' = O_i - O_i = 0 \tag{63}$$

$$P_i' = P_i - O_i \tag{64}$$

$$R_i' = R_i - O_i \tag{65}$$

The rotation was then applied through an angle θ, which was defined as

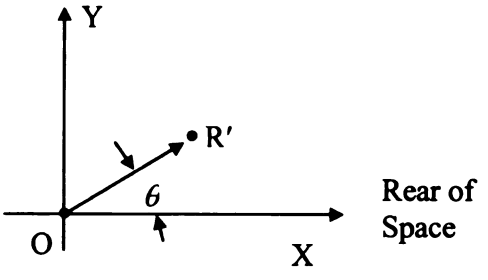
$$\theta = \sin^{-1}\left(\frac{R_y'}{|\mathbf{R}|}\right) \tag{66}$$

where

$$|\mathbf{R}| = \sqrt{R_i R_i} \qquad i = x, y, z \tag{67}$$

applying the summation convention.

This can be shown graphically,



View from Top

Figure 38: Rotation Angle for Data Transformation to Sagittal Plane

Rotation of this translated data through the angle θ, was completed as follows:

$$(\mathbf{P''}) = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{pmatrix} P'_x \\ P'_y \\ P'_z \end{pmatrix} \tag{68}$$

$$(\mathbf{R''}) = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{pmatrix} R'_x \\ R'_y \\ R'_z \end{pmatrix} \tag{69}$$

Point locations here denoted with the double prime (") are the point locations referred to in this document as the sagittal view target locations. The matrices are transformation matrices [10].

APPENDIX D

Pelvis Shape and Scaling

The pelvis shape used in this study was based on anthropometric data collected by Reynolds, *et al.* [11]. Points in coordinate pairs (mm) are listed below.

Table 22: Pelvis Point Coordinates

X	Z
-137.1	0.0
-125.0	-14.9
-128.5	-35.7
-122.2	-49.3
-148.3	-75.3
-145.2	-94.4
-122.6	-126.9
-90.7	-145.1
-68.2	-135.6
-63.8	-129.4
-61.4	-104.3
-61.0	-73.8
-58.5	-38.6
-45.3	-34.3
-25.6	-42.5
-18.2	-74.8
-21.4	-89.5
-13.9	-88.0
-2.6	-54.7
0.3	-31.8
-2.4	-10.7
0.0	0.0
-26.7	46.7
-36.7	47.8
-46.2	56.1
-52.3	56.3
-77.5	48.4
-112.3	29.4
-132.3	8.1

The pelvis outline created by plotting these points is shown in Figure 39.

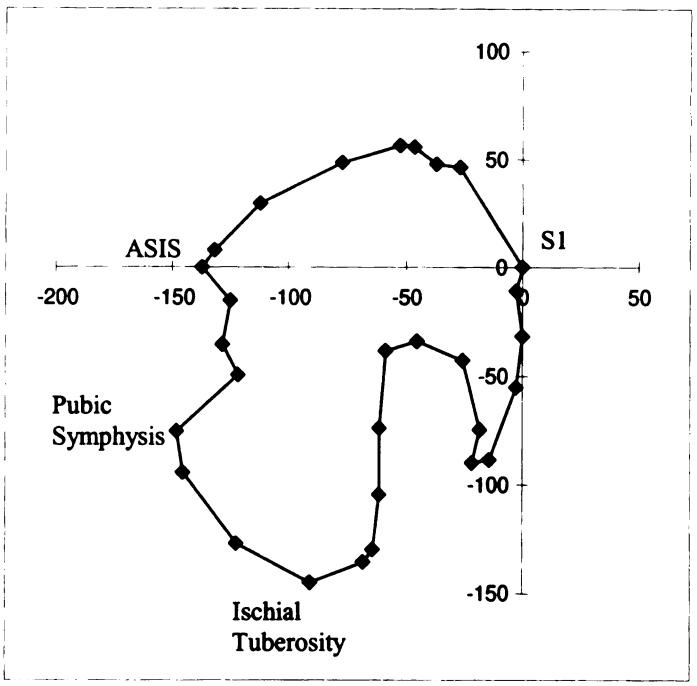


Figure 39: Reynolds Pelvis Shape (axes in mm)

For visual representation of the pelvis of each individual subject and for estimating the location of the hip joint center, the above pelvis shape was scaled for each subject. The first step in the scaling was to determine the subject's ASIS to S1 distance. The Reynolds pelvis shape was then scaled in the X direction based on the ratio of the subject's ASIS to S1 distance to the Reynolds pelvis' ASIS to S1 distance (137.1 mm). Next, information from the reference file was used to scale the height of the pelvis. In the reference file, the height of the seating surface was documented by a target lateral to the approximate location of the subject's ischial tuberosities. The thickness of the tissue under the pelvis, depressed by the weight of the seated subject was assumed to be 15 mm, based on data from Reynolds [16]. Therefore, the known location of the seat surface was 15 mm below the position of the ischial tuberosities. This information was used to scale

the pelvis in the Z direction, so that the pelvis height matched that of the individual subject.

APPENDIX E

Raw Output Data for Each Subject

Reference Data Target locations for Subject 01

	x	y	z
Origin	243.1	-214.4	187.3
Reference	459.6	-196.5	129.9
Manubrium	379.3	67.8	733.0
Xyphoid	321.5	49.6	588.5
C7	544.5	79.2	791.8
T4	565.3	83.7	688.1
S1	422.0	58.4	284.7
Left ASIS	276.7	-71.2	388.9
Left Lateral Femoral Condyle	-106.1	-204.6	402.3
Left Lateral Malleolis	-264.8	-183.7	19.0
Left Lateral Foot	-458.3	-182.3	-30.7

Test target data for Subject 01 follows (coordinates in millimeters);

Subject
01

Probe Length
376

InterASIS Dist.
215

InterPSIS Dist.
90

Heel to foot target dist.
235

Test Condition	Target Locations: Origin			ref 2		
	x	y	z	x	y	z
1	75.1	-282.1	-25.0	426.3	-272.9	-24.7
2	75.1	-282.0	-25.1	426.4	-272.9	-24.6
3	75.1	-282.1	-24.9	426.3	-273.1	-24.8
4	75.1	-282.1	-25.0	426.4	-273.0	-24.7
5	75.1	-282.0	-25.1	426.4	-273.0	-24.7
6	75.2	-282.0	-25.0	426.4	-272.9	-24.9
7	75.0	-282.1	-25.1	426.4	-273.0	-24.7
8	75.2	-282.0	-25.0	426.4	-272.9	-24.7
9	75.2	-282.1	-25.0	426.5	-273.1	-24.8
10	75.1	-282.0	-25.1	426.4	-272.9	-24.7
11	75.2	-282.1	-25.0	426.6	-273.0	-24.8
12	75.2	-282.1	-25.0	426.3	-272.9	-24.9
13	75.2	-282.1	-25.1	426.4	-273.0	-24.8
14	75.1	-282.0	-25.1	426.4	-272.9	-24.6
15	75.2	-282.0	-25.0	426.4	-272.9	-24.9
16	75.2	-282.1	-25.0	426.5	-273.1	-24.7
17	75.2	-282.2	-25.0	426.6	-273.0	-24.7
18	75.2	-282.1	-25.0	426.4	-272.9	-24.9
19	75.2	-282.1	-25.2	426.4	-272.9	-24.7
20	75.2	-282.1	-25.0	426.3	-273.1	-24.9
21	75.2	-282.1	-25.0	426.6	-273.0	-24.8
22	75.1	-282.0	-25.1	426.3	-273.0	-24.8

Test Condition	Target Locations: Elbow			Wrist		
	x	y	z	x	y	z
1	493.0	-240.9	409.5	245.8	-192.7	521.0
2	495.9	-240.3	417.1	246.7	-197.3	521.1
3	490.1	-242.7	413.2	232.9	-218.4	522.2
4	489.7	-240.4	420.8	232.8	-217.7	525.3
5	485.8	-222.4	415.8	224.1	-225.1	524.4
6	478.3	-239.8	424.2	219.4	-214.8	525.6
7	484.2	-246.2	417.9	225.2	-219.3	522.0
8	491.2	-244.1	419.6	234.0	-220.2	527.9
9	502.2	-240.8	417.0	246.5	-206.1	523.7
10	496.3	-220.6	416.8	238.0	-208.3	523.3
11	494.4	-239.3	409.7	243.0	-202.6	520.2
12	495.5	-242.6	412.6	240.5	-205.1	521.5
13	508.4	-220.6	407.7	257.1	-189.5	518.4
14	495.9	-240.3	417.1	246.7	-197.3	521.1
15	499.7	-235.0	409.5	248.4	-200.6	519.9
16	500.3	-234.7	409.9	251.2	-192.6	519.3
17	501.3	-238.9	412.3	250.3	-194.5	519.0
18	495.6	-240.2	410.6	248.6	-194.1	522.7
19	500.1	-236.1	411.2	250.4	-197.9	519.5
20	497.6	-227.3	411.0	244.0	-198.7	518.7
21	0.0	0.0	0.0	229.6	-220.8	516.8
22	501.1	-239.2	411.9	250.3	-200.1	519.9

Test Condition	Target Locations: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	465.2	33.3	738.1	394.0	19.2	600.0	332.7	-101.6	394.6
2	470.3	36.3	743.5	395.8	21.4	608.2	327.4	-101.7	399.9
3	473.5	33.7	741.0	395.7	19.9	608.1	317.3	-102.5	403.7
4	464.4	34.6	744.5	391.2	19.9	608.8	319.7	-101.6	403.3
5	474.9	39.8	748.4	389.2	26.4	621.1	316.8	-99.7	402.8
6	502.7	44.1	743.1	401.8	27.1	625.6	316.7	-94.0	401.9
7	492.2	26.8	746.2	398.4	12.9	623.4	324.7	-106.3	396.4
8	481.6	26.1	748.6	394.3	9.8	620.6	328.5	-109.9	394.3
9	477.9	22.9	745.7	395.9	10.5	614.5	332.4	-103.6	394.4
10	480.6	40.2	745.5	397.4	26.8	615.0	327.0	-95.0	399.9
11	446.1	33.2	733.6	384.1	19.0	592.0	336.5	-98.2	394.0
12	469.9	27.1	738.3	397.6	16.2	601.5	334.8	-99.6	396.7
13	466.3	43.5	738.1	395.2	31.1	600.4	338.3	-86.5	397.9
14	470.3	36.3	743.5	395.8	21.4	608.2	327.4	-101.7	399.9
15	448.0	31.3	732.1	384.0	17.5	591.4	339.6	-100.2	398.7
16	439.4	31.1	736.7	377.7	21.1	592.6	340.3	-97.4	397.9
17	449.2	27.9	738.4	381.5	15.8	598.1	338.4	-104.2	398.8
18	429.6	32.1	732.5	378.4	20.8	587.6	336.1	-104.9	394.1
19	461.7	34.7	739.3	389.9	25.5	601.3	336.4	-104.0	397.9
20	457.3	36.5	739.4	387.6	23.1	600.1	338.0	-103.5	394.8
21	485.1	34.9	745.2	397.1	17.6	616.8	329.5	-102.1	399.9
22	470.5	32.3	740.3	395.9	18.5	604.1	338.5	-103.7	397.3

Test Condition	Target Locations: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-93.3	-163.2	345.6	-352.8	-132.7	-6.5	-514.9	-141.8	103.5
2	-88.8	-180.8	336.2	-364.1	-147.1	-10.2	-520.1	-144.0	110.5
3	-102.9	-163.2	349.0	-358.0	-131.4	-4.7	-517.4	-137.6	107.8
4	-92.1	-180.3	344.6	-365.1	-175.8	-4.3	-520.4	-164.4	115.4
5	-101.1	-176.3	347.8	-364.5	-150.6	-5.1	-520.6	-144.3	112.8
6	-98.2	-182.5	343.5	-364.9	-155.1	-7.3	-520.4	-147.3	111.8
7	-96.0	-180.8	346.0	-360.4	-156.8	-0.1	-520.5	-139.8	110.4
8	-91.9	-182.5	328.8	-372.8	-152.4	-11.1	-521.5	-157.2	118.1
9	-88.5	-185.0	339.7	-356.4	-154.8	-0.3	-518.7	-151.9	110.7
10	-88.5	-181.2	339.1	-360.3	-149.1	-3.6	-520.0	-145.5	110.4
11	-89.0	-172.5	336.3	-364.5	-146.3	-9.2	-519.5	-145.0	111.3
12	-89.1	-183.9	338.0	-361.0	-150.0	-8.4	-519.6	-148.3	108.3
13	-87.9	-168.6	337.2	-361.3	-141.0	-5.9	-519.2	-141.4	110.1
14	-88.8	-180.8	336.2	-364.1	-147.1	-10.2	-520.1	-144.0	110.5
15	-94.2	-169.7	343.0	-356.0	-138.6	-1.1	-517.8	-143.8	110.2
16	-90.6	-175.8	338.3	-357.5	-139.6	-4.4	-517.9	-145.7	109.5
17	-89.1	-172.1	346.1	-351.4	-140.3	-0.7	-514.3	-140.3	101.0
18	-87.9	-196.5	336.1	-357.0	-164.1	-3.1	-517.5	-167.9	110.1
19	-90.4	-171.0	340.6	-355.2	-139.3	-6.7	-515.3	-153.1	105.7
20	-90.2	-174.4	341.6	-359.0	-147.7	-3.6	-518.9	-148.7	109.7
21	-90.6	-176.2	351.2	-346.4	-141.5	0.4	-514.0	-136.9	96.5
22	-89.7	-178.6	348.5	-347.0	-156.3	-1.1	-512.7	-166.1	102.5

Test Condition	Target Locations: Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	654.9	-399.2	1000.7	878.1	12.0	312.2	878.1	12.0	312.2
2	634.5	-416.1	1002.0	854.0	15.1	283.5	854.0	15.1	283.5
3	679.1	-329.1	1055.4	867.0	48.9	298.5	867.0	48.9	298.5
4	689.5	-391.3	1008.8	879.2	43.6	318.8	879.2	43.6	318.8
5	661.0	-345.0	1056.8	863.8	46.6	308.5	863.8	46.6	308.5
6	750.0	-330.2	1026.5	867.9	62.1	311.3	867.9	62.1	311.3
7	767.7	-375.6	990.8	866.7	32.6	308.9	866.7	32.6	308.9
8	704.1	-393.7	1014.7	873.0	23.2	322.4	873.0	23.2	322.4
9	660.5	-372.9	1049.5	869.9	19.9	308.6	869.9	19.9	308.6
10	709.2	-378.0	1014.3	865.1	54.8	305.0	865.1	54.8	305.0
11	676.4	-362.3	1024.9	865.0	63.5	306.5	865.0	63.5	306.5
12	700.9	-399.8	998.5	877.7	61.9	315.4	877.7	61.9	315.4
13	617.2	-368.2	1041.2	900.8	86.2	348.4	900.8	86.2	348.4
14	634.5	-416.1	1002.0	854.0	15.1	283.5	854.0	15.1	283.5
15	648.0	-363.2	1039.9	881.0	70.4	327.5	881.0	70.4	327.5
16	670.6	-341.5	1041.2	889.9	80.9	350.2	889.9	80.9	350.2
17	656.9	-360.1	1046.4	873.0	48.3	328.3	873.0	48.3	328.3
18	632.6	-342.7	1054.8	868.7	55.1	323.9	868.7	55.1	323.9
19	620.3	-372.1	1046.5	861.9	41.0	304.1	861.9	41.0	304.1
20	661.6	-421.3	979.5	866.9	68.9	307.2	866.9	68.9	307.2
21	771.6	-376.1	978.9	871.3	67.0	312.5	871.3	67.0	312.5
22	617.6	-392.4	1034.0	869.1	63.5	305.2	869.1	63.5	305.2
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	600.8	-280.4	883.9	736.2	18.6	414.3	736.2	18.6	414.3
2	596.7	-289.9	885.9	726.6	19.8	404.0	726.6	19.8	404.0
3	619.5	-245.2	913.4	731.1	38.2	407.1	731.1	38.2	407.1
4	623.6	-277.6	892.8	738.7	30.7	421.8	738.7	30.7	421.8
5	615.8	-250.8	916.1	723.3	37.9	412.2	723.3	37.9	412.2
6	672.0	-240.9	895.7	724.9	48.7	412.9	724.9	48.7	412.9
7	680.2	-272.0	878.3	726.6	27.4	412.7	726.6	27.4	412.7
8	638.9	-282.4	894.9	732.7	18.3	425.9	732.7	18.3	425.9
9	615.0	-272.0	913.0	730.1	20.0	413.9	730.1	20.0	413.9
10	641.6	-268.0	895.1	728.3	46.9	411.9	728.3	46.9	411.9
11	603.8	-264.0	899.4	731.6	44.8	419.0	731.6	44.8	419.0
12	631.0	-285.2	885.5	741.5	42.0	422.6	741.5	42.0	422.6
13	583.8	-260.2	906.7	752.6	62.3	438.8	752.6	62.3	438.8
14	596.7	-289.9	885.9	726.6	19.8	404.0	726.6	19.8	404.0
15	591.0	-262.8	907.4	740.6	48.6	429.6	740.6	48.6	429.6
16	599.0	-249.7	909.7	742.2	55.5	443.8	742.2	55.5	443.8
17	595.5	-263.2	913.5	733.6	32.3	431.4	733.6	32.3	431.4
18	574.3	-251.4	917.1	731.8	41.8	430.9	731.8	41.8	430.9
19	579.9	-267.7	911.3	724.9	31.8	412.3	724.9	31.8	412.3
20	601.7	-293.1	875.6	732.4	47.2	419.4	732.4	47.2	419.4
21	676.8	-269.4	876.7	733.4	47.1	420.7	733.4	47.1	420.7
22	586.9	-278.3	904.4	733.0	45.8	412.2	733.0	45.8	412.2

Test Condition	Target Locations: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	932.3	55.9	438.6	798.6	20.9	193.3	900.7	12.2	377.7
2	920.7	78.7	403.2	801.4	34.3	197.1	875.4	44.8	289.5
3	921.5	95.2	407.2	791.5	52.9	193.5	886.3	39.8	356.8
4	923.9	68.8	425.9	812.8	14.4	221.0	870.9	9.7	314.2
5	909.0	94.2	421.9	806.3	36.0	224.0	847.7	56.2	279.8
6	900.0	89.4	380.9	791.2	54.4	213.3	848.6	87.1	287.7
7	899.2	78.8	380.6	789.8	37.9	209.4	852.6	55.9	277.3
8	895.8	79.3	376.6	783.3	-16.0	201.2	886.9	11.9	358.8
9	901.0	60.1	364.9	811.3	-7.6	218.1	877.4	-4.5	299.6
10	898.8	52.7	356.9	789.3	38.4	197.2	852.6	43.4	263.7
11	919.6	23.3	396.3	819.9	28.3	213.3	894.5	72.5	340.3
12	918.6	81.8	395.2	918.6	81.8	395.2	893.8	35.6	334.2
13	926.2	56.8	401.7	828.6	44.9	218.3	893.2	48.1	321.0
14	920.7	78.7	403.2	801.4	34.3	197.1	875.4	44.8	289.5
15	924.5	17.7	403.1	835.8	28.4	223.4	817.4	33.7	160.2
16	921.6	49.6	414.3	859.6	22.8	259.7	896.8	-5.6	330.0
17	915.1	38.6	402.4	831.2	27.5	229.0	896.4	40.8	344.6
18	914.7	47.1	399.6	849.3	23.7	252.6	897.2	65.7	373.2
19	796.6	46.0	197.6	796.6	46.0	197.6	897.1	61.1	373.7
20	923.5	69.3	417.0	864.9	35.0	265.1	906.4	20.7	384.9
21	901.7	31.1	368.2	816.4	45.8	226.7	868.2	31.9	292.2
22	919.1	58.3	379.2	815.4	19.3	205.5	889.9	41.3	318.1
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	760.2	41.0	471.1	684.1	21.1	326.6	723.1	22.5	397.3
2	756.0	52.2	453.2	685.4	33.3	328.8	713.4	33.9	357.9
3	759.6	62.4	453.7	677.9	43.5	327.0	714.6	32.6	389.4
4	755.0	49.4	465.8	689.9	24.1	344.3	706.7	13.8	369.1
5	741.3	61.5	464.1	680.5	33.2	347.7	693.7	40.1	359.7
6	737.3	60.9	442.2	672.8	46.7	343.0	692.9	59.6	364.0
7	737.6	49.5	444.3	672.5	26.3	339.9	699.2	35.4	357.4
8	736.5	49.0	443.7	669.0	-4.9	333.0	714.2	11.6	390.6
9	744.5	36.5	438.1	688.8	1.2	341.7	715.2	5.0	361.4
10	742.4	42.2	433.4	672.7	37.5	330.3	700.6	37.7	348.0
11	754.3	19.9	448.4	697.7	26.4	337.4	724.6	48.2	379.1
12	754.0	51.8	446.6	754.0	51.8	446.6	725.0	28.5	378.4
13	760.4	46.4	450.6	703.6	39.9	339.7	726.7	43.8	368.8
14	756.0	52.2	453.2	685.4	33.3	328.8	713.4	33.9	357.9
15	758.2	18.7	452.0	707.8	25.7	342.0	685.0	24.7	271.7
16	754.1	38.3	458.3	719.4	26.5	362.5	728.6	8.1	374.5
17	749.5	28.5	452.7	700.7	23.0	345.4	725.1	30.3	380.0
18	749.5	36.8	451.1	711.1	23.7	358.0	723.1	50.6	395.9
19	680.1	36.2	329.6	680.1	36.2	329.6	724.2	44.1	396.3
20	756.1	46.1	458.9	721.7	28.1	364.2	728.3	27.9	399.6
21	744.4	24.9	438.2	690.3	34.7	348.8	705.9	27.8	360.4
22	754.4	40.8	439.9	688.1	24.6	329.4	723.7	28.6	367.8

Test Condition	Target Locations: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	795.2	12.1	142.0	786.3	3.7	98.3	786.3	3.7	98.3
2	769.6	18.8	129.6	855.9	66.1	267.9	775.8	28.0	93.3
3	756.6	18.9	125.8	844.0	42.3	283.0	773.3	55.2	113.3
4	870.9	9.7	314.2	840.1	73.0	302.1	765.9	39.7	103.1
5	750.0	34.4	132.3	767.1	25.8	105.6	767.1	25.8	105.6
6	755.1	50.2	139.0	835.6	79.5	265.1	776.3	18.5	111.8
7	758.5	20.5	128.5	769.0	10.1	92.2	769.0	10.1	92.2
8	886.9	11.9	358.8	780.5	44.2	96.9	780.5	44.2	96.9
9	810.9	22.5	167.5	781.9	46.8	94.9	781.9	46.8	94.9
10	775.5	43.9	140.1	853.1	55.2	293.4	773.1	58.7	94.9
11	809.7	71.3	157.3	790.7	50.7	99.9	790.7	50.7	99.9
12	808.8	26.6	161.1	761.3	77.5	72.8	761.3	77.5	72.8
13	808.6	74.6	155.1	805.2	47.8	124.1	805.2	47.8	124.1
14	769.6	18.8	129.6	855.9	66.1	267.9	855.9	66.1	267.9
15	817.4	33.7	160.2	810.3	18.3	128.6	810.3	18.3	128.6
16	832.8	35.2	178.6	813.9	77.9	146.1	813.9	77.9	146.1
17	814.2	35.9	160.8	790.5	90.1	108.9	790.5	90.1	108.9
18	843.9	42.1	206.2	814.0	42.1	144.4	814.0	42.1	144.4
19	845.7	51.5	209.5	816.7	21.5	145.9	816.7	21.5	145.9
20	821.1	45.7	163.4	813.7	56.7	139.8	813.7	56.7	139.8
21	772.8	28.5	142.0	855.4	65.6	304.3	761.2	28.8	76.5
22	777.7	44.0	126.5	798.5	56.7	116.3	798.5	56.7	116.3
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	665.0	18.5	259.1	641.9	8.9	198.6	641.9	8.9	198.6
2	644.8	19.4	251.4	684.8	46.6	304.7	634.6	22.5	196.7
3	636.6	24.6	251.7	674.0	33.5	315.7	627.1	41.9	212.2
4	706.7	13.8	369.1	667.9	44.8	326.0	624.4	29.5	207.0
5	631.9	28.3	262.5	623.1	23.1	205.2	623.1	23.1	205.2
6	629.0	40.2	264.7	665.1	53.1	305.1	626.4	21.4	203.1
7	635.6	23.5	252.6	628.3	11.1	198.1	628.3	11.1	198.1
8	714.2	11.6	390.6	637.2	26.6	197.5	637.2	26.6	197.5
9	677.7	17.5	277.7	638.9	31.1	196.2	638.9	31.1	196.2
10	651.0	36.9	264.0	678.1	41.3	316.6	633.6	40.8	200.1
11	685.0	43.1	272.3	644.1	35.6	195.3	644.1	35.6	195.3
12	680.7	16.1	274.6	633.5	43.6	186.3	633.5	43.6	186.3
13	686.1	44.2	270.6	651.2	38.6	208.1	651.2	38.6	208.1
14	644.8	19.4	251.4	684.8	46.6	304.7	684.8	46.6	304.7
15	685.0	24.7	271.7	653.1	16.9	206.9	653.1	16.9	206.9
16	689.0	33.4	282.4	655.4	49.5	216.9	655.4	49.5	216.9
17	682.6	26.6	272.4	642.4	54.8	198.8	642.4	54.8	198.8
18	689.3	33.1	289.6	657.4	29.8	222.9	657.4	29.8	222.9
19	690.9	35.2	290.1	659.2	18.2	223.3	659.2	18.2	223.3
20	680.9	33.3	265.4	658.4	36.8	217.4	658.4	36.8	217.4
21	649.5	20.8	264.9	680.9	42.4	321.7	628.7	23.7	192.6
22	652.5	33.4	247.2	650.1	38.3	208.0	650.1	38.3	208.0

Reference Data Target locations for Subject 02

	x	y	z
Origin	-59.7	-259.3	187.9
Reference	158.6	-253.8	130.3
Manubrium	93.5	2.8	738.2
Xyphoid	4.7	-2.4	601.0
C7	248.5	-5.5	809.5
T4	275.1	6.1	659.2
S1	122.2	15.6	268.3
Left ASIS	-20.8	-121.9	394.7
Left Lateral Femoral Condyle	-436.7	-186.9	403.4
Left Lateral Malleolis	-527.7	-169.3	17.6
Left Lateral Foot	-705.8	-224.5	-30.6

Test data for Subject 02 follows (coordinates in millimeters);

Subject	Test Condition	Target Locations for Subject 02: Origin x	y	z	ref 2 x	y	z
02	1	-44.2	-308.0	-25.5	307.7	-318.2	-23.2
	2	-44.3	-307.9	-25.6	307.7	-318.2	-23.2
Probe Length	3	-44.2	-307.9	-25.6	307.6	-318.2	-23.3
376	4	-44.3	-307.9	-25.5	307.6	-318.1	-23.2
	5	-44.3	-307.9	-25.5	307.6	-318.1	-23.2
InterASIS Dist.	6	-44.2	-307.9	-25.6	307.6	-318.1	-23.3
270	7	-44.3	-307.9	-25.6	307.6	-318.2	-23.3
	8	-44.2	-308.0	-25.5	307.6	-318.1	-23.2
InterPSIS width	9	-44.3	-308.0	-25.6	307.6	-318.1	-23.2
100	10	-44.3	-307.9	-25.6	307.6	-318.1	-23.3
	11	-44.3	-307.9	-25.6	307.6	-318.1	-23.2
Heel to foot	12	-44.3	-307.9	-25.6	307.6	-318.2	-23.3
target dist.	13	-44.3	-307.9	-25.6	307.7	-318.0	-23.2
237	14	-44.3	-307.9	-25.6	307.6	-318.2	-23.3
	15	-44.3	-307.9	-25.6	307.6	-318.2	-23.3
	16	-44.3	-307.9	-25.6	307.6	-318.1	-23.2
	17	-44.3	-307.9	-25.6	307.5	-318.1	-23.3
	18	-44.3	-307.9	-25.6	307.6	-318.2	-23.3
	19	-44.3	-307.9	-25.6	307.6	-318.1	-23.2
	20	-44.3	-307.9	-25.6	307.5	-318.1	-23.2
	21	-44.3	-307.9	-25.6	307.6	-318.1	-23.3
	22	-44.3	-307.9	-25.6	307.5	-318.1	-23.3

Test Condition	Target Locations for Subject 02: Elbow x	y	z	Wrist x	y	z
1	328.4	-302.1	465.2	121.9	-234.3	564.9
2	326.6	-307.6	468.3	119.1	-234.9	560.6
3	335.4	-302.3	475.3	122.8	-236.6	562.4
4	333.3	-300.4	471.6	123.9	-232.6	563.0
5	330.7	-296.7	477.3	115.0	-236.1	563.8
6	345.4	-304.4	476.2	132.2	-235.7	559.7
7	339.6	-288.6	480.0	118.7	-235.9	561.6
8	349.4	-308.1	484.4	130.3	-238.1	557.4
9	350.7	-302.2	484.2	134.3	-233.6	559.5
10	333.4	-301.4	477.1	121.0	-230.1	560.1
11	330.6	-291.2	475.4	115.7	-230.3	562.9
12	337.6	-301.9	474.2	125.3	-231.4	560.7
13	328.7	-299.0	471.7	120.1	-221.0	558.7
14	341.4	-294.2	471.2	125.7	-232.2	556.0
15	328.7	-294.4	468.4	117.2	-232.4	561.7
16	313.3	-296.6	445.6	118.8	-224.0	557.8
17	309.6	-297.9	438.6	116.4	-226.4	554.1
18	339.2	-313.9	466.1	135.1	-232.2	555.9
19	334.2	-298.3	462.5	127.4	-227.0	553.2
20	320.8	-295.0	461.4	115.4	-228.3	560.8
21	338.6	-300.1	479.6	121.5	-235.6	560.2
22	330.5	-307.0	480.0	117.7	-232.4	561.1

Test Condition	Target Locations for Subject 02: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	363.9	-4.5	748.5	265.4	-5.3	614.9	219.1	-139.7	398.9
2	359.8	-6.8	747.9	266.7	-9.3	613.1	207.3	-142.9	400.1
3	369.5	-2.9	755.1	266.6	-8.3	625.4	196.2	-142.6	405.8
4	363.5	-1.3	755.2	263.0	-3.6	625.3	195.1	-133.9	404.0
5	372.4	0.2	765.3	261.4	0.0	640.1	196.5	-128.3	403.4
6	389.5	-2.5	764.7	267.0	-4.9	647.3	194.2	-136.2	404.7
7	379.6	6.3	763.7	263.2	3.0	642.2	202.9	-126.2	399.9
8	387.4	-5.2	770.2	264.2	-7.4	649.7	210.0	-135.9	398.7
9	374.2	2.2	771.8	261.2	-1.9	645.3	217.8	-131.9	398.5
10	374.7	-0.8	759.2	264.6	-1.4	631.2	205.0	-132.3	400.2
11	352.2	10.6	750.5	255.1	4.5	611.0	229.8	-127.7	396.7
12	372.3	1.6	754.8	264.0	-3.1	625.4	217.6	-138.7	398.1
13	370.2	-1.7	752.7	263.7	-2.6	621.5	223.4	-135.2	395.3
14	372.1	8.6	754.8	264.8	6.3	624.2	225.4	-120.0	393.4
15	353.6	5.3	751.6	257.1	5.8	611.5	230.6	-129.2	394.8
16	306.4	3.1	718.5	251.4	-3.3	573.5	227.8	-131.6	392.2
17	306.3	-6.7	718.9	252.2	-8.4	575.1	222.7	-138.5	393.7
18	334.6	-6.4	748.6	247.5	-8.8	607.6	219.9	-142.1	395.5
19	322.1	0.9	741.9	249.3	-4.3	595.8	218.9	-133.6	396.0
20	325.0	5.5	742.4	247.3	4.1	596.9	225.4	-126.4	393.2
21	376.5	5.9	760.4	263.9	2.5	635.1	206.4	-130.6	401.2
22	368.4	-5.4	758.1	264.4	-8.9	626.1	215.9	-140.1	398.0

Test Condition	Target Locations for Subject 02: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-208.0	-196.1	332.7	-474.1	-208.9	3.8	-625.6	-211.9	100.7
2	-211.2	-202.5	335.9	-469.7	-205.8	2.7	-622.8	-217.5	96.5
3	-213.6	-201.7	342.2	-463.7	-200.0	3.5	-622.4	-202.7	90.2
4	-212.7	-196.7	341.0	-465.2	-210.1	5.3	-622.8	-213.3	94.7
5	-212.2	-195.2	340.4	-465.9	-204.6	5.1	-624.4	-202.9	93.2
6	-215.8	-201.4	341.2	-467.0	-195.8	4.1	-625.3	-186.5	91.4
7	-210.8	-187.5	335.0	-472.7	-189.9	4.4	-624.4	-189.9	100.4
8	-198.8	-203.1	333.3	-463.7	-215.4	5.2	-624.3	-207.8	91.5
9	-204.5	-187.4	328.5	-472.9	-186.5	1.7	-624.2	-193.5	100.6
10	-215.7	-188.3	331.9	-477.7	-207.5	2.6	-624.8	-214.4	107.0
11	-205.4	-187.9	324.7	-477.8	-204.8	2.2	-624.8	-212.0	106.7
12	-208.3	-199.3	334.0	-469.0	-220.1	3.9	-622.2	-231.4	98.7
13	-204.6	-191.1	332.4	-466.6	-200.6	4.7	-623.3	-203.1	97.8
14	-198.8	-179.3	331.5	-465.2	-195.1	4.5	-622.3	-197.3	94.6
15	-200.1	-188.4	330.7	-465.3	-194.6	3.7	-624.9	-194.6	91.7
16	-204.5	-184.1	325.7	-475.0	-181.0	2.2	-627.7	-182.5	102.0
17	-208.3	-198.9	330.6	-473.5	-211.0	4.2	-626.4	-212.8	101.6
18	-203.6	-208.6	335.8	-459.2	-198.3	0.9	-621.0	-201.4	81.7
19	-204.3	-197.0	328.9	-473.3	-210.6	3.4	-626.7	-211.4	102.0
20	-202.0	-193.3	330.4	-467.0	-191.9	0.8	-624.4	-193.6	91.8
21	-212.5	-193.0	336.3	-467.4	-189.5	3.5	-625.5	-188.9	96.4
22	-204.1	-208.4	330.4	-467.9	-204.3	1.0	-624.0	-215.4	93.8

Test Condition	Target Locations for Subject 02: Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	636.6	-428.5	975.2	776.6	-75.0	308.2	776.6	-75.0	308.2
2	640.9	-441.1	945.0	770.7	-64.0	294.6	770.7	-64.0	294.6
3	656.7	-437.6	950.0	769.6	-87.8	316.2	769.6	-87.8	316.2
4	589.9	-451.1	982.0	767.8	-36.3	303.1	767.8	-36.3	303.1
5	659.5	-443.4	942.1	752.3	-39.5	301.5	752.3	-39.5	301.5
6	700.9	-434.2	929.1	752.0	-14.0	294.6	752.0	-14.0	294.6
7	648.8	-420.1	978.3	752.7	-40.9	302.7	752.7	-40.9	302.7
8	708.2	-427.3	927.8	747.4	-56.1	300.0	747.4	-56.1	300.0
9	687.1	-424.5	940.7	753.7	-20.4	286.4	753.7	-20.4	286.4
10	718.6	-389.0	929.5	752.0	-58.0	292.6	752.0	-58.0	292.6
11	631.4	-374.0	1007.3	762.3	-46.3	274.7	762.3	-46.3	274.7
12	602.1	-394.9	1027.7	771.6	-32.6	296.3	771.6	-32.6	296.3
13	646.4	-412.8	975.6	760.1	-46.9	278.1	760.1	-46.9	278.1
14	641.4	-414.1	976.3	769.9	-18.8	291.4	769.9	-18.8	291.4
15	637.6	-397.7	971.4	783.6	-33.1	298.7	783.6	-33.1	298.7
16	536.9	-438.1	968.5	783.9	-30.5	281.0	783.9	-30.5	281.0
17	552.8	-434.1	960.1	799.7	-45.6	318.8	799.7	-45.6	318.8
18	545.3	-408.9	1042.7	785.5	-48.3	323.7	785.5	-48.3	323.7
19	524.3	-442.6	993.6	775.8	-6.5	294.0	775.8	-6.5	294.0
20	614.2	-422.9	943.8	780.0	-32.2	299.1	780.0	-32.2	299.1
21	672.8	-396.2	977.5	750.1	-28.7	281.5	750.1	-28.7	281.5
22	643.7	-436.5	965.4	760.6	-57.5	285.3	760.6	-57.5	285.3
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	543.8	-313.7	879.2	629.8	-43.0	396.8	629.8	-43.0	396.8
2	542.1	-318.0	865.7	624.2	-39.7	388.5	624.2	-39.7	388.5
3	555.2	-316.4	872.4	620.8	-52.5	397.2	620.8	-52.5	397.2
4	517.8	-320.8	886.7	617.8	-21.1	394.8	617.8	-21.1	394.8
5	562.0	-316.4	866.7	605.0	-19.6	396.3	605.0	-19.6	396.3
6	593.7	-313.4	856.8	605.5	-10.0	393.3	605.5	-10.0	393.3
7	560.0	-299.6	885.4	604.6	-20.7	396.1	604.6	-20.7	396.1
8	597.1	-307.7	860.0	602.4	-36.8	396.6	602.4	-36.8	396.6
9	578.6	-304.7	870.5	611.8	-14.0	390.3	611.8	-14.0	390.3
10	593.4	-286.7	858.4	607.9	-34.7	390.8	607.9	-34.7	390.8
11	534.5	-271.4	902.1	623.4	-22.3	380.1	623.4	-22.3	380.1
12	528.4	-284.7	910.5	624.1	-21.4	390.6	624.1	-21.4	390.6
13	551.6	-297.7	880.9	617.8	-26.9	381.1	617.8	-26.9	381.1
14	551.7	-294.3	882.4	625.0	-7.2	389.7	625.0	-7.2	389.7
15	538.2	-285.3	880.1	634.8	-17.0	391.0	634.8	-17.0	391.0
16	457.0	-311.7	874.5	638.0	-18.6	379.2	638.0	-18.6	379.2
17	465.7	-312.5	867.7	642.2	-28.0	395.0	642.2	-28.0	395.0
18	477.4	-297.6	918.3	627.5	-31.7	404.5	627.5	-31.7	404.5
19	457.3	-313.6	894.7	630.4	-6.0	392.8	630.4	-6.0	392.8
20	512.5	-302.7	865.0	631.9	-17.5	393.3	631.9	-17.5	393.3
21	570.9	-285.4	885.7	609.0	-17.1	386.7	609.0	-17.1	386.7
22	549.8	-313.2	881.2	619.1	-38.7	387.6	619.1	-38.7	387.6

Test Condition	Target Locations for Subject 02: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	822.7	-38.3	512.3	680.7	-30.5	163.1	792.3	5.0	367.5
2	815.7	-76.7	473.7	697.5	-46.4	181.5	779.5	-22.2	341.3
3	769.6	-87.8	316.2	692.6	-54.1	190.9	754.1	-71.7	287.5
4	804.9	-52.9	530.8	705.6	-19.1	211.2	772.2	-11.9	373.5
5	799.1	-27.0	491.6	677.1	-0.1	200.9	751.0	-13.5	314.1
6	791.2	-51.7	414.3	677.6	-15.9	199.7	747.1	-0.8	300.6
7	793.2	-76.0	457.8	679.3	14.2	197.9	754.9	24.8	300.0
8	792.9	-81.9	477.5	677.9	-56.7	197.2	756.1	-11.7	506.4
9	778.0	-43.3	327.0	680.4	-5.7	177.9	756.7	-7.9	260.1
10	798.3	-78.4	456.3	675.7	-10.4	184.9	743.5	-28.7	253.0
11	824.7	-38.2	528.7	685.9	4.4	151.4	801.0	-32.0	426.6
12	810.1	-77.5	504.6	677.5	-32.8	165.4	788.7	28.1	360.9
13	816.9	-47.8	503.9	683.3	-17.1	162.4	792.8	39.5	354.7
14	815.4	-52.6	526.8	687.7	-20.9	169.2	794.6	-24.9	423.2
15	809.0	-10.6	570.3	687.6	-7.2	154.4	804.1	-8.9	381.8
16	824.4	-25.8	572.5	684.2	-34.3	141.3	711.3	-64.3	127.3
17	714.0	-23.7	174.7	714.0	-23.7	174.7	676.3	-61.4	100.4
18	715.8	-42.1	201.4	715.8	-42.1	201.4	797.5	-6.0	359.0
19	812.0	-98.4	492.8	673.0	-34.5	152.1	797.5	-6.0	359.0
20	819.1	-35.1	549.8	678.7	-11.2	149.3	804.6	-22.1	419.7
21	802.7	-55.3	536.2	682.4	-26.1	187.6	765.2	-26.3	304.1
22	805.3	-107.8	497.7	695.2	-64.7	189.2	778.7	-58.0	314.6
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	646.5	-23.8	493.4	566.0	-18.0	298.9	616.3	-3.0	385.8
2	641.9	-45.7	473.8	565.1	-27.7	302.8	603.9	-21.7	369.6
3	620.8	-52.5	397.2	559.8	-30.1	308.5	589.0	-45.4	346.0
4	630.5	-29.0	505.9	570.1	-10.6	323.7	594.4	-9.0	393.0
5	621.6	-12.1	488.9	551.3	-2.2	324.3	580.9	-8.3	363.8
6	619.9	-29.5	448.3	552.3	-15.4	323.8	577.6	-5.9	356.6
7	620.6	-43.4	471.1	554.8	4.8	321.6	586.6	12.0	353.5
8	618.7	-49.8	481.9	553.6	-42.8	321.3	589.5	-10.9	457.3
9	620.1	-24.7	402.1	558.4	-5.3	306.1	594.8	-7.1	331.1
10	625.6	-44.4	468.1	559.7	-13.8	314.2	585.9	-18.2	332.2
11	650.1	-16.9	499.5	571.4	9.3	286.9	625.7	-19.2	411.8
12	638.2	-45.3	490.7	563.2	-17.2	301.5	608.3	14.3	377.9
13	646.0	-27.2	491.8	569.5	-10.0	298.3	612.9	22.1	373.9
14	641.2	-24.8	501.1	571.4	-11.2	300.6	619.6	-3.0	412.2
15	646.0	-6.1	523.5	574.9	0.5	291.6	628.0	-5.2	387.2
16	654.4	-12.8	519.6	578.2	-20.0	280.6	575.6	-38.6	236.9
17	585.1	-15.1	295.5	585.1	-15.1	295.5	555.6	-37.9	227.9
18	587.9	-31.2	319.1	587.9	-31.2	319.1	616.4	1.8	375.7
19	642.3	-51.7	481.0	563.6	-16.6	289.1	616.4	1.8	375.7
20	645.7	-16.9	510.5	568.5	-2.7	287.1	629.2	-10.3	410.0
21	627.8	-31.8	508.6	553.3	-13.6	311.0	596.7	-17.3	356.7
22	635.0	-63.2	486.6	572.3	-44.8	311.5	611.3	-38.7	360.6

Test Condition	Target Locations for Subject 02: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	680.2	-21.4	123.3	669.9	-56.3	83.7	669.9	-56.3	83.7
2	673.9	-30.0	129.8	671.9	-53.7	103.4	671.9	-53.7	103.4
3	670.2	-42.3	141.4	672.7	-25.0	124.2	672.7	-25.0	124.2
4	674.3	-13.4	148.0	658.4	-17.8	108.2	658.4	-17.8	108.2
5	666.0	-25.9	150.4	651.3	-5.5	94.1	651.3	-5.5	94.1
6	666.2	-1.1	154.4	662.7	-5.8	108.5	662.7	-5.8	108.5
7	684.4	-19.6	158.4	674.8	6.9	106.1	674.8	6.9	106.1
8	668.8	-15.8	131.0	677.9	-37.1	97.1	677.9	-37.1	97.1
9	671.9	-29.2	122.7	663.6	9.3	68.6	663.6	9.3	68.6
10	673.3	7.6	140.9	659.9	-5.6	86.6	659.9	-5.6	86.6
11	675.0	-17.4	96.9	678.2	-38.4	73.5	678.2	-38.4	73.5
12	684.3	-12.8	126.3	680.1	-7.2	93.2	680.1	-7.2	93.2
13	688.8	9.8	119.5	684.5	-40.1	91.0	684.5	-40.1	91.0
14	667.4	-36.6	102.1	680.8	-15.8	72.4	680.8	-15.8	72.4
15	681.6	-5.5	101.0	686.8	-13.2	73.6	686.8	-13.2	73.6
16	711.3	-64.3	127.3	688.8	-41.2	79.2	688.8	-41.2	79.2
17	676.3	-61.4	100.4	683.2	-31.6	83.1	683.2	-31.6	83.1
18	717.6	-18.3	156.9	677.9	-26.6	80.8	677.9	-26.6	80.8
19	717.6	-18.3	156.9	685.9	-61.5	104.4	685.9	-61.5	104.4
20	684.2	-28.8	107.9	704.0	-60.0	120.5	704.0	-60.0	120.5
21	673.5	-36.9	139.7	666.7	-28.2	92.9	666.7	-28.2	92.9
22	680.3	-46.6	126.4	692.5	-50.0	113.8	692.5	-50.0	113.8
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	544.3	-11.9	239.8	524.7	-33.3	182.1	524.7	-33.3	182.1
2	543.2	-26.4	247.9	524.9	-34.5	199.1	524.9	-34.5	199.1
3	538.0	-25.5	256.7	521.1	-16.2	215.0	521.1	-16.2	215.0
4	537.6	-10.7	260.5	513.8	-10.0	209.4	513.8	-10.0	209.4
5	530.7	-15.2	264.1	508.8	3.2	201.2	508.8	3.2	201.2
6	530.6	-7.1	265.9	515.1	-7.2	206.6	515.1	-7.2	206.6
7	547.1	-14.3	269.5	525.0	5.6	200.9	525.0	5.6	200.9
8	539.9	-14.9	251.7	529.4	-24.9	192.3	529.4	-24.9	192.3
9	538.7	-12.6	241.9	525.9	2.3	179.9	525.9	2.3	179.9
10	540.9	2.8	255.9	517.3	-4.5	191.0	517.3	-4.5	191.0
11	555.1	-8.8	226.5	535.0	-21.5	173.6	535.0	-21.5	173.6
12	553.2	-10.0	244.8	528.8	-7.5	184.0	528.8	-7.5	184.0
13	552.0	13.1	236.7	533.4	-22.7	180.5	533.4	-22.7	180.5
14	549.0	-14.6	231.5	536.9	-2.7	173.9	536.9	-2.7	173.9
15	557.1	-1.5	228.5	540.3	-7.6	172.3	540.3	-7.6	172.3
16	575.6	-38.6	236.9	540.5	-21.8	172.2	540.5	-21.8	172.2
17	555.6	-37.9	227.9	533.8	-19.4	177.2	533.8	-19.4	177.2
18	571.7	-11.4	255.9	531.1	-18.3	178.7	531.1	-18.3	178.7
19	571.7	-11.4	255.9	535.3	-31.9	191.4	535.3	-31.9	191.4
20	555.7	-13.4	229.9	547.7	-31.2	197.5	547.7	-31.2	197.5
21	541.1	-22.6	254.6	522.4	-18.6	194.0	522.4	-18.6	194.0
22	550.8	-35.8	244.4	541.3	-33.7	203.4	541.3	-33.7	203.4

Reference Data Target locations for Subject 03

	x	y	z
Origin	140.6	-227.9	187.3
Reference	357.7	-226.6	128.8
Manubrium	344.3	17.7	762.1
Xyphoid	234.0	30.0	609.7
C7	497.9	15.4	783.4
T4	500.3	13.8	662.7
S1	349.6	29.2	298.9
Left ASIS	191.6	-78.4	393.0
Left Lateral Femoral Condyle	-211.0	-113.0	426.0
Left Lateral Malleolis	-341.4	-98.3	32.4
Left Lateral Foot	-529.8	-91.9	-35.3

Test data for Subject 03 follows (coordinates in millimeters);

Subject	Test Condition	Target Locations for Subject 03: Origin x	y	z	ref 2 x	y	z
03	1	91.5	-318.5	-24.8	442.5	-311.5	-25.2
	2	91.6	-318.5	-24.7	442.5	-311.5	-25.3
Probe Length	3	X	X	X	X	X	X
376	4	91.5	-318.5	-24.8	442.4	-311.6	-25.3
	5	91.5	-318.5	-24.8	442.5	-311.5	-25.3
InterASIS Dist.	6	91.5	-318.5	-24.9	442.5	-311.5	-25.3
190	7	91.6	-318.5	-24.7	442.5	-311.5	-25.3
	8	91.5	-318.5	-24.7	442.5	-311.5	-25.4
InterPSIS width	9	91.5	-318.5	-24.8	442.5	-311.6	-25.4
120	10	91.5	-318.5	-24.8	442.6	-311.4	-25.4
	11	91.5	-318.5	-24.7	442.5	-311.5	-25.3
Heel to foot	12	91.5	-318.5	-24.8	442.5	-311.5	-25.4
target dist.	13	91.5	-318.5	-24.7	442.5	-311.5	-25.3
263	14	91.5	-318.5	-24.9	442.5	-311.5	-25.3
	15	91.5	-318.5	-24.8	442.5	-311.5	-25.4
	16	91.5	-318.5	-24.9	442.4	-311.4	-25.4
	17	91.5	-318.4	-24.8	442.4	-311.4	-25.4
	18	91.5	-318.5	-24.9	442.4	-311.5	-25.4
	19	91.5	-318.4	-24.8	442.4	-311.5	-25.4
	20	91.4	-318.3	-24.8	442.4	-311.5	-25.5
	21	91.4	-318.4	-24.8	442.4	-311.6	-25.3
	22	91.5	-318.4	-24.8	442.5	-311.5	-25.4

Test Condition	Target Locations for Subject 03: Elbow x	y	z	Wrist x	y	z
1	492.8	-265.8	405.1	260.1	-216.2	530.2
2	500.0	-259.1	407.6	266.1	-207.1	527.4
3	X	X	X	X	X	X
4	481.4	-283.5	397.1	258.2	-215.9	528.7
5	483.6	-276.0	396.9	256.7	-222.0	533.5
6	491.4	-258.6	411.9	256.2	-206.3	536.0
7	484.5	-268.1	402.4	258.0	-206.8	528.7
8	498.8	-261.9	405.4	267.4	-200.6	523.6
9	495.2	-266.9	404.0	263.8	-211.9	528.0
10	493.8	-275.9	401.0	267.0	-217.5	530.9
11	510.3	-262.2	418.6	271.7	-203.3	525.9
12	490.3	-268.3	399.7	260.1	-217.3	528.0
13	488.1	-262.5	392.1	261.1	-216.2	527.7
14	487.4	-264.9	393.2	259.9	-217.5	527.6
15	501.9	-263.6	407.6	268.9	-210.8	527.3
16	486.0	-270.6	386.1	262.6	-228.0	530.3
17	487.5	-261.4	388.9	264.5	-200.5	522.1
18	500.8	-258.2	403.8	266.4	-210.5	525.6
19	495.4	-248.9	388.4	267.9	-211.9	524.5
20	484.5	-264.2	377.4	266.5	-204.4	518.9
21	490.7	-276.7	393.1	268.0	-209.1	525.0
22	490.4	-251.3	391.4	259.7	-212.9	525.8

Test Condition — **Target Locations for Subject 03:**

	Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	494.1	-22.9	751.7	396.9	-19.2	597.2	358.7	-140.4	393.4
2	499.4	-9.0	756.5	397.7	-4.9	604.2	341.5	-134.9	400.3
3	X	X	X	X	X	X	X	X	X
4	497.4	-33.5	747.4	395.8	-23.5	600.0	323.3	-154.4	407.9
5	491.9	-23.7	748.8	390.2	-15.7	602.6	322.2	-146.4	409.3
6	502.6	9.0	753.4	392.3	8.6	609.8	321.2	-119.3	409.5
7	489.1	-19.1	754.0	392.7	-10.0	602.4	341.5	-140.0	401.9
8	501.0	-13.9	757.7	396.0	-6.5	608.3	348.7	-131.9	397.6
9	499.5	-17.9	755.2	396.1	-13.2	604.1	351.0	-139.9	398.8
10	495.9	-22.1	753.2	396.0	-19.1	601.5	342.1	-147.7	405.6
11	490.3	-13.8	749.4	399.5	-14.6	590.0	364.7	-135.9	394.5
12	485.3	-19.4	748.0	397.1	-13.8	591.2	356.3	-138.8	397.0
13	481.9	-32.7	747.6	394.5	-22.1	588.0	365.8	-140.8	392.6
14	490.9	-25.2	748.7	394.0	-15.9	592.9	368.9	-139.8	392.4
15	479.9	-19.5	742.0	396.5	-18.8	581.4	364.4	-143.0	393.2
16	468.1	-27.0	733.2	395.3	-18.4	567.3	367.0	-143.1	393.1
17	489.0	-26.1	744.7	397.9	-15.7	584.8	366.0	-133.6	393.3
18	482.9	-8.4	743.4	398.4	-7.8	583.2	354.6	-129.8	395.5
19	474.3	-14.5	739.7	397.9	-4.6	576.4	356.6	-129.8	395.3
20	467.9	-29.2	734.6	392.8	-14.1	572.4	365.9	-136.0	394.0
21	482.2	-35.1	749.5	393.2	-26.0	595.4	338.3	-147.8	399.0
22	485.6	-15.5	748.2	395.5	-5.9	591.1	356.5	-124.5	393.8

Test Condition — **Target Locations for Subject 03:**

	Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-73.0	-172.0	342.6	-373.4	-157.4	12.1	-504.9	-165.4	151.3
2	-69.9	-189.2	354.5	-359.1	-194.7	15.7	-506.0	-198.9	140.8
3	X	X	X	X	X	X	X	X	X
4	-90.1	-207.3	373.3	-350.4	-184.6	14.4	-504.6	-192.3	129.9
5	-93.7	-195.2	364.1	-365.5	-157.1	15.3	-508.8	-158.1	141.4
6	-93.9	-179.2	366.1	-369.2	-180.1	16.3	-507.4	-177.1	150.1
7	-75.3	-173.6	363.5	-350.1	-167.0	17.1	-505.0	-178.3	130.4
8	-73.0	-173.5	352.3	-363.3	-169.3	11.4	-507.4	-183.2	139.7
9	-69.8	-187.5	350.2	-363.9	-186.4	14.4	-508.8	-182.7	144.2
10	-79.1	-185.5	362.4	-358.5	-179.1	14.7	-507.3	-171.2	140.1
11	-68.6	-170.8	347.6	-365.3	-172.6	12.3	-508.1	-177.3	143.3
12	-76.5	-159.3	339.1	-380.0	-147.8	9.3	-507.2	-148.4	157.3
13	-65.6	-182.3	349.0	-360.8	-181.5	13.6	-507.6	-183.7	141.0
14	-69.7	-182.1	344.6	-367.1	-178.7	12.8	-506.9	-184.0	148.1
15	-69.1	-179.0	347.2	-364.4	-174.0	11.7	-508.1	-187.1	142.8
16	-71.4	-176.0	351.2	-362.4	-153.6	14.5	-507.9	-157.1	139.1
17	-66.3	-181.6	348.5	-364.4	-184.5	14.4	-509.1	-179.2	143.1
18	-71.6	-173.9	353.7	-361.8	-183.1	14.0	-507.4	-189.1	141.5
19	-66.3	-192.3	343.5	-365.8	-203.1	11.1	-504.6	-220.1	146.4
20	-72.9	-166.3	343.3	-373.7	-174.9	13.5	-507.1	-170.2	153.3
21	-70.9	-200.5	365.8	-345.1	-192.0	15.8	-504.6	-191.4	124.2
22	-68.1	-183.6	349.3	-363.5	-193.0	16.0	-508.3	-187.4	145.7

Test Condition	Target Locations for Subject 03: Probe1 Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	744.2	-416.7	969.9	917.9	-81.2	344.9	917.9	-81.2	344.9
2	739.5	-457.0	920.7	921.1	-39.4	343.3	921.1	-39.4	343.3
3	X	X	X	X	X	X	X	X	X
4	683.9	-505.3	925.0	922.5	-63.3	347.8	922.5	-63.3	347.8
5	713.2	-468.0	919.6	927.7	-18.8	363.0	927.7	-18.8	363.0
6	718.2	-418.6	967.4	918.8	4.5	346.9	918.8	4.5	346.9
7	728.9	-442.3	940.9	905.1	-31.0	329.4	905.1	-31.0	329.4
8	755.8	-425.3	952.6	905.9	-38.8	334.1	905.9	-38.8	334.1
9	721.5	-452.4	942.2	904.2	-26.8	321.3	904.2	-26.8	321.3
10	716.8	-464.8	935.6	914.7	-32.8	333.3	914.7	-32.8	333.3
11	699.6	-438.9	984.5	905.6	-22.1	310.4	905.6	-22.1	310.4
12	702.0	-437.9	968.8	890.1	-54.3	307.2	890.1	-54.3	307.2
13	734.3	-467.3	919.7	922.3	-27.3	347.1	922.3	-27.3	347.1
14	715.7	-466.1	922.6	911.4	-0.6	331.8	911.4	-0.6	331.8
15	730.3	-385.6	1009.8	920.9	-54.1	332.1	920.9	-54.1	332.1
16	621.5	-434.0	1000.6	944.1	-43.3	354.0	944.1	-43.3	354.0
17	713.9	-448.7	952.3	941.4	-18.6	353.4	941.4	-18.6	353.4
18	731.3	-443.0	935.8	933.7	-26.6	339.2	933.7	-26.6	339.2
19	690.2	-467.3	924.3	929.0	-17.5	339.8	929.0	-17.5	339.8
20	729.2	-440.6	920.8	928.3	-24.8	345.5	928.3	-24.8	345.5
21	657.0	-481.1	953.2	919.5	-12.9	340.1	919.5	-12.9	340.1
22	636.2	-478.4	930.1	921.1	23.9	346.4	921.1	23.9	346.4
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	650.8	-308.0	868.9	770.8	-57.3	436.1	770.8	-57.3	436.1
2	651.5	-327.8	841.4	773.3	-29.3	434.1	773.3	-29.3	434.1
3	X	X	X	X	X	X	X	X	X
4	618.6	-368.0	836.2	770.6	-49.3	432.8	770.6	-49.3	432.8
5	633.2	-337.8	832.5	773.3	-20.3	444.2	773.3	-20.3	444.2
6	644.5	-296.9	862.6	770.0	-1.1	435.5	770.0	-1.1	435.5
7	644.0	-318.7	848.5	761.0	-25.1	426.5	761.0	-25.1	426.5
8	662.8	-311.6	855.8	763.4	-24.5	433.9	763.4	-24.5	433.9
9	644.9	-326.1	848.4	762.3	-19.5	423.3	762.3	-19.5	423.3
10	637.1	-337.5	845.2	769.7	-26.0	429.5	769.7	-26.0	429.5
11	634.0	-314.7	879.1	768.9	-20.8	419.0	768.9	-20.8	419.0
12	625.6	-320.5	865.6	758.0	-39.0	420.5	758.0	-39.0	420.5
13	644.1	-343.6	835.1	776.5	-25.6	442.6	776.5	-25.6	442.6
14	634.9	-337.1	835.3	770.0	-10.6	434.3	770.0	-10.6	434.3
15	641.6	-291.2	892.1	778.3	-41.0	431.8	778.3	-41.0	431.8
16	578.9	-320.6	873.5	794.0	-34.1	440.4	794.0	-34.1	440.4
17	635.2	-331.4	849.0	790.0	-19.0	440.6	790.0	-19.0	440.6
18	642.3	-320.0	847.7	787.2	-22.9	434.5	787.2	-22.9	434.5
19	614.9	-334.8	837.0	783.4	-15.5	435.3	783.4	-15.5	435.3
20	636.2	-324.8	828.3	782.6	-24.8	441.3	782.6	-24.8	441.3
21	598.2	-350.3	851.8	773.4	-24.8	434.6	773.4	-24.8	434.6
22	589.1	-335.5	838.9	775.9	5.5	440.0	775.9	5.5	440.0

Test Condition	Target Locations for Subject 03: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	844.0	-23.9	226.6	844.0	-23.9	226.6	796.4	-28.2	124.8
2	811.9	-16.7	198.8	811.9	-16.7	198.8	894.6	1.3	326.1
3	X	X	X	X	X	X	X	X	X
4	832.5	-17.0	214.4	832.5	-17.0	214.4	778.8	-13.1	143.9
5	852.6	-35.3	249.0	852.6	-35.3	249.0	871.6	37.9	304.0
6	811.5	14.3	209.2	811.5	14.3	209.2	871.6	37.9	304.0
7	950.9	-69.4	456.8	814.3	-75.6	213.1	889.6	20.0	313.8
8	941.8	-93.2	447.6	823.3	-14.0	219.0	909.5	-34.4	386.3
9	934.4	-128.3	437.8	857.0	3.6	239.7	907.6	25.2	352.6
10	808.7	29.8	203.9	808.7	29.8	203.9	896.6	12.6	328.0
11	956.4	-115.3	471.0	849.8	-36.5	215.7	849.6	-22.0	167.4
12	947.1	-113.6	459.9	811.1	-26.4	197.0	913.1	3.5	349.4
13	950.8	-12.9	404.1	869.4	-19.1	249.1	796.9	-41.7	117.2
14	949.8	-43.9	405.6	848.5	-13.1	225.5	856.0	26.1	181.9
15	963.1	-100.5	456.7	885.4	-8.5	242.8	876.1	-33.1	198.6
16	875.5	-69.8	232.1	875.5	-69.8	232.1	874.9	-8.2	184.3
17	861.3	-44.8	224.2	861.3	-44.8	224.2	877.3	-22.7	202.5
18	825.2	-11.2	190.9	825.2	-11.2	190.9	849.9	30.7	175.5
19	965.2	-98.6	495.2	874.1	-52.8	235.2	841.4	31.0	163.3
20	958.7	-105.2	455.5	875.6	-55.4	237.4	847.5	-11.8	154.5
21	956.3	-81.9	459.1	840.6	11.6	222.7	897.2	33.5	334.5
22	947.0	-78.0	417.2	847.2	-46.0	230.2	916.8	18.0	365.5

Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	721.8	-28.2	352.6	721.8	-28.2	352.6	672.8	-26.1	247.3
2	703.8	-18.6	337.5	703.8	-18.6	337.5	726.2	-8.4	375.1
3	X	X	X	X	X	X	X	X	X
4	704.2	-22.8	338.9	704.2	-22.8	338.9	652.9	-22.3	263.8
5	721.3	-30.6	364.4	721.3	-30.6	364.4	710.7	12.4	364.9
6	698.2	3.3	343.8	698.2	3.3	343.8	710.7	12.4	364.9
7	782.5	-47.2	488.8	703.7	-50.1	347.0	726.6	-1.3	366.8
8	777.7	-54.6	482.6	707.6	-10.8	348.1	736.5	-26.1	400.9
9	774.9	-73.6	476.1	734.3	-8.8	358.2	735.7	3.9	383.0
10	702.3	5.5	340.5	702.3	5.5	340.5	728.1	-6.6	374.8
11	790.2	-69.9	490.8	731.2	-33.2	344.8	711.0	-23.4	273.0
12	781.7	-68.3	486.7	706.2	-26.2	338.4	741.8	-12.5	381.1
13	799.7	-26.7	463.6	737.1	-24.6	366.7	678.1	-30.7	244.5
14	785.4	-32.0	460.5	726.4	-17.9	351.4	711.6	4.6	282.3
15	795.7	-62.9	483.1	749.7	-17.2	351.8	723.0	-29.7	282.4
16	749.8	-49.0	351.0	749.8	-49.0	351.0	724.5	-16.3	277.6
17	738.9	-33.3	348.9	738.9	-33.3	348.9	722.9	-19.3	286.2
18	720.5	-15.6	331.8	720.5	-15.6	331.8	709.5	5.5	274.1
19	795.7	-54.0	501.2	743.1	-33.1	348.5	707.7	7.6	271.7
20	793.0	-61.0	482.8	744.0	-38.3	351.2	717.8	-21.7	265.2
21	786.2	-58.3	486.7	716.2	-10.4	345.1	727.8	3.5	377.8
22	784.2	-47.8	467.4	723.3	-28.4	352.0	743.8	4.9	389.2

Test Condition	Target Locations for Subject 03: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	796.4	-28.2	124.8	818.5	-5.6	111.8	818.5	-5.6	111.8
2	781.2	-11.7	130.5	853.9	13.2	244.3	768.0	-8.2	77.3
3	X	X	X	X	X	X	X		
4	778.8	-13.1	143.9	827.1	22.7	242.4	760.5	-14.1	100.9
5	776.7	1.8	152.8	824.3	11.1	230.0	764.2	-32.6	106.7
6	776.7	1.8	152.8	824.3	11.1	230.0	769.3	13.8	115.4
7	780.5	-16.3	130.7	843.4	11.2	220.9	787.8	-2.9	105.1
8	836.2	5.9	179.5	875.3	17.3	308.4	829.4	-2.2	148.4
9	835.1	-15.0	176.5	873.7	27.3	284.1	803.4	9.2	109.1
10	801.7	-6.3	148.3	850.9	6.8	242.0	784.4	-10.9	99.5
11	849.6	-22.0	167.4	844.5	-23.7	147.1	844.5	-23.7	147.1
12	826.9	-24.5	155.5	827.8	-26.9	128.1	827.8	-26.9	128.1
13	796.9	-41.7	117.2	824.0	-7.7	109.6	824.0	-7.7	109.6
14	856.0	26.1	181.9	829.8	-18.5	113.7	829.8	-18.5	113.7
15	876.1	-33.1	198.6	844.5	-42.7	141.6	844.5	-42.7	141.6
16	874.9	-8.2	184.3	818.3	-19.8	93.3	818.3	-19.8	93.3
17	877.3	-22.7	202.5	838.6	42.7	140.4	838.6	42.7	140.4
18	849.9	30.7	175.5	821.4	-8.2	113.5	821.4	-8.2	113.5
19	841.4	31.0	163.3	825.4	7.2	122.4	825.4	7.2	122.4
20	847.5	-11.8	154.5	847.3	-33.2	144.7	847.3	-33.2	144.7
21	812.5	-19.0	165.0	849.1	10.3	236.4	784.4	6.0	100.2
22	830.1	7.1	160.0	819.4	-22.1	110.2	819.4	-22.1	110.2
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	672.8	-26.1	247.3	668.3	-17.3	201.4	668.3	-17.3	201.4
2	657.1	-14.5	253.7	688.6	-6.9	299.2	638.9	-21.4	196.0
3	X	X	X	X	X	X			
4	652.9	-22.3	263.8	662.6	-5.4	299.0	623.1	-24.2	212.1
5	645.5	-0.8	270.5	657.3	0.3	291.5	626.2	-26.5	213.9
6	645.5	-0.8	270.5	657.3	0.3	291.5	627.6	4.1	218.7
7	657.4	-17.6	253.7	682.8	-6.8	285.8	646.7	-15.8	208.8
8	694.9	-8.3	277.6	700.7	-0.9	329.2	669.5	-9.8	218.6
9	696.0	-20.4	276.3	700.6	3.2	313.5	660.0	-8.3	209.2
10	670.5	-14.9	264.0	686.3	-12.2	298.4	645.2	-23.1	206.2
11	711.0	-23.4	273.0	684.2	-23.6	218.5	684.2	-23.6	218.5
12	704.3	-31.6	272.0	676.4	-32.0	215.6	676.4	-32.0	215.6
13	678.1	-30.7	244.5	673.8	-16.2	199.8	673.8	-16.2	199.8
14	711.6	4.6	282.3	676.3	-22.8	197.9	676.3	-22.8	197.9
15	723.0	-29.7	282.4	685.4	-38.6	212.7	685.4	-38.6	212.7
16	724.5	-16.3	277.6	671.1	-25.1	190.3	671.1	-25.1	190.3
17	722.9	-19.3	286.2	682.3	11.6	213.8	682.3	11.6	213.8
18	709.5	5.5	274.1	669.7	-15.5	200.5	669.7	-15.5	200.5
19	707.7	7.6	271.7	674.1	-7.1	209.0	674.1	-7.1	209.0
20	717.8	-21.7	265.2	686.3	-30.0	214.5	686.3	-30.0	214.5
21	674.9	-27.2	272.4	685.0	-8.2	293.9	645.5	-11.1	206.5
22	703.4	-9.2	273.2	670.9	-21.2	203.1	670.9	-21.2	203.1

Reference Data Target locations for Subject 04

	x	y	z
Origin	31.9	-297.4	187.6
Reference	249.3	-306.4	130.4
Manubrium	201.5	-25.9	727.1
Xyphoid	141.4	-40.1	580.5
C7	335.7	-44.8	813.0
T4	370.8	-43.4	678.3
S1	225.3	-42.4	258.3
Left ASIS	82.3	-149.9	394.0
Left Lateral Femoral Condyle	-324.3	-196.6	414.1
Left Lateral Malleolis	-403.3	-175.4	19.6
Left Lateral Foot	-575.2	-186.1	-30.4

Test data for Subject 04 follows (coordinates in millimeters):

Subject	Test Condition	Target Locations for Subject 04: Origin x	y	z	ref 2 x	y	z
04	1	31.1	-381.7	-26.3	382.6	-384.5	-25.4
	2	31.3	-381.5	-26.3	382.5	-384.6	-25.4
Probe Length	3	31.4	-381.5	-26.4	382.6	-384.5	-25.4
376	4	31.1	-381.5	-26.6	382.5	-384.6	-25.4
	5	31.1	-381.5	-26.6	382.5	-384.6	-25.5
InterASIS Dist.	6	31.3	-381.5	-26.3	382.6	-384.5	-25.5
245	7	31.3	-381.8	-26.3	382.5	-384.6	-25.5
	8	31.1	-381.5	-26.5	382.5	-384.7	-25.5
InterPSIS width	9	31.1	-381.5	-26.6	382.5	-384.6	-25.4
105	10	31.2	-381.5	-26.4	382.5	-384.6	-25.4
	11	31.1	-381.5	-26.5	382.2	-384.5	-25.5
Heel to foot	12	31.3	-381.8	-26.4	382.5	-384.6	-25.4
target dist.	13	31.1	-381.4	-26.5	382.5	-384.6	-25.5
225	14	31.0	-381.7	-26.5	382.5	-384.6	-25.5
	15	31.2	-381.5	-26.6	382.5	-384.5	-25.5
	16	31.2	-381.5	-26.4	382.5	-384.6	-25.5
	17	31.1	-381.5	-26.5	382.3	-384.6	-25.5
	18	31.2	-381.5	-26.7	382.5	-384.6	-25.4
	19	31.2	-381.5	-26.4	382.5	-384.6	-25.5
	20	31.0	-381.4	-26.5	382.5	-384.6	-25.4
	21	31.1	-381.5	-26.6	382.5	-384.7	-25.5
	22	31.1	-381.4	-26.5	382.5	-384.6	-25.4

Test Condition	Target Locations for Subject 04: Elbow x	y	z	Wrist x	y	z
1	432.6	-356.8	418.0	209.9	-273.6	523.3
2	0.0	0.0	0.0	206.5	-278.1	521.7
3	431.3	-336.8	417.5	205.1	-268.6	526.3
4	431.6	-346.5	419.8	208.0	-264.8	525.8
5	435.2	-344.0	425.0	207.6	-270.1	527.9
6	432.5	-354.1	425.7	207.3	-273.1	526.6
7	434.5	-350.0	424.4	206.4	-273.6	526.7
8	432.3	-347.0	427.3	206.5	-268.8	526.0
9	442.5	-350.6	424.3	213.7	-274.4	522.6
10	0.0	0.0	0.0	212.1	-279.3	529.2
11	432.8	-343.7	412.9	210.3	-276.6	530.3
12	427.6	-340.7	411.5	203.5	-271.5	525.4
13	428.6	-348.1	416.7	202.6	-278.3	527.1
14	429.4	-345.6	414.1	207.2	-273.2	526.8
15	429.2	-352.3	414.0	207.1	-278.3	527.6
16	427.4	-352.6	408.2	205.8	-276.2	521.8
17	424.0	-341.1	410.2	204.4	-267.9	526.2
18	429.3	-345.1	412.9	207.0	-265.0	519.1
19	429.2	-344.9	410.7	205.1	-276.0	523.4
20	426.5	-353.8	413.3	205.4	-274.2	524.8
21	432.6	-346.8	422.0	206.6	-275.3	528.2
22	426.0	-351.8	415.2	201.3	-278.7	525.0

Test Condition	Target Locations for Subject 04: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	426.7	-78.5	739.8	360.7	-90.1	596.7	294.6	-208.1	393.6
2	434.8	-77.5	740.5	359.1	-92.5	601.3	285.0	-204.7	398.4
3	437.2	-76.1	745.7	357.5	-90.7	609.4	266.8	-209.1	401.6
4	443.1	-82.9	747.3	359.9	-95.1	610.8	266.9	-208.1	401.6
5	425.5	-70.3	747.7	350.5	-84.7	607.7	268.1	-203.4	401.9
6	453.4	-73.3	747.3	361.8	-86.8	616.5	268.7	-203.4	405.2
7	449.5	-74.3	749.5	358.4	-88.2	616.1	282.2	-210.0	401.6
8	465.0	-82.1	756.1	364.7	-95.2	625.7	285.5	-214.1	393.9
9	451.8	-71.3	753.6	363.0	-85.5	616.5	293.6	-204.2	392.6
10	446.0	-68.9	752.8	361.2	-80.4	615.9	279.8	-203.7	398.2
11	424.5	-72.0	740.1	359.6	-85.0	592.6	290.9	-208.4	395.5
12	432.2	-75.0	739.6	360.9	-86.2	597.6	292.0	-205.4	393.6
13	430.1	-78.4	743.1	358.7	-89.4	600.0	297.4	-204.8	391.6
14	435.1	-78.4	746.7	359.0	-88.4	602.3	298.5	-203.5	391.2
15	430.1	-71.2	736.1	362.1	-84.1	589.8	299.6	-202.3	391.6
16	414.4	-74.8	732.3	359.2	-85.5	582.5	299.3	-204.0	391.6
17	421.7	-71.6	736.5	357.9	-84.6	589.3	299.7	-203.3	394.7
18	426.6	-77.5	739.7	358.0	-90.5	596.1	293.9	-207.2	392.5
19	423.8	-74.8	737.1	358.6	-86.3	590.7	294.1	-206.0	393.0
20	422.8	-76.9	740.1	357.2	-88.2	595.1	296.7	-207.3	392.2
21	438.3	-74.0	748.7	362.1	-87.1	610.4	278.1	-211.2	396.1
22	426.5	-76.6	742.1	357.8	-88.4	598.5	290.0	-207.2	393.3

Test Condition	Target Locations for Subject 04: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-119.6	-286.5	328.0	-396.6	-267.6	-2.3	-547.4	-288.2	82.5
2	-130.4	-291.8	331.2	-397.7	-264.7	-2.8	-549.9	-286.5	86.5
3	-133.4	-283.2	343.0	-390.8	-268.2	0.0	-550.3	-278.0	83.6
4	-140.3	-278.8	339.9	-399.2	-251.9	0.3	-550.9	-261.5	87.7
5	-137.3	-281.9	343.7	-388.5	-259.3	-0.1	-545.2	-282.2	77.4
6	-140.0	-290.1	345.2	-398.2	-271.3	-0.7	-551.4	-276.4	85.6
7	-137.5	-294.1	333.8	-401.7	-266.9	-3.1	-550.4	-283.6	85.7
8	-122.2	-294.5	326.4	-398.1	-270.4	-4.8	-551.9	-287.9	85.9
9	-118.6	-281.2	327.7	-396.8	-268.8	-1.6	-550.0	-284.6	85.0
10	-125.8	-283.1	331.0	-397.1	-253.8	-0.9	-550.5	-267.0	86.9
11	-121.8	-283.1	327.8	-396.8	-260.8	-2.2	-547.9	-278.9	81.2
12	-123.4	-283.1	326.1	-397.9	-256.8	-2.1	-550.7	-272.2	88.3
13	-115.7	-285.7	322.5	-398.8	-276.2	-3.8	-552.9	-293.0	87.3
14	-117.7	-283.1	326.2	-398.6	-278.5	-2.7	-552.2	-296.1	86.9
15	-120.7	-275.5	326.7	-397.7	-257.7	-0.5	-550.8	-272.3	89.1
16	-121.7	-274.6	327.7	-398.3	-259.3	1.5	-551.1	-266.0	88.5
17	-117.1	-281.2	328.5	-396.0	-262.4	-4.8	-549.6	-278.5	79.5
18	-121.6	-281.4	327.9	-396.5	-264.8	-3.8	-549.7	-284.5	83.1
19	-121.6	-282.8	325.3	-399.3	-259.9	-1.8	-551.3	-273.5	88.8
20	-120.3	-279.7	327.2	-397.4	-266.0	-1.9	-550.3	-283.6	86.0
21	-119.8	-285.7	329.8	-397.0	-269.5	-1.7	-551.1	-281.5	83.3
22	-120.5	-281.0	328.9	-396.5	-263.9	-1.0	-548.4	-286.5	83.4

Test Condition	Target Locations for Subject 04:								
	Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	604.6	-546.6	955.5	864.4	-104.6	346.2	864.4	-104.6	346.2
2	737.6	-513.8	881.6	832.8	-105.2	300.8	832.8	-105.2	300.8
3	655.8	-492.3	997.3	842.8	-51.8	318.4	842.8	-51.8	318.4
4	639.3	-503.6	1004.5	833.9	-127.3	308.5	833.9	-127.3	308.5
5	595.0	-490.6	1020.8	824.4	-78.9	307.9	824.4	-78.9	307.9
6	680.2	-487.5	991.6	835.7	-103.4	313.7	835.7	-103.4	313.7
7	659.9	-535.5	948.3	837.0	-73.8	319.4	837.0	-73.8	319.4
8	657.0	-542.0	968.2	837.5	-95.5	317.1	837.5	-95.5	317.1
9	633.1	-542.0	957.0	823.9	-72.4	300.4	823.9	-72.4	300.4
10	669.3	-497.9	981.6	839.4	-63.4	316.1	839.4	-63.4	316.1
11	569.2	-486.2	1028.8	850.6	-70.4	316.7	850.6	-70.4	316.7
12	593.5	-511.8	994.4	848.0	-99.2	322.0	848.0	-99.2	322.0
13	645.7	-523.0	961.9	826.9	-70.4	296.4	826.9	-70.4	296.4
14	631.4	-525.9	969.2	839.3	-79.1	312.9	839.3	-79.1	312.9
15	660.9	-439.3	1018.9	831.5	-55.1	296.0	831.5	-55.1	296.0
16	541.0	-551.4	957.0	853.5	-101.6	325.2	853.5	-101.6	325.2
17	609.3	-508.1	982.7	856.0	-34.4	326.5	856.0	-34.4	326.5
18	663.6	-500.3	967.0	870.7	-89.8	347.5	870.7	-89.8	347.5
19	608.0	-497.9	1002.4	851.0	-65.3	319.5	851.0	-65.3	319.5
20	571.2	-488.6	1025.9	829.0	-65.3	296.1	829.0	-65.3	296.1
21	604.5	-477.9	1039.2	820.2	-87.9	294.3	820.2	-87.9	294.3
22	676.6	-522.1	932.3	852.6	-80.1	327.4	852.6	-80.1	327.4
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	550.7	-408.7	863.0	717.7	-96.5	441.1	717.7	-96.5	441.1
2	625.9	-390.1	821.5	697.3	-95.2	412.3	697.3	-95.2	412.3
3	580.2	-378.4	883.9	702.6	-71.8	421.6	702.6	-71.8	421.6
4	575.7	-386.5	887.3	696.0	-110.9	413.0	696.0	-110.9	413.0
5	546.5	-374.0	900.8	686.7	-82.1	416.9	686.7	-82.1	416.9
6	603.5	-373.9	882.0	692.2	-94.2	414.8	692.2	-94.2	414.8
7	592.8	-401.4	860.1	695.7	-81.6	422.5	695.7	-81.6	422.5
8	595.8	-408.7	872.3	690.2	-92.0	416.4	690.2	-92.0	416.4
9	576.3	-403.7	865.1	693.8	-82.6	415.3	693.8	-82.6	415.3
10	593.1	-377.8	875.7	701.3	-73.5	423.2	701.3	-73.5	423.2
11	528.1	-371.6	899.0	714.0	-76.9	425.5	714.0	-76.9	425.5
12	542.8	-387.4	878.8	710.5	-93.1	429.3	710.5	-93.1	429.3
13	572.8	-395.0	863.7	696.5	-78.3	413.7	696.5	-78.3	413.7
14	565.9	-397.6	867.0	704.0	-85.3	422.2	704.0	-85.3	422.2
15	577.4	-345.9	892.4	702.0	-68.6	413.3	702.0	-68.6	413.3
16	507.6	-408.9	857.8	715.9	-96.8	432.7	715.9	-96.8	432.7
17	547.8	-384.3	872.1	715.7	-58.0	430.4	715.7	-58.0	430.4
18	579.3	-383.4	868.0	723.0	-91.7	440.4	723.0	-91.7	440.4
19	546.6	-381.5	885.8	713.4	-74.4	427.4	713.4	-74.4	427.4
20	528.9	-375.9	898.9	698.1	-75.7	413.2	698.1	-75.7	413.2
21	553.1	-370.3	907.5	691.6	-90.4	413.6	691.6	-90.4	413.6
22	587.1	-396.7	851.0	711.9	-84.8	431.4	711.9	-84.8	431.4

Test Condition	Target Locations for Subject 04: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	886.2	-83.2	379.8	787.0	-124.0	217.6	766.3	-122.7	156.8
2	886.7	-86.8	400.3	767.2	-123.0	204.5	748.8	-126.6	152.8
3	891.6	-73.3	430.4	810.5	-86.8	253.5	748.5	-74.0	165.9
4	889.1	-77.0	425.9	776.7	-106.4	221.1	758.3	-108.3	183.0
5	881.4	-108.8	424.8	776.1	-74.8	227.5	741.2	-82.6	166.0
6	878.6	-80.6	404.2	774.3	-90.1	227.7	759.8	-95.8	190.5
7	875.6	-70.8	392.8	776.2	-94.5	224.0	770.8	-90.4	184.4
8	874.5	-85.4	395.7	779.0	-58.3	232.8	766.8	-57.8	174.4
9	868.4	-97.6	360.2	779.5	-89.6	220.8	733.2	-91.9	137.7
10	882.6	-92.8	399.7	780.6	-97.0	225.5	774.1	-85.9	195.0
11	894.3	-79.8	387.0	798.0	-100.7	217.0	783.2	-91.1	167.9
12	875.5	-65.2	358.9	790.3	-99.8	216.5	777.8	-106.1	164.0
13	889.9	-92.8	403.9	889.9	-92.8	403.9	769.2	-69.2	155.6
14	894.6	-53.6	432.4	894.6	-53.6	432.4	796.7	-102.1	183.9
15	898.8	-28.6	412.7	898.8	-28.6	412.7	825.1	-86.7	218.7
16	910.5	-57.1	461.9	910.5	-57.1	461.9	818.1	-136.2	204.4
17	898.9	-91.5	393.2	827.2	-89.0	240.5	814.3	-141.4	196.6
18	897.3	-106.2	409.1	812.5	-82.8	232.2	808.9	-115.5	197.1
19	891.1	-42.5	377.9	777.9	-98.9	195.3	783.0	-119.0	161.4
20	898.3	-7.6	460.4	898.3	-7.6	460.4	792.1	-104.5	189.9
21	875.5	-27.2	395.1	875.5	-27.2	395.1	743.1	-103.3	160.7
22	878.0	-43.0	376.0	792.8	-120.0	224.0	776.8	-93.9	170.8
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	721.6	-84.9	442.3	662.0	-106.5	338.1	635.6	-108.2	272.4
2	720.6	-86.7	452.6	652.1	-105.0	337.0	621.2	-109.1	271.2
3	721.4	-81.0	466.8	668.5	-88.8	356.1	612.4	-83.1	280.7
4	719.6	-80.3	466.2	650.5	-96.9	340.9	623.4	-104.5	292.0
5	713.4	-97.3	467.0	645.4	-79.4	346.7	607.7	-85.4	282.6
6	711.7	-81.5	455.2	645.9	-84.3	346.3	622.3	-96.1	296.9
7	709.3	-80.7	449.3	648.6	-88.5	343.9	633.3	-95.8	291.5
8	707.8	-89.0	450.5	648.1	-75.4	347.7	626.7	-77.6	280.4
9	710.7	-92.6	436.1	653.0	-87.0	340.8	616.6	-89.5	268.5
10	716.7	-89.0	453.7	652.6	-91.1	343.7	633.4	-88.3	301.1
11	728.4	-85.3	441.7	670.8	-95.7	337.1	652.4	-98.9	279.1
12	718.4	-75.5	433.6	664.5	-90.1	337.4	649.3	-105.0	279.3
13	722.7	-91.9	452.5	722.7	-91.9	452.5	650.2	-88.0	276.9
14	725.2	-73.9	467.6	725.2	-73.9	467.6	653.8	-97.2	287.0
15	732.2	-56.8	457.3	732.2	-56.8	457.3	669.9	-85.6	300.0
16	736.0	-72.8	478.1	736.0	-72.8	478.1	666.9	-115.0	290.8
17	733.3	-91.1	444.6	691.3	-90.0	350.3	664.5	-116.1	287.0
18	729.0	-98.4	452.6	680.4	-89.5	346.1	660.6	-105.4	291.2
19	727.8	-63.8	440.1	662.5	-92.8	328.2	647.4	-107.4	271.2
20	726.5	-45.8	477.6	726.5	-45.8	477.6	660.5	-90.0	290.3
21	710.9	-58.6	448.4	710.9	-58.6	448.4	615.9	-99.9	281.2
22	720.2	-65.4	442.1	664.1	-101.4	341.0	644.2	-96.7	282.7

Test Condition	Target Locations for Subject 04: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	766.3	-122.7	156.8	764.6	-111.4	107.8	764.6	-111.4	107.8
2	748.8	-126.6	152.8	753.7	-99.3	115.7	753.7	-99.3	115.7
3	748.5	-74.0	165.9	736.8	-98.6	110.1	736.8	-98.6	110.1
4	758.3	-108.3	183.0	733.9	-103.8	108.8	733.9	-103.8	108.8
5	741.2	-82.6	166.0	738.2	-79.0	115.6	738.2	-79.0	115.6
6	759.8	-95.8	190.5	755.5	-122.7	158.8	755.5	-122.7	158.8
7	770.8	-90.4	184.4	759.2	-109.4	134.7	759.2	-109.4	134.7
8	766.8	-57.8	174.4	767.7	-142.4	131.5	767.7	-142.4	131.5
9	733.2	-91.9	137.7	775.8	-96.5	133.0	775.8	-96.5	133.0
10	774.1	-85.9	195.0	768.9	-95.5	143.5	768.9	-95.5	143.5
11	783.2	-91.1	167.9	766.7	-96.5	112.2	766.7	-96.5	112.2
12	777.8	-106.1	164.0	779.4	-101.4	139.1	779.4	-101.4	139.1
13	769.2	-69.2	155.6	777.4	-88.4	126.1	777.4	-88.4	126.1
14	796.7	-102.1	183.9	781.9	-76.0	134.8	781.9	-76.0	134.8
15	825.1	-86.7	218.7	794.0	-106.2	166.2	794.0	-106.2	166.2
16	818.1	-136.2	204.4	789.2	-134.3	159.5	789.2	-134.3	159.5
17	814.3	-141.4	196.6	783.8	-118.6	140.3	783.8	-118.6	140.3
18	808.9	-115.5	197.1	761.0	-116.8	97.8	761.0	-116.8	97.8
19	783.0	-119.0	161.4	775.4	-114.9	125.4	775.4	-114.9	125.4
20	792.1	-104.5	189.9	784.9	-102.1	143.1	784.9	-102.1	143.1
21	743.1	-103.3	160.7	755.2	-78.3	113.2	755.2	-78.3	113.2
22	776.8	-93.9	170.8	773.9	-132.9	132.7	773.9	-132.9	132.7
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	635.6	-108.2	272.4	610.4	-104.7	193.7	610.4	-104.7	193.7
2	621.2	-109.1	271.2	596.7	-96.4	195.2	596.7	-96.4	195.2
3	612.4	-83.1	280.7	585.8	-98.3	200.0	585.8	-98.3	200.0
4	623.4	-104.5	292.0	583.6	-99.8	199.8	583.6	-99.8	199.8
5	607.7	-85.4	282.6	585.6	-86.0	201.8	585.6	-86.0	201.8
6	622.3	-96.1	296.9	592.3	-109.5	223.1	592.3	-109.5	223.1
7	633.3	-95.8	291.5	598.1	-107.5	204.7	598.1	-107.5	204.7
8	626.7	-77.6	280.4	607.9	-124.2	201.6	607.9	-124.2	201.6
9	616.6	-89.5	268.5	614.7	-94.6	202.8	614.7	-94.6	202.8
10	633.4	-88.3	301.1	608.4	-95.2	213.3	608.4	-95.2	213.3
11	652.4	-98.9	279.1	611.0	-97.8	195.3	611.0	-97.8	195.3
12	649.3	-105.0	279.3	617.0	-98.8	205.1	617.0	-98.8	205.1
13	650.2	-88.0	276.9	617.8	-90.0	198.9	617.8	-90.0	198.9
14	653.8	-97.2	287.0	619.0	-82.8	200.9	619.0	-82.8	200.9
15	669.9	-85.6	300.0	625.6	-99.2	215.9	625.6	-99.2	215.9
16	666.9	-115.0	290.8	623.1	-115.7	213.5	623.1	-115.7	213.5
17	664.5	-116.1	287.0	620.3	-107.5	202.2	620.3	-107.5	202.2
18	660.6	-105.4	291.2	612.2	-110.0	184.9	612.2	-110.0	184.9
19	647.4	-107.4	271.2	616.0	-105.6	199.2	616.0	-105.6	199.2
20	660.5	-90.0	290.3	621.0	-100.7	205.5	621.0	-100.7	205.5
21	615.9	-99.9	281.2	601.6	-87.5	197.1	601.6	-87.5	197.1
22	644.2	-96.7	282.7	614.5	-115.2	204.2	614.5	-115.2	204.2

Reference Data Target locations for Subject 05

	x	y	z
Origin	-196.5	-222.8	187.9
Reference	22.0	-220.2	130.4
Manubrium	-67.5	43.3	715.0
Xyphoid	-114.1	31.3	576.3
C7	77.8	42.5	801.1
T4	122.5	47.1	691.6
S1	14.9	36.1	308.8
Left ASIS	-163.2	-90.7	398.1
Left Lateral Femoral Condyle	-580.4	-134.9	425.7
Left Lateral Malleolis	-756.7	-115.7	12.4
Left Lateral Foot	-958.1	-109.2	-43.4

Test data for Subject 05 follows (coordinates in millimeters);

Subject	Test Condition	Targe Locations for Subject 05: Origin x	y	z	ref 2 x	y	z
05	1	-161.9	-205.4	-25.8	190.0	-197.7	-24.5
	2	-162.0	-205.6	-25.8	189.9	-197.8	-24.5
Probe Length	3	-161.9	-205.7	-25.8	190.0	-197.8	-24.5
376	4	-161.9	-205.7	-25.7	190.0	-197.7	-24.5
	5	-161.8	-205.5	-25.8	189.9	-197.8	-24.5
InterASIS Dist.	6	-161.8	-205.5	-25.9	189.9	-197.8	-24.5
250	7	-161.8	-205.5	-25.8	189.9	-197.8	-24.6
	8	-161.9	-205.4	-25.9	190.0	-197.7	-24.5
InterPSIS width	9	-161.8	-205.5	-25.9	190.0	-197.8	-24.5
110	10	-161.9	-205.4	-25.8	190.0	-197.7	-24.5
	11	-161.9	-205.4	-26.0	190.0	-197.7	-24.5
Heel to foot	12	-161.9	-205.4	-26.0	190.0	-197.6	-24.5
target dist.	13	-161.9	-205.4	-25.9	189.9	-197.7	-24.5
260	14	-161.9	-205.4	-25.8	190.0	-197.8	-24.5
	15	-161.9	-205.4	-26.0	190.0	-197.8	-24.5
	16	-161.9	-205.4	-25.9	189.9	-197.7	-24.5
	17	-161.9	-205.4	-26.0	189.9	-197.8	-24.4
	18	-161.9	-205.6	-25.9	189.8	-197.8	-24.6
	19	-161.9	-205.4	-26.0	189.9	-197.8	-24.6
	20	-161.9	-205.4	-26.0	190.0	-197.8	-24.5
	21	-161.9	-205.6	-25.9	190.0	-197.8	-24.5
	22	-161.9	-205.4	-26.0	190.0	-197.7	-24.5

Test Condition	Targe Locations for Subject 05: Elbow x	y	z	Wrist x	y	z
1	215.0	-198.3	422.0	-3.2	-121.3	552.9
2	236.1	-167.0	430.2	-8.6	-127.4	534.9
3	247.0	-168.2	427.0	6.1	-119.3	530.1
4	236.6	-165.7	414.4	-4.9	-126.2	527.8
5	223.0	-186.0	430.9	-21.7	-135.8	531.2
6	226.2	-177.3	427.0	-18.1	-133.0	534.4
7	234.9	-163.0	432.4	-13.6	-125.3	530.7
8	238.9	-139.9	434.0	-13.6	-126.6	534.5
9	222.5	-164.6	430.9	-23.6	-124.9	530.7
10	225.2	-182.5	432.6	-16.0	-120.4	531.0
11	226.0	-177.5	430.4	-12.1	-115.4	529.4
12	225.3	-160.3	419.9	-10.1	-99.9	524.9
13	235.2	-143.8	420.8	-10.4	-115.9	524.5
14	220.1	-172.9	428.3	-25.4	-128.3	528.5
15	227.3	-155.9	407.5	-6.5	-105.2	521.9
16	216.8	-183.8	430.6	-24.4	-127.2	529.8
17	216.1	-169.3	418.9	-26.4	-129.5	524.6
18	221.5	-165.0	416.1	-21.4	-133.3	528.2
19	220.5	-167.6	421.6	-19.5	-127.7	533.4
20	215.8	-158.3	421.3	-15.6	-86.3	523.5
21	237.8	-151.8	424.5	-5.4	-113.0	529.7
22	229.0	-147.7	417.2	-15.7	-118.6	526.7

Test Condition	Targe Locations for Subject 05: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	193.5	100.0	728.6	130.6	91.1	589.8	89.8	-45.8	399.6
2	190.8	133.1	731.8	127.7	120.0	590.2	82.8	-11.1	402.3
3	189.9	127.9	732.4	132.4	113.5	590.8	77.2	-14.0	404.2
4	201.4	112.1	740.4	136.1	103.1	600.4	79.9	-20.4	404.3
5	213.9	106.5	749.5	131.6	90.8	614.9	79.1	-31.7	400.6
6	222.6	106.6	746.7	140.9	99.7	614.1	78.2	-25.7	403.9
7	209.5	133.3	748.8	131.6	118.5	613.0	79.1	-12.4	401.6
8	208.4	156.1	748.0	131.4	139.9	611.3	86.2	9.6	399.5
9	208.2	132.1	739.7	134.0	118.0	601.0	88.5	-14.2	401.0
10	208.6	110.2	740.5	136.9	96.3	601.6	88.5	-29.6	399.6
11	175.0	116.4	724.1	125.9	101.9	579.6	94.0	-23.3	397.5
12	191.4	127.7	728.1	137.8	112.6	585.3	89.4	-20.0	400.4
13	190.3	138.5	739.8	132.4	125.1	595.2	93.5	0.5	397.0
14	186.9	120.4	728.2	130.8	104.1	583.7	91.9	-21.7	399.1
15	186.9	128.7	720.1	135.2	111.7	578.3	92.5	-19.3	400.3
16	155.9	118.8	716.0	117.5	103.5	569.7	93.7	-24.1	395.4
17	154.6	117.9	721.1	113.7	106.7	575.1	91.6	-18.7	397.0
18	153.7	121.8	718.3	118.4	108.2	572.2	87.0	-20.3	398.9
19	172.8	123.9	722.8	123.8	110.3	579.8	89.8	-9.6	396.5
20	166.7	135.2	718.4	122.6	118.8	573.2	93.5	-6.3	396.7
21	198.2	130.6	735.7	136.9	117.8	594.8	84.1	-11.2	400.9
22	185.9	135.5	725.5	131.6	118.7	582.5	89.4	-2.1	397.7

Test Condition	Targe Locations for Subject 05: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-345.3	-102.3	341.3	-651.2	-55.2	-8.8	-772.8	-72.6	150.2
2	-344.0	-81.0	334.5	-650.1	-16.2	-14.9	-772.3	-48.8	143.9
3	-344.5	-94.3	340.9	-649.5	-38.0	-9.8	-774.9	-48.9	147.5
4	-339.7	-90.7	339.9	-646.0	-12.1	-5.9	-779.4	13.2	151.1
5	-338.5	-109.2	336.2	-643.8	-44.2	-10.8	-776.4	-68.2	142.8
6	-341.9	-81.1	343.6	0.0	0.0	0.0	-780.8	-23.3	148.2
7	-337.6	-84.1	336.4	-643.6	-17.0	-15.1	-775.4	-51.2	136.3
8	-335.6	-56.6	347.9	-637.2	-1.4	-6.9	-781.7	-13.3	138.1
9	-342.7	-70.5	339.9	-648.2	-6.9	-8.9	-780.8	-14.9	148.4
10	-334.9	-101.9	344.9	-635.1	-36.1	-7.3	-779.8	-55.5	136.9
11	-337.8	-102.9	334.1	-644.2	-23.4	-10.5	-780.3	-37.2	143.0
12	-340.0	-101.1	328.4	-653.5	-30.5	-13.7	-777.8	-41.9	151.1
13	-331.3	-83.1	331.5	-643.4	-30.8	-14.0	-774.5	-71.0	137.2
14	-338.3	-89.6	331.4	-644.6	-12.0	-14.2	-775.9	-45.5	138.4
15	-340.8	-88.3	332.9	-648.6	-13.3	-12.1	-778.5	-28.7	146.7
16	-338.1	-112.6	325.0	-644.9	-19.3	-17.2	-776.3	-54.4	135.4
17	-339.8	-98.1	330.8	-649.1	-24.7	-13.8	-777.4	-48.4	144.1
18	-340.9	-97.8	327.8	-648.9	-13.0	-14.9	-777.7	-36.7	143.6
19	-340.9	-86.6	335.8	-646.4	-16.0	-12.8	-778.9	-38.7	142.9
20	-337.5	-86.9	338.0	-645.8	-32.7	-11.3	-775.7	-59.7	143.5
21	-342.6	-79.5	341.8	-648.6	-25.9	-9.1	-779.0	-38.2	149.0
22	-338.6	-70.4	340.4	-644.7	-18.0	-11.3	-775.7	-44.5	142.3

Test Condition	Targe Locations for Subject 05:								
	Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	485.3	-314.5	949.0	667.9	23.8	355.2	667.9	23.8	355.2
2	476.5	-291.0	956.9	638.0	78.1	295.1	638.0	78.1	295.1
3	504.9	-274.3	960.2	662.1	75.3	335.9	662.1	75.3	335.9
4	471.9	-314.9	953.3	627.3	95.3	287.6	627.3	95.3	287.6
5	494.5	-330.6	945.3	622.4	94.1	294.2	622.4	94.1	294.2
6	511.8	-313.4	962.1	616.8	77.5	289.2	616.8	77.5	289.2
7	429.8	-356.5	934.9	636.3	102.3	320.6	636.3	102.3	320.6
8	510.4	-287.0	928.4	617.2	108.0	299.8	617.2	108.0	299.8
9	457.0	-314.0	963.0	625.7	97.4	290.3	625.7	97.4	290.3
10	489.7	-337.0	936.1	614.2	60.0	276.6	614.2	60.0	276.6
11	419.3	-282.6	1014.2	650.5	104.0	310.3	650.5	104.0	310.3
12	476.9	-309.8	936.1	659.7	105.4	321.0	659.7	105.4	321.0
13	442.1	-304.7	964.9	657.0	88.1	329.0	657.0	88.1	329.0
14	446.8	-296.2	986.2	662.2	84.9	329.1	662.2	84.9	329.1
15	468.5	-316.3	906.0	650.6	104.5	302.9	650.6	104.5	302.9
16	425.7	-340.9	921.9	662.3	118.3	336.6	662.3	118.3	336.6
17	395.3	-302.3	987.4	633.4	87.3	298.8	633.4	87.3	298.8
18	399.8	-341.7	931.3	659.0	95.9	338.6	659.0	95.9	338.6
19	434.1	-327.3	936.9	637.4	111.5	293.5	637.4	111.5	293.5
20	383.1	-312.6	973.5	634.0	71.8	292.9	634.0	71.8	292.9
21	479.0	-324.7	919.6	628.1	141.8	285.6	628.1	141.8	285.6
22	437.8	-312.6	948.5	662.6	126.7	328.6	662.6	126.7	328.6
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	379.4	-208.0	855.4	512.3	57.1	427.0	512.3	57.1	427.0
2	379.2	-176.9	863.2	494.8	104.9	394.2	494.8	104.9	394.2
3	395.5	-172.3	865.3	510.0	97.6	417.9	510.0	97.6	417.9
4	376.0	-202.4	856.9	481.8	103.1	388.6	481.8	103.1	388.6
5	392.2	-215.7	858.5	478.5	99.0	396.0	478.5	99.0	396.0
6	412.3	-204.7	863.6	476.8	93.1	394.4	476.8	93.1	394.4
7	358.7	-217.0	852.8	486.3	116.7	411.4	486.3	116.7	411.4
8	406.9	-166.0	850.4	474.3	129.5	399.7	474.3	129.5	399.7
9	374.1	-190.8	866.7	481.6	112.3	392.0	481.6	112.3	392.0
10	392.0	-214.4	853.9	479.8	83.6	388.8	479.8	83.6	388.8
11	339.8	-179.7	895.2	502.9	109.5	405.3	502.9	109.5	405.3
12	375.4	-194.4	848.5	508.0	113.2	411.6	508.0	113.2	411.6
13	357.8	-184.0	866.3	507.3	114.7	416.7	507.3	114.7	416.7
14	357.3	-187.5	878.7	510.4	100.2	416.0	510.4	100.2	416.0
15	363.5	-198.0	827.7	504.3	112.6	399.8	504.3	112.6	399.8
16	333.9	-211.4	844.8	508.0	117.6	421.3	508.0	117.6	421.3
17	314.3	-190.9	876.5	492.2	103.5	403.1	492.2	103.5	403.1
18	315.1	-213.6	844.7	507.3	106.8	425.3	507.3	106.8	425.3
19	341.8	-203.7	850.4	494.9	117.7	396.0	494.9	117.7	396.0
20	311.2	-189.5	869.0	493.1	102.3	393.8	493.1	102.3	393.8
21	381.5	-199.8	841.4	485.2	136.6	387.7	485.2	136.6	387.7
22	351.8	-190.2	854.7	509.3	130.0	414.8	509.3	130.0	414.8

Test Condition	Targe Locations for Subject 05:								
	Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	690.6	73.4	488.9	610.7	82.8	225.6	645.1	69.4	295.8
2	689.3	81.8	523.0	604.6	147.1	221.8	651.4	104.6	335.3
3	686.5	56.7	454.3	601.9	119.7	215.7	643.0	143.7	313.5
4	676.2	55.0	454.1	563.6	141.2	195.4	602.7	163.7	244.4
5	667.7	22.6	506.0	563.5	117.1	208.9	603.0	157.8	265.3
6	637.6	77.5	324.4	555.5	167.7	214.3	603.3	127.6	257.8
7	662.7	58.7	419.0	562.4	116.4	207.3	642.9	119.1	382.9
8	658.4	42.6	448.3	564.0	149.4	208.0	618.8	155.4	276.3
9	669.9	28.7	463.9	558.3	130.1	194.2	633.1	154.4	290.4
10	654.4	-18.4	408.9	565.9	118.6	197.2	614.6	115.5	255.7
11	684.6	27.8	480.0	575.9	114.6	185.3	655.1	128.4	307.6
12	664.3	15.7	380.6	564.8	125.7	180.7	629.1	153.5	258.5
13	670.9	39.8	400.3	573.8	127.3	189.8	641.3	186.0	284.9
14	669.2	68.8	343.9	565.3	110.5	178.4	638.7	152.4	271.8
15	674.9	4.7	437.6	567.3	137.4	175.6	655.1	147.5	309.9
16	679.7	9.3	487.1	578.6	129.3	187.8	661.7	156.9	323.2
17	681.8	48.7	407.1	591.8	140.9	198.5	650.4	134.8	286.3
18	670.4	93.3	347.4	588.3	131.0	195.3	642.4	129.7	277.0
19	674.3	24.3	418.0	578.7	93.7	194.8	646.1	124.1	288.5
20	678.6	14.4	471.8	571.0	141.0	178.4	656.3	161.2	311.6
21	650.4	-10.1	415.3	564.7	95.2	195.7	620.8	154.1	263.6
22	668.9	90.9	346.4	566.2	157.5	180.7	631.5	162.7	259.4
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	516.3	84.9	485.4	466.4	88.1	326.7	479.0	81.5	352.1
2	514.3	104.2	500.9	463.0	138.4	325.6	480.3	118.8	373.8
3	513.5	88.8	466.6	458.1	123.1	322.3	474.4	135.3	363.1
4	503.5	88.5	467.8	438.7	132.6	319.8	454.1	142.1	336.7
5	493.8	58.5	497.1	434.8	110.3	329.0	447.8	133.0	345.4
6	481.7	94.3	404.5	428.9	135.4	332.4	447.0	118.4	338.6
7	494.3	90.0	454.4	433.8	120.6	328.0	466.4	120.8	400.9
8	490.2	91.4	467.8	435.5	148.5	327.4	456.8	152.1	347.4
9	500.4	74.8	473.9	437.8	122.3	319.4	467.6	141.6	352.1
10	492.8	41.1	445.0	439.3	113.7	319.5	460.6	111.5	340.4
11	514.5	70.0	479.4	452.4	118.2	310.9	487.2	123.6	356.7
12	503.8	67.7	429.3	445.6	122.6	310.3	474.2	135.6	339.2
13	506.8	88.5	438.8	448.9	136.1	313.5	478.2	165.6	348.1
14	507.8	91.4	411.2	445.9	110.9	307.8	478.6	135.1	342.7
15	510.2	63.0	456.7	447.9	132.8	305.8	485.8	134.9	357.7
16	510.8	63.1	481.2	453.6	128.4	311.4	491.8	138.4	364.7
17	513.0	83.1	441.1	460.4	129.9	313.9	486.6	127.2	347.4
18	507.1	106.0	412.6	457.2	126.1	311.5	480.4	123.9	344.7
19	508.6	74.3	448.1	453.7	109.9	317.1	481.3	126.3	348.7
20	511.3	68.7	474.3	449.4	138.2	306.5	491.8	146.6	359.6
21	493.7	57.4	449.3	440.3	114.1	317.8	464.8	141.1	343.5
22	506.7	113.9	413.0	445.5	147.4	308.8	475.0	149.8	338.2

Test Condition	Targe Locations for Subject 05:								
	Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	578.3	107.4	161.2	535.8	28.5	89.1	535.8	28.5	89.1
2	574.7	119.8	169.2	531.6	95.1	90.5	531.6	95.1	90.5
3	571.0	115.2	173.0	605.7	113.9	245.9	538.4	97.3	110.6
4	545.7	150.5	151.5	590.6	159.4	224.8	512.0	130.5	80.4
5	545.3	123.8	157.3	603.5	108.9	248.6	511.0	109.5	78.9
6	603.3	127.6	257.8	590.9	122.1	226.8	508.5	109.7	80.2
7	642.9	119.1	382.9	603.2	189.6	255.8	553.6	142.3	124.3
8	547.1	161.3	149.4	549.5	161.8	108.2	549.5	161.8	108.2
9	553.4	118.3	144.0	533.9	122.5	84.4	533.9	122.5	84.4
10	558.2	125.6	156.9	604.3	144.7	230.4	561.7	118.5	130.3
11	570.1	140.4	145.2	544.7	116.9	85.0	544.7	116.9	85.0
12	562.2	120.8	144.1	547.5	169.4	104.7	547.5	169.4	104.7
13	575.3	155.6	156.5	562.0	168.8	113.0	562.0	168.8	113.0
14	574.5	133.4	154.8	546.7	84.9	91.2	546.7	84.9	91.2
15	585.2	155.5	165.0	568.0	123.0	116.0	568.0	123.0	116.0
16	594.1	110.5	164.5	574.4	110.5	121.1	574.4	110.5	121.1
17	557.7	120.5	125.4	552.8	139.9	94.9	552.8	139.9	94.9
18	566.6	118.5	143.3	520.6	124.7	63.9	520.6	124.7	63.9
19	579.7	142.9	159.7	547.2	136.0	94.2	547.2	136.0	94.2
20	603.0	114.7	183.7	571.7	94.6	124.6	571.7	94.6	124.6
21	550.3	155.2	145.7	614.6	131.9	248.9	556.9	150.2	124.9
22	555.2	126.3	134.0	548.5	176.8	101.3	548.5	176.8	101.3
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	436.2	101.2	264.3	401.6	57.3	200.9	401.6	57.3	200.9
2	430.9	117.4	271.3	397.0	109.4	203.1	397.0	109.4	203.1
3	426.0	122.3	272.2	438.5	113.3	301.0	394.4	104.1	211.2
4	406.9	130.1	260.8	429.3	134.7	289.4	381.9	121.0	199.6
5	400.3	109.4	265.5	435.3	109.0	302.3	382.7	105.8	199.3
6	447.0	118.4	338.6	432.8	106.2	294.3	381.0	97.1	200.5
7	466.4	120.8	400.9	437.2	158.3	304.9	402.9	129.7	216.0
8	415.1	153.7	265.1	404.3	155.4	211.1	404.3	155.4	211.1
9	422.0	120.0	260.1	398.9	122.2	197.6	398.9	122.2	197.6
10	421.9	117.4	267.9	439.4	128.0	292.3	407.8	112.9	215.5
11	436.1	130.3	258.6	405.4	115.2	194.0	405.4	115.2	194.0
12	429.8	118.9	259.3	407.4	144.5	208.7	407.4	144.5	208.7
13	436.5	149.2	264.0	413.7	156.2	209.7	413.7	156.2	209.7
14	437.0	126.5	264.4	407.2	99.5	197.9	407.2	99.5	197.9
15	441.7	138.9	265.2	417.8	119.7	207.8	417.8	119.7	207.8
16	449.9	113.3	264.0	422.4	110.7	210.2	422.4	110.7	210.2
17	430.5	120.7	246.7	411.0	127.9	198.9	411.0	127.9	198.9
18	433.9	119.4	257.7	394.5	119.6	190.5	394.5	119.6	190.5
19	437.7	134.1	263.6	407.6	131.2	200.8	407.6	131.2	200.8
20	451.6	123.3	272.1	419.8	111.4	212.6	419.8	111.4	212.6
21	418.7	140.0	261.6	446.1	129.2	300.5	405.7	137.1	215.0
22	425.1	128.7	251.9	408.2	155.1	205.8	408.2	155.1	205.8

Reference Data Target locations for Subject 06

	x	y	z
Origin	53.3	-285.9	191.1
Reference	271.2	-281.5	132.0
Manubrium	185.9	-21.9	709.0
Xyphoid	111.6	-22.6	569.4
C7	327.4	-12.5	802.5
T4	368.6	-8.2	690.1
S1	261.2	-11.6	306.5
Left ASIS	104.9	-150.1	388.6
Left Lateral Femoral Condyle	-317.0	-235.2	380.6
Left Lateral Malleolis	-507.9	-158.7	13.9
Left Lateral Foot	-686.4	-153.1	-38.6

Test data for Subject 06 follows (coordinates in millimeters);

Subject
06

Probe Length
376

InterASIS Dist.
250

InterPSIS width
95

Heel to foot target dist.
225

Target Locations for Subject 06:

Test Condition	Origin			ref 2		
	x	y	z	x	y	z
1	-118.5	-306.9	-25.1	233.8	-320.6	-23.7
2	-118.5	-306.9	-25.1	233.8	-320.6	-23.8
3	-118.5	-306.9	-25.1	233.8	-320.7	-23.7
4	-118.5	-306.9	-25.1	233.8	-320.7	-23.8
5	-118.5	-306.9	-25.1	233.8	-320.6	-23.8
6	-118.5	-306.9	-25.1	233.8	-320.7	-23.9
7	-118.5	-306.9	-25.2	233.8	-320.7	-23.8
8	-118.5	-306.9	-25.2	233.8	-320.7	-23.8
9	-118.5	-306.9	-25.2	233.6	-320.7	-24.0
10	-118.5	-306.9	-25.2	233.8	-320.6	-23.8
11	-118.4	-306.6	-25.4	233.8	-320.6	-23.8
12	-118.5	-306.9	-25.2	233.8	-320.7	-23.9
13	-118.5	-306.9	-25.2	233.8	-320.7	-23.7
14	-118.5	-306.9	-25.2	233.7	-320.6	-23.8
15	-118.4	-306.7	-25.3	233.8	-320.6	-23.7
16	-118.5	-306.7	-25.3	233.8	-320.7	-23.8
17	-118.5	-306.7	-25.3	233.8	-320.6	-23.8
18	-118.4	-306.5	-25.3	233.8	-320.7	-24.0
19	-118.4	-306.6	-25.4	233.8	-320.6	-23.8
20	-118.4	-306.6	-25.4	233.8	-320.8	-23.9
21	-118.4	-306.6	-25.3	233.8	-320.7	-23.7
22	-118.5	-306.9	-25.2	233.8	-320.7	-23.9

Test Condition	Elbow			Wrist		
	x	y	z	x	y	z
1	254.7	-309.1	432.5	51.8	-224.4	543.1
2	260.5	-292.0	429.4	56.8	-216.1	543.8
3	253.4	-308.8	441.9	43.5	-232.7	545.7
4	256.3	-304.9	439.7	47.3	-227.3	544.9
5	257.6	-303.6	443.1	50.3	-215.6	542.0
6	265.8	-304.6	443.9	56.4	-219.4	541.5
7	264.4	-303.1	437.4	59.4	-218.2	542.3
8	260.4	-300.5	443.5	50.3	-225.8	549.8
9	252.0	-306.7	428.8	46.7	-232.1	545.6
10	255.8	-300.6	439.1	47.9	-224.9	548.5
11	255.0	-298.4	427.1	57.0	-215.9	545.1
12	254.9	-309.8	431.7	56.6	-221.9	545.7
13	259.0	-295.2	432.3	56.0	-218.7	546.5
14	264.3	-298.9	434.2	56.8	-224.0	541.3
15	257.1	-304.6	427.7	54.6	-227.3	544.4
16	252.2	-301.3	422.6	55.4	-221.7	543.6
17	253.2	-299.4	417.7	56.3	-220.5	537.9
18	246.0	-304.9	421.7	45.7	-230.6	542.4
19	261.1	-296.4	435.7	54.1	-222.7	544.0
20	262.9	-297.2	432.1	51.1	-232.3	540.7
21	258.3	-303.8	439.5	47.4	-227.6	544.4
22	259.1	-297.7	439.3	47.2	-232.8	549.1

Target Locations for Subject 06:

Test Condition	Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	282.3	-44.7	716.0	190.0	-40.2	584.2	156.5	-176.0	389.8
2	291.2	-24.2	716.4	188.1	-21.4	589.1	154.2	-150.9	390.9
3	292.4	-45.2	725.3	193.1	-43.1	597.2	142.0	-177.3	393.1
4	294.3	-43.6	726.4	190.5	-39.5	600.2	144.4	-170.1	393.6
5	298.5	-42.2	731.6	188.5	-41.1	608.2	144.7	-173.9	394.3
6	303.0	-36.3	730.9	190.5	-35.4	609.0	141.9	-168.4	392.6
7	290.5	-40.4	727.2	185.4	-37.4	601.3	148.8	-171.2	393.7
8	292.3	-34.7	728.5	183.4	-34.6	602.2	154.9	-166.0	389.6
9	285.7	-45.7	717.9	183.3	-43.1	590.6	154.6	-176.1	393.5
10	297.1	-36.8	726.4	189.6	-32.3	602.3	150.5	-165.2	391.8
11	269.4	-34.9	709.5	188.3	-34.3	574.7	159.8	-169.1	387.3
12	282.4	-48.8	716.7	187.5	-46.2	587.1	155.5	-178.7	389.7
13	284.8	-31.9	718.2	186.8	-29.4	587.8	163.3	-161.9	388.5
14	284.0	-33.3	720.3	186.1	-30.6	589.1	164.9	-161.4	389.1
15	271.7	-40.8	712.7	186.0	-39.7	575.9	165.3	-171.3	385.1
16	258.9	-34.3	707.4	183.5	-31.0	568.6	167.3	-164.9	386.5
17	254.8	-37.1	700.2	183.5	-34.3	562.1	165.8	-167.6	386.1
18	260.3	-40.3	703.9	182.5	-41.0	567.6	158.4	-175.5	389.1
19	273.0	-26.7	718.3	185.5	-25.5	582.4	161.7	-157.8	390.1
20	278.0	-30.2	717.7	184.1	-28.1	581.2	163.0	-162.4	387.5
21	288.1	-35.3	724.0	186.3	-34.2	595.9	150.9	-168.1	388.9
22	284.3	-28.2	717.7	186.2	-29.2	588.2	155.6	-162.3	385.0

Test Condition	Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-280.0	-244.8	327.1	0.0	0.0	0.0	-696.2	-179.6	100.0
2	-287.2	-236.3	322.2	-558.5	-150.6	-17.0	-696.8	-164.1	103.8
3	-275.2	-243.7	335.2	-515.2	-138.1	-13.2	-679.0	-163.4	61.8
4	-279.1	-226.9	334.7	0.0	0.0	0.0	-693.3	-144.3	95.3
5	-275.6	-236.8	339.9	-515.9	-150.4	-9.2	-681.5	-166.5	70.4
6	-283.3	-226.4	331.3	0.0	0.0	0.0	-692.4	-142.0	95.8
7	-282.6	-225.4	335.5	0.0	0.0	0.0	-694.1	-174.6	97.8
8	-279.9	-228.9	323.8	0.0	0.0	0.0	-695.2	-168.8	101.1
9	-292.2	-226.3	338.0	0.0	0.0	0.0	-697.0	-175.9	102.3
10	-279.1	-230.0	331.3	0.0	0.0	0.0	-693.6	-168.6	95.7
11	-277.2	-228.3	326.0	0.0	0.0	0.0	-693.5	-167.9	96.4
12	-282.5	-235.6	334.7	0.0	0.0	0.0	-691.4	-158.3	88.8
13	-274.7	-232.5	316.8	-558.1	-166.8	-15.5	-698.3	-176.8	107.2
14	-277.6	-224.7	316.4	0.0	0.0	0.0	-695.5	-163.8	101.2
15	-274.9	-232.6	318.6	0.0	0.0	0.0	-691.9	-162.7	93.2
16	-271.5	-233.6	319.4	0.0	0.0	0.0	-697.3	-172.5	104.3
17	-271.6	-251.5	304.8	-560.7	-168.1	-18.5	-698.6	-181.7	107.1
18	-284.0	-238.6	320.6	-557.9	-146.0	-19.9	-695.2	-166.8	99.5
19	-276.6	-214.4	339.0	-525.6	-127.7	-6.8	-684.1	-130.3	79.6
20	-271.8	-236.6	317.2	0.0	0.0	0.0	-696.0	-176.8	101.1
21	-275.4	-245.8	319.0	0.0	0.0	0.0	-695.4	-162.3	99.0
22	-275.6	-237.9	318.3	0.0	0.0	0.0	-694.5	-171.6	99.0

Test Condition	Target Locations for Subject 06:								
	Probe1 Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	492.9	-463.5	971.9	731.7	-107.7	338.1	731.7	-107.7	338.1
2	525.5	-451.4	946.4	725.1	-130.8	353.3	725.1	-130.8	353.3
3	474.4	-460.8	1007.5	718.4	-139.4	332.7	718.4	-139.4	332.7
4	494.9	-446.5	1003.7	721.9	-70.2	324.9	721.9	-70.2	324.9
5	534.6	-481.2	954.2	707.7	-69.0	314.1	707.7	-69.0	314.1
6	512.6	-462.9	978.4	710.0	-99.6	324.7	710.0	-99.6	324.7
7	508.6	-454.1	987.8	705.8	-76.6	313.0	705.8	-76.6	313.0
8	444.6	-484.4	980.7	704.6	-62.1	312.3	704.6	-62.1	312.3
9	442.3	-452.6	1012.2	730.5	-93.0	352.1	730.5	-93.0	352.1
10	537.5	-445.3	974.4	717.1	-134.7	341.3	717.1	-134.7	341.3
11	485.1	-442.9	984.7	721.9	-102.7	321.0	721.9	-102.7	321.0
12	501.0	-490.0	953.2	727.8	-92.1	334.5	727.8	-92.1	334.5
13	466.5	-447.9	1005.8	706.9	-65.5	302.8	706.9	-65.5	302.8
14	466.1	-464.8	980.6	730.1	-82.0	344.9	730.1	-82.0	344.9
15	487.6	-458.1	969.6	705.9	-129.1	306.9	705.9	-129.1	306.9
16	443.9	-442.0	996.3	726.1	-83.5	316.2	726.1	-83.5	316.2
17	389.5	-490.1	966.5	724.6	-89.5	325.8	724.6	-89.5	325.8
18	473.3	-433.8	990.2	718.2	-100.5	313.7	718.2	-100.5	313.7
19	497.1	-424.8	994.4	727.8	-84.2	330.6	727.8	-84.2	330.6
20	531.6	-441.9	948.0	725.1	-81.8	321.1	725.1	-81.8	321.1
21	514.4	-419.6	1007.6	724.2	-70.0	335.4	724.2	-70.0	335.4
22	468.9	-446.0	1005.5	722.9	-68.2	322.8	722.9	-68.2	322.8
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	416.0	-342.7	868.2	576.4	-77.0	421.9	576.4	-77.0	421.9
2	439.7	-328.9	852.9	572.4	-80.4	425.7	572.4	-80.4	425.7
3	411.3	-343.0	891.7	570.1	-95.0	420.6	570.1	-95.0	420.6
4	421.9	-333.9	888.2	574.4	-60.7	419.5	574.4	-60.7	419.5
5	447.5	-356.6	863.6	559.4	-58.4	410.6	559.4	-58.4	410.6
6	439.5	-339.1	874.5	561.9	-74.0	416.7	561.9	-74.0	416.7
7	429.7	-338.3	880.0	559.4	-60.3	410.8	559.4	-60.3	410.8
8	398.9	-350.0	875.4	554.0	-48.3	407.5	554.0	-48.3	407.5
9	392.7	-338.0	887.0	572.2	-72.2	427.8	572.2	-72.2	427.8
10	448.8	-333.1	870.9	566.7	-84.7	423.3	566.7	-84.7	423.3
11	402.8	-331.9	874.8	574.5	-70.5	412.9	574.5	-70.5	412.9
12	420.8	-362.9	860.1	574.3	-72.6	421.6	574.3	-72.6	421.6
13	403.9	-332.4	888.3	560.5	-47.2	402.8	560.5	-47.2	402.8
14	404.2	-337.9	874.9	574.8	-57.2	424.8	574.8	-57.2	424.8
15	406.5	-339.4	867.4	564.2	-87.6	404.3	564.2	-87.6	404.3
16	373.8	-328.2	880.7	576.6	-62.8	409.2	576.6	-62.8	409.2
17	342.3	-354.9	863.3	580.5	-68.8	419.3	580.5	-68.8	419.3
18	390.0	-327.9	876.3	569.8	-74.4	406.3	569.8	-74.4	406.3
19	412.1	-316.3	884.0	575.7	-58.6	416.7	575.7	-58.6	416.7
20	433.3	-326.2	858.0	575.2	-61.6	412.5	575.2	-61.6	412.5
21	432.3	-316.6	889.9	571.1	-57.0	423.0	571.1	-57.0	423.0
22	408.5	-327.5	889.0	571.8	-52.5	414.1	571.8	-52.5	414.1

Test Condition	Target Locations for Subject 06: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	766.7	-84.6	517.2	612.9	-67.2	177.9	726.0	-87.9	393.5
2	626.8	-84.9	193.7	626.8	-84.9	193.7	619.1	-49.0	154.8
3	759.0	-116.6	489.1	624.7	-57.7	191.5	705.5	-9.9	326.6
4	758.3	-51.3	436.3	611.4	-85.3	186.4	700.2	-34.6	315.3
5	742.8	-129.8	449.6	618.1	-86.4	203.1	701.0	-33.2	340.6
6	746.9	-118.8	452.6	615.1	-39.9	197.7	694.9	7.6	325.6
7	744.8	-120.5	439.8	607.9	-64.1	191.7	705.6	-15.5	339.8
8	748.1	-96.0	441.0	610.7	-51.4	191.4	706.1	48.4	357.4
9	757.2	-100.7	522.2	612.5	-69.2	186.7	696.5	-51.9	279.4
10	748.1	-129.1	485.2	652.0	-98.5	231.9	685.4	-49.3	269.4
11	748.2	-129.3	500.0	609.7	-60.5	170.4	621.6	-31.9	140.1
12	756.8	-118.8	494.6	615.9	-48.7	183.0	726.7	-26.4	417.0
13	764.0	-76.0	496.3	608.9	-90.5	184.1	727.5	-38.4	444.2
14	758.9	-92.6	484.5	612.6	-65.1	182.1	694.3	-42.5	261.3
15	763.3	-109.7	456.1	644.2	-53.8	197.5	705.2	-34.5	267.6
16	754.7	-83.2	373.3	694.2	-54.6	238.4	718.3	-42.3	281.3
17	765.9	-124.5	510.0	677.8	-62.8	227.5	700.5	-69.0	255.4
18	625.7	-15.2	180.5	625.7	-15.2	180.5	703.1	-63.3	266.8
19	759.2	-111.9	494.8	613.5	-39.9	175.1	693.4	-63.2	256.9
20	755.8	-141.0	477.7	623.3	-48.1	178.8	692.4	-32.1	248.5
21	739.4	-158.0	451.4	612.6	-43.7	186.3	716.9	-52.3	375.8
22	744.9	-153.9	526.6	613.6	-57.2	183.1	729.1	-17.8	410.5
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	590.5	-62.4	505.7	504.2	-60.1	317.1	551.3	-64.5	408.0
2	503.8	-52.1	319.9	503.8	-52.1	319.9	483.7	-29.1	269.1
3	585.7	-83.3	492.7	507.5	-51.8	321.2	536.2	-27.5	374.6
4	584.3	-48.5	466.7	490.2	-74.4	321.2	532.3	-36.9	369.4
5	573.1	-88.6	475.2	497.9	-67.5	332.5	529.3	-37.2	382.7
6	576.0	-83.4	476.5	498.4	-41.6	330.1	526.4	-15.0	374.9
7	575.7	-81.8	470.4	497.0	-57.4	330.4	534.5	-26.3	381.4
8	576.8	-68.4	471.0	498.8	-45.1	329.9	537.3	8.5	387.6
9	581.5	-74.1	510.3	502.1	-55.9	324.5	535.5	-44.3	353.1
10	578.6	-81.3	492.1	520.9	-66.3	346.0	528.7	-40.2	350.1
11	591.9	-77.3	499.2	479.1	-82.3	318.0	492.5	-30.5	260.8
12	585.2	-83.2	496.8	504.9	-49.7	321.1	549.4	-34.6	420.4
13	589.1	-55.8	497.7	501.1	-61.9	321.9	553.9	-35.2	434.3
14	585.6	-61.1	490.8	503.7	-49.1	320.4	537.3	-35.9	342.6
15	590.5	-76.5	474.5	520.8	-46.7	320.9	545.8	-33.5	343.4
16	589.1	-61.8	430.8	547.3	-44.1	340.9	555.1	-36.5	348.3
17	591.8	-82.8	498.5	541.6	-49.9	340.4	544.8	-49.3	337.4
18	515.7	-32.2	318.9	515.7	-32.2	318.9	544.7	-52.3	343.8
19	587.9	-71.3	495.3	506.2	-34.7	315.8	539.6	-45.1	341.6
20	586.4	-91.9	485.7	514.5	-41.3	314.1	541.9	-29.7	338.2
21	573.4	-104.0	474.5	500.8	-44.3	325.2	544.4	-43.5	400.4
22	578.6	-96.3	512.8	504.3	-44.6	320.5	551.4	-22.3	416.4

Test Condition	Target Locations for Subject 06: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	625.4	-54.6	150.8	639.7	-50.0	142.9	639.7	-50.0	142.9
2	619.1	-49.0	154.8	616.3	-77.8	129.6	616.3	-77.8	129.6
3	616.7	-58.1	162.7	629.9	-53.3	148.1	629.9	-53.3	148.1
4	614.4	-35.7	163.0	612.5	-65.8	116.2	612.5	-65.8	116.2
5	612.7	-59.5	168.5	621.4	-108.2	142.3	621.4	-108.2	142.3
6	613.5	-58.6	167.5	608.9	-46.1	107.3	608.9	-46.1	107.3
7	619.2	-43.0	163.9	624.8	-142.1	153.1	624.8	-142.1	153.1
8	620.1	-59.6	153.2	634.7	-32.3	131.1	634.7	-32.3	131.1
9	617.7	-70.2	151.9	633.8	-104.2	158.0	633.8	-104.2	158.0
10	618.4	-50.7	157.9	631.6	-99.6	146.4	631.6	-99.6	146.4
11	621.6	-31.9	140.1	631.3	-65.9	120.1	631.3	-65.9	120.1
12	726.7	-26.4	417.0	634.4	-119.4	150.0	634.4	-119.4	150.0
13	727.5	-38.4	444.2	642.8	-93.6	151.0	642.8	-93.6	151.0
14	615.7	-43.1	140.3	643.4	-23.5	137.4	643.4	-23.5	137.4
15	628.9	-46.7	144.2	641.3	-89.3	136.6	641.3	-89.3	136.6
16	636.1	-42.9	144.3	638.7	-21.5	119.2	638.7	-21.5	119.2
17	623.6	-33.8	137.7	643.6	-10.3	141.6	643.6	-10.3	141.6
18	634.4	-42.1	156.5	624.2	-65.6	113.0	624.2	-65.6	113.0
19	620.7	-54.4	145.7	621.9	-24.5	100.7	621.9	-24.5	100.7
20	624.2	-26.2	142.1	621.1	-12.8	96.2	621.1	-12.8	96.2
21	716.9	-52.3	375.8	628.2	-49.0	129.5	628.2	-49.0	129.5
22	729.1	-17.8	410.5	631.7	23.3	129.9	631.7	23.3	129.9
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	489.7	-39.5	266.5	477.7	-47.3	214.1	477.7	-47.3	214.1
2	483.7	-29.1	269.1	460.9	-47.4	207.8	460.9	-47.4	207.8
3	481.9	-50.0	277.3	474.5	-49.3	231.8	474.5	-49.3	231.8
4	480.3	-36.9	278.7	463.1	-53.2	210.0	463.1	-53.2	210.0
5	477.9	-48.4	282.4	469.1	-77.9	227.2	469.1	-77.9	227.2
6	477.7	-51.0	281.5	460.9	-43.0	204.2	460.9	-43.0	204.2
7	483.5	-38.1	277.3	470.2	-95.8	224.9	470.2	-95.8	224.9
8	484.7	-38.5	268.2	476.2	-33.8	209.7	476.2	-33.8	209.7
9	483.3	-51.3	267.0	471.1	-75.5	221.3	471.1	-75.5	221.3
10	480.7	-33.8	270.2	472.7	-69.7	218.9	472.7	-69.7	218.9
11	492.5	-30.5	260.8	476.3	-51.1	203.8	476.3	-51.1	203.8
12	549.4	-34.6	420.4	475.6	-86.5	219.3	475.6	-86.5	219.3
13	553.9	-35.2	434.3	482.4	-63.2	217.4	482.4	-63.2	217.4
14	488.4	-34.4	262.6	481.8	-28.4	208.0	481.8	-28.4	208.0
15	495.6	-38.6	261.0	482.3	-64.7	208.5	482.3	-64.7	208.5
16	502.2	-32.7	260.0	481.6	-25.2	199.3	481.6	-25.2	199.3
17	496.2	-30.8	259.8	482.2	-19.2	212.9	482.2	-19.2	212.9
18	498.6	-39.3	269.9	468.9	-56.2	198.4	468.9	-56.2	198.4
19	489.3	-35.1	263.8	472.1	-24.4	194.5	472.1	-24.4	194.5
20	494.5	-23.2	262.0	472.0	-18.8	189.7	472.0	-18.8	189.7
21	544.4	-43.5	400.4	471.3	-41.8	210.8	471.3	-41.8	210.8
22	551.4	-22.3	416.4	475.1	-0.9	210.2	475.1	-0.9	210.2

Reference Data Target locations for Subject 07

	x	y	z
Origin	-79.5	-247.9	189.0
Reference	137.7	-268.4	130.9
Manubrium	115.8	-3.8	726.5
Xyphoid	43.4	-9.3	573.8
C7	258.8	-12.8	767.2
T4	276.8	-14.0	676.0
S1	135.9	-6.8	282.9
Left ASIS	-8.4	-81.3	378.6
Left Lateral Femoral Condyle	-438.4	-204.3	352.8
Left Lateral Malleolis	-628.5	-134.3	33.6
Left Lateral Foot	-838.8	-104.3	-36.3

Test data for Subject 07 follows (coordinates in millimeters);

Subject
07

Probe Length
376

InterASIS Dist.
235

InterPSIS width
85

Heel to foot target dist.
280

Test Condition — **Target Locations for Subject 07:**

	Origin			ref 2		
	x	y	z	x	y	z
1	60.4	-373.1	-26.6	410.7	-410.9	-25.6
2	60.5	-373.1	-26.5	410.7	-410.8	-25.6
3	60.5	-373.1	-26.5	410.6	-410.8	-25.6
4	60.4	-373.2	-26.4	410.7	-410.9	-25.6
5	60.4	-373.1	-26.5	410.7	-410.8	-25.6
6	60.4	-373.1	-26.5	410.7	-410.9	-25.7
7	60.5	-373.1	-26.5	410.7	-410.8	-25.6
8	60.7	-373.3	-26.4	411.1	-411.0	-25.6
9	60.7	-373.2	-26.4	411.1	-411.0	-25.6
10	60.7	-373.3	-26.4	411.1	-410.9	-25.6
11	60.7	-373.3	-26.4	411.1	-411.0	-25.6
12	60.7	-373.2	-26.4	411.1	-411.0	-25.6
13	60.7	-373.2	-26.5	411.0	-411.0	-25.6
14	60.8	-373.3	-26.5	411.1	-411.0	-25.6
15	60.8	-373.3	-26.4	411.1	-411.0	-25.6
16	60.8	-373.3	-26.4	411.1	-410.9	-25.6
17	60.7	-373.3	-26.4	411.1	-411.0	-25.6
18	60.7	-373.3	-26.5	411.1	-411.0	-25.6
19	60.7	-373.2	-26.4	411.1	-411.0	-25.6
20	60.7	-373.3	-26.5	411.1	-411.0	-25.7
21	60.9	-373.2	-26.5	411.1	-411.0	-25.7
22	60.7	-373.1	-26.5	411.1	-411.0	-25.6

Test Condition — **Target Locations for Subject 07:**

	Elbow			Wrist		
	x	y	z	x	y	z
1	437.0	-393.1	436.7	226.5	-308.0	560.6
2	448.0	-398.9	439.6	234.8	-311.2	559.5
3	435.5	-400.8	440.1	223.9	-314.7	561.8
4	447.1	-410.0	450.0	234.0	-311.1	559.8
5	440.4	-401.6	452.5	226.0	-307.8	567.4
6	446.6	-403.1	456.6	228.0	-313.4	566.5
7	453.1	-396.6	449.0	233.7	-312.6	563.6
8	448.3	-405.7	452.8	224.4	-325.9	567.2
9	450.9	-399.6	443.6	232.4	-319.4	562.1
10	436.5	-388.7	444.4	221.4	-309.8	568.8
11	436.1	-398.9	441.8	224.1	-312.7	566.1
12	441.7	-391.7	437.7	229.6	-308.2	560.3
13	442.2	-403.3	440.1	232.1	-314.8	562.5
14	442.3	-400.4	438.8	228.0	-319.7	562.2
15	440.7	-386.1	432.4	231.8	-306.9	561.0
16	447.0	-397.6	443.3	231.2	-315.5	561.3
17	435.3	-398.4	433.1	225.5	-312.5	555.8
18	446.5	-395.7	433.2	238.1	-310.5	559.5
19	441.7	-397.1	437.4	231.5	-311.2	560.9
20	431.5	-396.2	437.0	218.4	-315.9	563.3
21	446.5	-405.2	447.8	232.9	-314.3	565.2
22	451.6	-392.8	441.8	234.5	-311.5	560.0

Test Condition	Target Locations for Subject 07:								
	Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	480.2	-119.0	728.3	410.9	-118.9	572.1	349.1	-214.5	386.0
2	484.3	-117.8	730.2	416.5	-119.1	579.3	344.0	-217.8	392.3
3	489.6	-121.9	730.6	414.5	-121.8	581.8	334.4	-216.3	395.3
4	498.0	-122.9	736.8	414.1	-120.6	591.8	331.5	-214.8	393.7
5	508.9	-120.4	744.2	413.9	-114.6	605.0	331.2	-207.9	394.5
6	522.7	-120.3	744.7	419.1	-115.1	611.7	324.4	-208.0	395.7
7	501.7	-121.9	746.6	413.3	-119.0	602.2	338.2	-210.7	386.5
8	500.1	-121.0	745.8	409.9	-118.9	602.7	337.3	-214.6	387.4
9	495.2	-118.2	737.7	415.3	-115.5	590.2	342.6	-210.2	390.4
10	495.8	-113.3	738.2	416.3	-107.5	590.9	342.1	-205.0	390.6
11	477.5	-118.3	731.4	411.2	-119.0	579.8	344.4	-217.6	391.9
12	480.9	-113.5	729.2	414.6	-111.2	576.7	349.1	-209.0	386.9
13	481.4	-120.0	728.4	414.4	-118.5	575.3	349.0	-216.8	384.2
14	483.3	-118.1	728.7	414.2	-116.9	576.0	348.3	-217.6	382.5
15	475.3	-108.5	727.6	412.8	-108.0	572.0	352.7	-210.7	389.4
16	475.3	-110.1	732.1	408.4	-112.6	579.7	350.3	-210.8	385.4
17	467.9	-122.7	730.7	407.8	-121.4	572.9	346.7	-221.0	385.1
18	470.9	-116.0	728.8	410.5	-115.7	573.0	350.7	-216.0	389.8
19	475.2	-116.4	728.4	412.4	-118.4	572.8	349.4	-215.9	387.0
20	474.1	-114.8	725.9	411.8	-118.6	570.4	350.3	-216.2	385.3
21	501.8	-117.2	736.3	413.8	-115.0	594.3	338.7	-216.2	392.0
22	489.6	-110.7	732.9	416.4	-112.6	583.2	348.9	-213.8	390.4

Test Condition	Target Locations for Subject 07:								
	Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-87.1	-303.7	328.6	-336.3	-258.6	18.2	-516.5	-238.3	129.5
2	-92.6	-295.3	335.3	-335.9	-244.6	20.5	-514.7	-219.6	127.4
3	-97.5	-297.6	344.8	-333.4	-262.4	18.7	-512.6	-243.7	123.0
4	-95.3	-309.1	335.3	-335.5	-259.0	18.9	-516.9	-237.2	128.1
5	-88.6	-315.7	328.9	-338.9	-269.7	18.0	-517.8	-247.4	130.5
6	-88.4	-322.5	324.2	-339.5	-255.7	15.6	-516.5	-238.1	126.1
7	-81.8	-316.0	321.9	-338.1	-259.8	16.8	-517.8	-244.5	128.1
8	-83.3	-318.2	318.5	-345.5	-267.0	17.2	-517.6	-250.6	140.2
9	-83.3	-305.1	323.5	-342.4	-250.5	17.5	-515.0	-231.8	133.0
10	-75.9	-317.2	320.1	0.0	0.0	0.0	-514.1	-233.1	126.7
11	-82.4	-324.5	316.9	0.0	0.0	0.0	-517.0	-244.0	140.5
12	-76.9	-325.5	312.2	0.0	0.0	0.0	-518.1	-254.4	139.1
13	-82.2	-318.6	321.5	-342.0	-264.9	17.9	-516.9	-244.9	132.6
14	-78.5	-326.5	320.6	-337.1	-273.9	18.7	-517.5	-254.6	126.7
15	-79.7	-313.2	322.7	-339.7	-266.9	17.0	-517.3	-250.1	131.9
16	-78.0	-320.7	318.5	0.0	0.0	0.0	-517.0	-245.0	129.8
17	-81.2	-328.5	313.2	0.0	0.0	0.0	-516.8	-243.1	141.2
18	-82.0	-321.8	322.6	-336.1	-262.6	17.1	-516.5	-244.3	126.5
19	-83.3	-313.4	322.7	-345.5	-263.8	18.8	-517.5	-236.6	137.6
20	-85.8	-308.4	327.2	-335.0	-257.8	18.6	-516.3	-240.1	126.0
21	-90.7	-317.1	318.2	-352.9	-250.4	17.4	-516.9	-228.7	141.2
22	-79.1	-324.0	321.5	-337.2	-272.5	18.2	-516.3	-254.1	125.0

Test Condition	Target Locations for Subject 07: Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	718.7	-558.4	909.4	907.0	-179.0	322.1	907.0	-179.0	322.1
2	696.0	-566.3	932.6	884.7	-211.8	301.0	884.7	-211.8	301.0
3	678.7	-608.8	880.1	889.8	-210.7	312.7	889.8	-210.7	312.7
4	723.4	-589.6	895.1	886.8	-179.6	308.1	886.8	-179.6	308.1
5	751.9	-597.9	847.2	879.9	-194.8	320.3	879.9	-194.8	320.3
6	735.8	-566.6	946.3	881.5	-188.7	318.9	881.5	-188.7	318.9
7	744.3	-611.5	854.0	879.1	-166.2	312.0	879.1	-166.2	312.0
8	744.3	-578.2	895.9	876.4	-202.1	318.8	876.4	-202.1	318.8
9	761.9	-588.6	821.9	880.1	-192.5	301.8	880.1	-192.5	301.8
10	701.3	-613.9	832.2	880.6	-182.6	302.3	880.6	-182.6	302.3
11	672.3	-600.0	880.4	903.4	-207.8	332.1	903.4	-207.8	332.1
12	656.1	-570.5	962.3	894.3	-151.5	299.3	894.3	-151.5	299.3
13	667.1	-598.8	929.9	899.5	-179.6	307.5	899.5	-179.6	307.5
14	730.2	-577.2	871.7	901.3	-168.6	308.8	901.3	-168.6	308.8
15	701.4	-584.3	871.7	903.2	-140.9	310.2	903.2	-140.9	310.2
16	687.6	-571.6	917.2	907.1	-192.0	331.9	907.1	-192.0	331.9
17	701.7	-581.1	908.8	888.0	-182.1	299.1	888.0	-182.1	299.1
18	643.5	-606.6	913.1	891.5	-184.1	307.1	891.5	-184.1	307.1
19	670.9	-577.7	925.4	899.6	-165.8	310.5	899.6	-165.8	310.5
20	701.2	-573.6	901.0	902.7	-161.9	319.3	902.7	-161.9	319.3
21	778.4	-566.8	848.7	892.6	-163.5	312.8	892.6	-163.5	312.8
22	702.2	-555.4	944.9	892.8	-140.3	306.8	892.8	-140.3	306.8
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	629.8	-443.8	831.0	753.4	-152.2	408.2	753.4	-152.2	408.2
2	619.0	-448.8	843.2	741.2	-172.3	397.9	741.2	-172.3	397.9
3	610.3	-472.1	815.3	742.2	-173.2	403.2	742.2	-173.2	403.2
4	643.5	-461.5	826.2	738.7	-156.1	403.5	738.7	-156.1	403.5
5	664.5	-465.9	798.7	733.4	-159.1	413.1	733.4	-159.1	413.1
6	664.0	-450.0	851.7	732.4	-157.1	409.5	732.4	-157.1	409.5
7	649.5	-470.6	804.1	731.6	-146.2	408.4	731.6	-146.2	408.4
8	660.2	-456.2	825.3	729.5	-165.1	410.4	729.5	-165.1	410.4
9	659.9	-462.2	785.0	737.5	-158.4	401.0	737.5	-158.4	401.0
10	628.0	-470.8	790.7	737.2	-149.4	401.3	737.2	-149.4	401.3
11	604.8	-465.5	817.5	753.5	-165.0	416.8	753.5	-165.0	416.8
12	590.0	-441.9	860.1	748.0	-133.0	397.7	748.0	-133.0	397.7
13	595.4	-463.3	841.8	749.9	-153.8	400.3	749.9	-153.8	400.3
14	637.9	-454.1	810.3	751.4	-147.0	402.4	751.4	-147.0	402.4
15	616.3	-455.6	808.5	752.6	-128.5	404.1	752.6	-128.5	404.1
16	612.1	-447.9	837.1	749.6	-154.8	411.9	749.6	-154.8	411.9
17	606.2	-453.8	830.0	742.0	-157.5	397.8	742.0	-157.5	397.8
18	575.8	-464.3	832.5	745.3	-154.0	402.2	745.3	-154.0	402.2
19	603.2	-452.7	840.5	750.7	-143.6	405.0	750.7	-143.6	405.0
20	617.7	-453.1	824.5	753.7	-141.8	404.8	753.7	-141.8	404.8
21	673.2	-447.7	798.8	742.8	-141.0	405.7	742.8	-141.0	405.7
22	627.2	-440.3	851.8	744.1	-131.6	404.1	744.1	-131.6	404.1

Test Condition	Target Locations for Subject 07: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	742.3	-126.1	130.5	742.3	-126.1	130.5	806.0	-110.7	117.5
2	782.5	-136.4	162.6	782.5	-136.4	162.6	891.3	-131.0	383.9
3	774.4	-155.0	162.0	774.4	-155.0	162.0	867.5	-151.3	264.5
4	730.1	-134.6	142.6	730.1	-134.6	142.6	851.1	-156.4	230.6
5	724.7	-141.3	150.2	724.7	-141.3	150.2	850.6	-142.9	243.3
6	724.7	-141.3	150.2	724.7	-141.3	150.2	830.0	-152.4	219.2
7	915.6	-207.5	452.5	769.2	-128.9	170.0	839.6	-179.4	217.9
8	728.2	-203.3	155.9	728.2	-203.3	155.9	874.4	-172.8	319.4
9	718.3	-179.1	140.1	718.3	-179.1	140.1	869.1	-158.2	259.3
10	724.5	-133.3	139.9	724.5	-133.3	139.9	848.9	-129.4	211.4
11	796.7	-161.2	165.1	796.7	-161.2	165.1	880.2	-158.2	286.4
12	771.7	-140.4	149.5	771.7	-140.4	149.5	883.3	-142.9	454.3
13	772.1	-154.1	147.5	772.1	-154.1	147.5	816.6	-136.8	129.9
14	786.2	-145.0	158.2	786.2	-145.0	158.2	807.3	-145.2	117.6
15	830.1	-122.7	194.9	830.1	-122.7	194.9	805.9	-128.6	114.2
16	800.5	-175.4	177.9	800.5	-175.4	177.9	809.4	-129.7	122.2
17	790.0	-132.1	163.3	790.0	-132.1	163.3	802.2	-141.8	112.6
18	793.3	-177.6	170.4	793.3	-177.6	170.4	894.1	-138.6	331.0
19	783.7	-136.5	154.8	783.7	-136.5	154.8	903.3	-152.7	399.3
20	799.2	-148.4	162.1	799.2	-148.4	162.1	805.1	-133.4	110.1
21	738.7	-147.3	147.3	738.7	-147.3	147.3	863.0	-151.8	252.8
22	788.2	-109.1	171.6	788.2	-109.1	171.6	876.0	-208.0	428.3
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	655.9	-121.7	283.8	655.9	-121.7	283.8	667.3	-111.4	225.5
2	677.0	-130.3	303.1	677.0	-130.3	303.1	715.2	-120.7	378.2
3	670.9	-142.4	303.4	670.9	-142.4	303.4	700.0	-137.2	318.6
4	645.1	-131.8	294.6	645.1	-131.8	294.6	691.9	-138.2	303.2
5	639.5	-128.5	304.3	639.5	-128.5	304.3	687.1	-125.4	309.9
6	639.5	-128.5	304.3	639.5	-128.5	304.3	674.2	-133.7	301.8
7	747.0	-164.1	472.0	662.7	-122.6	309.2	685.3	-148.6	297.7
8	637.4	-163.4	302.5	637.4	-163.4	302.5	701.4	-145.7	346.1
9	640.9	-150.4	295.7	640.9	-150.4	295.7	703.0	-134.8	314.1
10	644.5	-120.7	296.0	644.5	-120.7	296.0	693.2	-113.2	294.3
11	683.3	-142.4	298.5	683.3	-142.4	298.5	710.4	-138.1	328.3
12	679.0	-121.4	297.7	679.0	-121.4	297.7	712.7	-123.4	412.5
13	670.8	-135.3	291.6	670.8	-135.3	291.6	677.4	-124.4	235.0
14	681.5	-132.2	299.3	681.5	-132.2	299.3	675.6	-125.5	232.4
15	705.4	-116.7	318.1	705.4	-116.7	318.1	668.3	-118.3	225.6
16	687.8	-145.4	310.0	687.8	-145.4	310.0	674.2	-119.0	234.6
17	683.5	-131.1	302.1	683.5	-131.1	302.1	665.1	-131.1	224.5
18	684.5	-149.9	305.7	684.5	-149.9	305.7	719.8	-126.2	348.2
19	681.2	-124.4	298.3	681.2	-124.4	298.3	718.9	-128.3	382.3
20	687.0	-135.7	300.3	687.0	-135.7	300.3	665.3	-121.9	219.3
21	651.7	-132.2	299.6	651.7	-132.2	299.6	699.5	-132.8	314.4
22	681.6	-115.3	310.9	681.6	-115.3	310.9	706.4	-161.3	401.6

Test Condition	Target Locations for Subject 07: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	806.0	-110.7	117.5	871.1	-178.0	371.1	794.7	-149.1	81.9
2	821.7	-159.0	147.9	866.1	-141.0	365.8	787.4	-150.1	83.1
3	797.3	-171.5	131.4	824.6	-159.0	162.7	787.2	-158.0	98.9
4	797.2	-158.5	128.3	852.2	-134.3	242.1	852.2	-134.3	242.1
5	798.1	-105.9	140.5	851.0	-133.6	238.6	788.8	-109.8	101.8
6	797.1	-124.4	149.9	849.2	-171.2	340.1	783.6	-156.7	105.0
7	796.9	-129.1	128.6	833.2	-171.2	185.8	789.5	-136.5	86.3
8	799.2	-138.1	125.8	784.4	-136.1	73.5	784.4	-136.1	73.5
9	809.9	-94.4	134.6	787.9	-134.8	70.9	787.9	-134.8	70.9
10	799.4	-118.8	125.7	841.9	-107.2	191.1	785.7	-144.7	74.4
11	829.4	-161.7	177.5	789.5	-160.1	75.1	789.5	-160.1	75.1
12	854.9	-135.3	191.0	792.5	-114.1	70.6	792.5	-114.1	70.6
13	816.6	-136.8	129.9	795.3	-134.2	73.8	795.3	-134.2	73.8
14	807.3	-145.2	117.6	794.3	-142.3	72.7	794.3	-142.3	72.7
15	805.9	-128.6	114.2	789.9	-145.8	70.4	789.9	-145.8	70.4
16	809.4	-129.7	122.2	790.0	-176.2	75.0	790.0	-176.2	75.0
17	802.2	-141.8	112.6	797.0	-135.3	75.0	797.0	-135.3	75.0
18	804.7	-138.9	113.2	790.4	-141.4	70.2	790.4	-141.4	70.2
19	845.3	-135.4	177.9	790.5	-134.1	68.6	790.5	-134.1	68.6
20	805.1	-133.4	110.1	794.9	-134.3	71.8	794.9	-134.3	71.8
21	801.4	-96.8	130.1	844.7	-195.2	396.1	791.0	-130.2	82.0
22	831.0	-104.4	156.5	789.7	-128.5	69.6	789.7	-128.5	69.6
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	667.3	-111.4	225.5	696.2	-146.4	346.9	648.6	-133.7	180.1
2	672.7	-135.8	239.1	692.1	-125.3	344.6	643.3	-139.7	184.7
3	660.1	-148.2	240.3	668.4	-142.2	243.4	637.9	-140.3	190.7
4	660.0	-139.8	238.7	678.2	-125.2	283.8	678.2	-125.2	283.8
5	656.3	-103.5	245.1	676.4	-122.1	283.2	642.2	-115.8	197.2
6	652.0	-118.0	249.5	675.3	-145.0	333.9	635.4	-135.5	199.7
7	662.6	-117.7	238.5	673.2	-144.6	254.6	643.3	-130.3	184.9
8	660.3	-126.2	234.2	645.5	-129.6	181.5	645.5	-129.6	181.5
9	669.0	-103.3	239.0	648.2	-124.5	179.4	648.2	-124.5	179.4
10	660.8	-110.0	232.7	682.5	-110.9	257.5	645.9	-128.3	180.9
11	685.2	-136.7	254.3	647.9	-141.9	178.8	647.9	-141.9	178.8
12	692.1	-122.0	257.1	651.8	-111.6	177.8	651.8	-111.6	177.8
13	677.4	-124.4	235.0	653.7	-123.3	177.6	653.7	-123.3	177.6
14	675.6	-125.5	232.4	652.7	-130.6	176.3	652.7	-130.6	176.3
15	668.3	-118.3	225.6	650.8	-128.3	177.2	650.8	-128.3	177.2
16	674.2	-119.0	234.6	649.2	-146.8	178.2	649.2	-146.8	178.2
17	665.1	-131.1	224.5	653.5	-130.1	175.9	653.5	-130.1	175.9
18	666.8	-126.6	224.4	652.6	-124.4	177.2	652.6	-124.4	177.2
19	689.7	-127.2	254.7	650.6	-127.0	176.8	650.6	-127.0	176.8
20	665.3	-121.9	219.3	654.1	-128.5	175.9	654.1	-128.5	175.9
21	665.1	-99.5	239.6	676.5	-158.6	359.0	645.5	-129.0	181.5
22	678.1	-107.5	241.6	650.5	-122.6	178.3	650.5	-122.6	178.3

Reference Data Target locations for Subject 08

	x	y	z
Origin	249.0	-414.5	188.5
Reference	467.8	-397.9	129.0
Manubrium	396.8	-148.5	723.9
Xyphoid	317.2	-146.5	590.2
C7	554.1	-133.8	783.8
T4	568.8	-132.8	649.7
S1	438.1	-139.8	290.4
Left ASIS	300.2	-282.6	396.3
Left Lateral Femoral Condyle	-118.4	-386.5	415.6
Left Lateral Malleolis	-158.9	-333.8	38.3
Left Lateral Foot	-325.7	-361.5	-51.9

Test data for Subject 08 follows (coordinates in millimeters);

Subject
08

Probe Length
386.5

InterASIS Dist.
280

InterPSIS width
120

Heel to foot target dist.
245

Test Condition	TargetLocations: Origin			ref 2		
	x	y	z	x	y	z
1	x	x	x	x	x	x
2	152.7	-375.3	-27.3	503.8	-346.9	-25.4
3	152.5	-375.2	-27.2	503.8	-347.0	-25.4
4	152.7	-375.3	-27.3	503.8	-347.0	-25.4
5	152.3	-375.1	-27.1	503.7	-347.0	-25.4
6	152.7	-375.3	-27.3	503.8	-347.0	-25.4
7	152.6	-375.3	-27.3	503.8	-346.9	-25.5
8	152.6	-375.3	-27.3	503.8	-347.0	-25.5
9	152.6	-375.2	-27.1	503.8	-347.0	-25.4
10	152.6	-375.3	-27.2	503.8	-347.0	-25.5
11	152.6	-375.3	-27.3	503.7	-347.0	-25.4
12	152.7	-375.3	-27.3	503.8	-346.9	-25.4
13	152.6	-375.3	-27.2	503.7	-346.9	-25.5
14	152.6	-375.1	-27.2	503.8	-347.0	-25.5
15	152.7	-375.3	-27.3	503.8	-347.0	-25.5
16	152.4	-375.1	-27.1	503.8	-346.9	-25.4
17	152.7	-375.3	-27.3	503.8	-346.9	-25.5
18	152.7	-375.3	-27.3	503.8	-346.9	-25.4
19	152.7	-375.3	-27.2	503.8	-346.9	-25.5
20	152.7	-375.3	-27.2	503.8	-347.0	-25.4
21	152.6	-375.2	-27.1	503.8	-346.9	-25.4
22	152.6	-375.2	-27.3	503.8	-347.0	-25.5

Test Condition	TargetLocations: Elbow			Wrist		
	x	y	z	x	y	z
1	x	x	x	x	x	x
2	538.7	-330.4	409.8	316.7	-290.9	556.9
3	543.7	-340.0	405.6	313.4	-284.4	533.7
4	540.9	-343.4	413.9	304.5	-294.2	537.8
5	542.9	-343.4	416.2	298.5	-302.6	544.6
6	535.1	-346.0	429.0	282.7	-314.8	541.3
7	541.0	-343.5	425.1	297.0	-305.1	540.5
8	545.7	-335.1	426.1	300.7	-309.3	543.4
9	554.3	-335.5	415.6	322.9	-272.7	538.4
10	553.9	-334.9	415.2	320.2	-281.2	538.2
11	547.3	-336.2	413.6	328.6	-276.8	556.9
12	538.7	-330.4	409.8	316.7	-290.9	556.9
13	538.8	-340.5	416.0	313.6	-305.4	559.5
14	541.6	-335.5	419.4	312.5	-300.6	558.6
15	543.9	-328.5	409.2	320.1	-294.1	555.3
16	539.3	-344.1	407.8	322.6	-280.1	555.1
17	541.8	-339.1	406.3	327.4	-279.2	556.2
18	538.7	-330.4	409.8	316.7	-290.9	556.9
19	543.3	-342.5	413.0	320.0	-293.2	556.5
20	536.9	-322.0	409.6	312.5	-296.3	556.5
21	547.2	-323.8	417.2	321.4	-287.1	558.7
22	541.5	-331.6	410.7	316.1	-297.7	554.5

Test Condition	TargetLocations: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	504.5	-35.4	725.0	427.3	-36.6	589.4	403.1	-180.8	402.4
3	511.6	-42.7	721.4	429.2	-45.7	589.9	393.9	-191.5	409.9
4	553.8	-47.7	728.6	448.5	-51.6	614.9	390.3	-195.2	410.3
5	555.8	-42.6	727.7	448.1	-48.1	615.9	388.7	-198.0	407.9
6	588.6	-38.7	728.5	464.1	-44.0	633.5	387.6	-196.0	411.3
7	569.0	-42.9	733.4	455.7	-47.9	626.0	398.6	-197.3	406.6
8	579.7	-33.6	734.4	463.0	-42.7	628.5	400.5	-192.4	406.7
9	517.1	-35.0	730.4	432.4	-39.0	599.4	406.5	-187.2	409.2
10	515.8	-35.3	726.5	431.7	-39.2	597.3	344.3	-388.2	455.2
11	509.3	-36.6	721.9	432.3	-41.9	587.4	409.1	-190.4	400.2
12	504.5	-35.4	725.0	427.3	-36.6	589.4	403.1	-180.8	402.4
13	513.0	-43.3	727.0	430.5	-43.1	595.2	408.7	-190.3	401.9
14	508.6	-41.2	728.1	429.6	-40.9	594.3	405.3	-185.0	403.9
15	515.0	-32.4	723.2	436.2	-33.2	588.9	406.6	-174.6	405.1
16	517.3	-46.2	715.8	440.7	-46.7	581.4	411.2	-188.7	404.6
17	519.8	-43.4	718.7	440.3	-45.5	585.3	409.9	-188.0	405.1
18	504.5	-35.4	725.0	427.3	-36.6	589.4	403.1	-180.8	402.4
19	525.5	-44.7	725.7	439.8	-46.3	597.0	407.5	-191.2	403.8
20	514.9	-26.9	722.4	433.7	-28.3	589.1	408.5	-169.1	405.3
21	520.3	-26.2	729.0	431.8	-28.3	600.3	397.0	-175.1	406.9
22	506.8	-37.1	726.4	429.1	-36.2	592.2	403.7	-175.7	407.5

Test Condition	TargetLocations: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	-23.4	-285.2	376.7	0.0	0.0	0.0	0.0	0.0	0.0
3	-51.6	-281.0	367.1	-442.9	-324.9	91.4	0.0	0.0	0.0
4	-50.4	-276.6	369.7	-263.6	-296.8	21.7	-445.8	-324.8	96.8
5	-47.4	-277.7	370.8	-252.7	-256.0	22.0	-440.5	-298.4	74.8
6	-52.6	-280.2	358.9	0.0	0.0	0.0	-443.8	-316.5	94.5
7	-39.4	-280.0	351.3	0.0	0.0	0.0	-447.5	-326.6	104.3
8	-24.6	-295.7	344.3	0.0	0.0	0.0	-442.1	-325.5	87.6
9	-34.9	-258.2	354.2	0.0	0.0	0.0	-445.3	-309.7	95.8
10	-36.9	-288.5	349.6	0.0	0.0	0.0	-445.8	-299.6	91.2
11	-33.1	-286.7	343.3	-287.8	-248.9	21.1	-445.2	-304.5	92.9
12	-23.4	-285.2	376.7	0.0	0.0	0.0	0.0	0.0	0.0
13	-27.0	-306.3	334.8	0.0	0.0	0.0	-444.2	-326.2	94.7
14	-37.2	-270.7	355.0	0.0	0.0	0.0	-458.2	-278.8	109.8
15	-32.3	-271.2	343.0	0.0	0.0	0.0	-449.3	-310.3	104.1
16	-36.6	-275.3	350.8	-290.1	-269.0	25.9	-450.1	-309.8	104.4
17	-37.7	-267.2	350.7	-284.5	-230.8	22.1	-446.9	-276.1	88.8
18	-23.4	-285.2	376.7	0.0	0.0	0.0	0.0	0.0	0.0
19	-31.2	-284.4	351.7	-274.9	-247.0	23.1	-445.0	-284.7	80.8
20	-34.3	-263.6	350.9	0.0	0.0	0.0	-448.6	-307.9	102.6
21	-30.6	-296.4	351.6	0.0	0.0	0.0	-441.1	-326.3	85.1
22	-33.4	-259.0	350.5	-286.0	-232.1	17.2	-443.5	-308.6	97.0

Test Condition	Target Locations for Subject 08:								
	Probe- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	845.0	-507.6	779.2	904.0	-41.2	243.1	904.0	-41.2	243.1
3	830.5	-456.4	908.9	920.5	-17.1	257.3	920.5	-17.1	257.3
4	881.5	-505.9	800.2	930.4	-15.3	267.3	930.4	-15.3	267.3
5	936.1	-449.6	808.8	929.0	16.3	269.5	929.0	16.3	269.5
6	940.8	-495.4	749.2	939.8	-5.6	275.6	939.8	-5.6	275.6
7	916.0	-492.8	784.7	929.2	-30.5	264.7	929.2	-30.5	264.7
8	905.7	-486.2	832.7	924.5	-22.8	255.3	924.5	-22.8	255.3
9	899.6	-441.2	831.1	900.4	-23.5	241.1	900.4	-23.5	241.1
10	893.1	-447.1	823.5	912.8	-11.8	251.6	912.8	-11.8	251.6
11	862.7	-460.2	869.6	907.4	-35.1	238.3	907.4	-35.1	238.3
12	845.0	-507.6	779.2	904.0	-41.2	243.1	904.0	-41.2	243.1
13	856.0	-511.0	786.9	906.5	-24.7	243.1	906.5	-24.7	243.1
14	818.8	-518.2	853.7	900.4	3.4	241.8	900.4	3.4	241.8
15	853.9	-460.8	871.5	905.0	-5.0	234.8	905.0	-5.0	234.8
16	796.3	-518.3	887.7	917.6	-31.7	232.1	917.6	-31.7	232.1
17	846.2	-510.6	826.1	929.0	-10.8	244.2	929.0	-10.8	244.2
18	845.0	-507.6	779.2	904.0	-41.2	243.1	904.0	-41.2	243.1
19	786.2	-547.9	830.3	915.2	-47.6	240.2	915.2	-47.6	240.2
20	776.7	-521.4	854.9	906.2	-1.2	235.9	906.2	-1.2	235.9
21	880.7	-428.1	878.2	909.7	22.8	253.1	909.7	22.8	253.1
22	831.4	-484.3	868.1	901.5	-26.9	242.6	901.5	-26.9	242.6
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	726.9	-378.0	758.3	775.8	-33.3	362.9	775.8	-33.3	362.9
3	716.7	-349.5	826.1	784.3	-25.1	369.2	784.3	-25.1	369.2
4	772.3	-383.8	767.9	788.4	-26.9	372.1	788.4	-26.9	372.1
5	807.5	-346.3	770.4	788.0	-7.7	372.5	788.0	-7.7	372.5
6	828.1	-371.4	733.1	794.8	-19.6	374.3	794.8	-19.6	374.3
7	802.5	-372.3	758.9	789.3	-34.2	371.5	789.3	-34.2	371.5
8	801.0	-363.8	786.7	783.4	-23.3	361.7	783.4	-23.3	361.7
9	761.1	-340.5	787.8	774.1	-25.1	363.2	774.1	-25.1	363.2
10	756.8	-341.2	784.2	778.4	-18.9	364.0	778.4	-18.9	364.0
11	738.6	-350.0	808.3	780.7	-33.6	360.1	780.7	-33.6	360.1
12	726.9	-378.0	758.3	775.8	-33.3	362.9	775.8	-33.3	362.9
13	736.6	-382.7	763.6	778.4	-28.4	362.7	778.4	-28.4	362.7
14	717.6	-382.9	800.9	774.7	-13.2	361.8	774.7	-13.2	361.8
15	733.3	-348.5	807.2	779.8	-13.6	357.8	779.8	-13.6	357.8
16	704.8	-386.8	813.5	790.9	-34.6	353.4	790.9	-34.6	353.4
17	733.1	-382.3	780.7	793.3	-21.8	355.5	793.3	-21.8	355.5
18	726.9	-378.0	758.3	775.8	-33.3	362.9	775.8	-33.3	362.9
19	700.5	-399.7	785.1	785.6	-41.6	358.4	785.6	-41.6	358.4
20	692.4	-376.3	798.8	780.1	-7.6	357.9	780.1	-7.6	357.9
21	752.3	-324.9	813.3	779.1	3.5	369.1	779.1	3.5	369.1
22	718.5	-363.4	806.5	774.6	-27.3	363.8	774.6	-27.3	363.8

Test Condition	Target Locations for Subject 08:								
	Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	981.4	4.3	371.4	838.3	17.0	148.3	919.6	5.6	236.4
3	821.6	-29.9	138.9	821.6	-29.9	138.9	937.1	33.6	381.3
4	820.1	-8.8	146.1	820.1	-8.8	146.1	932.8	1.3	407.1
5	977.9	-0.3	378.9	844.2	-21.9	166.7	890.7	-14.8	233.9
6	819.7	-12.5	145.4	819.7	-12.5	145.4	890.4	-7.3	235.9
7	985.3	-1.7	415.0	819.7	1.8	149.2	897.3	25.2	245.3
8	820.9	-0.3	148.9	820.9	-0.3	148.9	921.5	42.9	413.8
9	967.9	32.1	348.4	819.6	-4.5	136.5	938.0	38.9	328.6
10	959.7	10.2	318.0	852.8	2.9	164.9	906.8	21.9	231.2
11	989.2	19.5	379.4	886.3	1.9	185.3	934.4	53.6	281.5
12	981.4	4.3	371.4	838.3	17.0	148.3	919.6	5.6	236.4
13	986.6	-11.2	390.5	815.2	-11.5	128.7	914.5	24.1	224.8
14	983.1	1.7	377.7	851.9	3.5	158.8	932.7	23.4	271.3
15	990.8	3.2	385.3	849.1	21.5	152.0	935.3	81.5	326.5
16	807.4	-23.3	112.4	807.4	-23.3	112.4	943.4	23.2	276.7
17	806.5	-8.1	113.6	806.5	-8.1	113.6	938.4	58.1	284.3
18	981.4	4.3	371.4	838.3	17.0	148.3	919.6	5.6	236.4
19	986.1	23.8	369.8	864.3	-31.3	160.0	899.4	6.3	190.5
20	986.3	26.8	364.2	901.8	71.9	217.1	934.1	48.3	268.8
21	979.3	-3.9	370.1	837.0	0.5	150.3	912.3	1.0	241.9
22	978.0	10.7	362.8	819.8	6.9	133.8	943.7	42.2	372.5
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x	x	x	x
2	811.3	-4.8	419.1	727.2	0.4	284.6	761.1	-5.5	313.5
3	716.2	-30.1	281.3	716.2	-30.1	281.3	759.6	8.2	388.4
4	713.7	-23.8	289.3	713.7	-23.8	289.3	755.9	-14.2	403.4
5	807.4	-15.2	423.8	719.7	-28.0	292.1	733.6	-22.3	313.4
6	714.1	-24.2	288.6	714.1	-24.2	288.6	731.8	-17.9	314.5
7	809.5	-12.5	442.7	713.4	-13.8	289.6	739.0	-1.8	318.2
8	714.1	-10.0	289.5	714.1	-10.0	289.5	748.8	7.5	401.4
9	803.2	7.8	407.7	716.7	-11.8	280.9	765.8	8.2	356.5
10	801.7	-3.3	395.6	729.6	-10.3	291.1	749.9	0.5	309.9
11	818.1	0.2	422.7	754.8	-12.5	302.6	768.5	16.6	330.6
12	811.3	-4.8	419.1	727.2	0.4	284.6	761.1	-5.5	313.5
13	814.9	-18.4	431.3	711.8	-16.5	271.2	757.3	0.6	302.9
14	812.1	-10.4	422.6	734.7	-12.1	289.5	765.9	-0.8	325.6
15	819.8	-4.3	425.9	733.3	5.7	284.0	767.4	35.0	354.1
16	718.2	-28.5	264.3	718.2	-28.5	264.3	775.9	-0.7	327.6
17	716.0	-19.8	264.5	716.0	-19.8	264.5	772.9	18.5	332.1
18	811.3	-4.8	419.1	727.2	0.4	284.6	761.1	-5.5	313.5
19	818.0	-0.3	417.1	741.6	-32.9	287.2	753.4	-13.4	289.1
20	817.0	9.9	414.0	761.4	32.8	317.8	768.6	22.7	325.4
21	809.5	-7.5	418.7	721.9	-7.1	283.9	751.5	-6.5	314.1
22	809.0	-0.4	415.1	718.9	-4.9	280.2	768.1	14.2	380.0

Test Condition	Target Locations for Subject 08: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x	x	x			
2	832.2	23.0	100.3	820.7	20.3	59.6	820.7	20.3	59.6
3	837.2	-2.0	125.3	832.1	-3.7	97.8	832.1	-3.7	97.8
4	848.6	-28.9	145.8	829.7	-23.9	90.4	829.7	-23.9	90.4
5	827.8	-12.8	130.7	828.5	-10.3	91.2	828.5	-10.3	91.2
6	823.8	0.5	132.0	826.0	17.3	102.7	826.0	17.3	102.7
7	824.7	-0.4	119.1	815.3	-2.1	67.7	815.3	-2.1	67.7
8	921.5	42.9	413.8	813.3	-2.5	62.3	813.3	-2.5	62.3
9	938.0	38.9	328.6	821.5	5.9	56.9	821.5	5.9	56.9
10	828.6	15.5	107.1	819.8	-2.1	62.6	819.8	-2.1	62.6
11	853.6	17.5	114.6	822.1	-3.9	56.4	822.1	-3.9	56.4
12	832.2	23.0	100.3	820.7	20.3	59.6	820.7	20.3	59.6
13	832.3	-14.0	94.0	835.8	-4.2	63.7	835.8	-4.2	63.7
14	836.1	26.2	102.9	830.7	18.6	62.3	830.7	18.6	62.3
15	852.3	27.4	118.5	818.3	68.9	60.3	818.3	68.9	60.3
16	865.7	14.2	122.3	831.3	23.8	64.1	831.3	23.8	64.1
17	856.2	31.7	116.4	828.4	41.8	61.6	828.4	41.8	61.6
18	832.2	23.0	100.3	820.7	20.3	59.6	820.7	20.3	59.6
19	830.4	14.8	96.4	824.5	-11.2	54.9	824.5	-11.2	54.9
20	832.0	48.5	95.1	821.5	84.1	70.8	821.5	84.1	70.8
21	826.0	63.0	116.5	816.0	19.2	63.2	816.0	19.2	63.2
22	943.7	42.2	372.5	910.2	40.1	254.7	820.6	17.0	55.6
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	x	x	x	x					
2	705.0	2.2	221.1	685.4	-3.3	170.1	685.4	-3.3	170.1
3	701.6	-12.3	237.4	683.1	-18.2	190.3	683.1	-18.2	190.3
4	704.7	-31.3	250.0	681.6	-35.2	186.7	681.6	-35.2	186.7
5	691.5	-20.2	242.5	680.5	-25.5	186.6	680.5	-25.5	186.6
6	687.0	-9.1	243.8	675.9	-11.0	190.9	675.9	-11.0	190.9
7	690.2	-12.9	233.0	678.1	-22.0	176.7	678.1	-22.0	176.7
8	748.8	7.5	401.4	678.5	-20.4	174.8	678.5	-20.4	174.8
9	765.8	8.2	356.5	686.2	-10.2	168.8	686.2	-10.2	168.8
10	697.7	-4.7	224.8	686.1	-16.4	176.3	686.1	-16.4	176.3
11	712.7	-1.6	222.2	690.8	-20.1	173.0	690.8	-20.1	173.0
12	705.0	2.2	221.1	685.4	-3.3	170.1	685.4	-3.3	170.1
13	708.0	-21.2	218.5	694.9	-19.5	170.4	694.9	-19.5	170.4
14	706.6	-0.6	220.2	693.7	-7.1	171.1	693.7	-7.1	171.1
15	715.6	4.6	227.9	685.6	23.1	168.3	685.6	23.1	168.3
16	727.0	-7.3	232.9	691.2	-6.0	166.5	691.2	-6.0	166.5
17	720.4	1.7	225.6	694.5	2.8	169.8	694.5	2.8	169.8
18	705.0	2.2	221.1	685.4	-3.3	170.1	685.4	-3.3	170.1
19	706.2	-9.0	219.1	690.5	-30.3	167.8	690.5	-30.3	167.8
20	706.4	23.2	217.8	686.6	33.7	173.6	686.6	33.7	173.6
21	699.8	24.9	232.2	680.0	-2.3	173.2	680.0	-2.3	173.2
22	768.1	14.2	380.0	739.7	7.5	289.1	686.3	-4.8	167.6

Reference Data Target locations for Subject 09

	x	y	z
Origin	-56.1	-232.6	194.1
Reference	167.2	-214.5	129.5
Manubrium	143.0	52.2	724.3
Xyphoid	66.8	48.6	606.4
C7	305.0	58.3	762.7
T4	300.5	56.0	666.0
S1	142.7	32.7	286.7
Left ASIS	-28.0	-83.7	378.2
Left Lateral Femoral Condyle	-411.6	-144.7	387.7
Left Lateral Malleolis	-506.7	-92.8	25.7
Left Lateral Foot	-682.6	-114.7	-14.2

Test data for Subject 09 follows (coordinates in millimeters);

Subject	Test Condition	Target Locations for Subject 09: Origin x	y	z	ref 2 x	y	z
09	1	-202.4	-267.5	-26.2	149.6	-254.8	-25.1
	2	-202.4	-267.5	-26.2	149.6	-254.8	-25.0
Probe Length	3	-202.4	-267.5	-26.2	149.7	-254.9	-25.1
376	4	-202.4	-267.5	-26.1	149.7	-254.9	-25.1
	5	-202.4	-267.5	-26.1	149.3	-254.6	-25.3
InterASIS Dist.	6	-202.4	-267.5	-26.2	149.5	-254.9	-25.0
245	7	-202.4	-267.5	-26.2	149.7	-254.7	-25.2
	8	-202.4	-267.4	-26.3	149.7	-254.9	-25.0
InterPSIS width	9	-202.4	-267.4	-26.2	149.7	-254.8	-25.1
95	10	-202.4	-267.5	-26.2	149.6	-254.9	-25.0
	11	-202.4	-267.5	-26.2	149.6	-254.8	-25.1
Heel to foot target dis	12	-202.5	-267.5	-26.2	149.6	-254.8	-25.1
target dist.	13	-202.4	-267.3	-26.2	149.7	-254.8	-25.1
225	14	-202.4	-267.3	-26.3	149.7	-254.8	-25.0
	15	-202.4	-267.3	-26.2	149.7	-254.8	-25.0
	16	-202.4	-267.4	-26.2	149.7	-254.8	-25.0
	17	-202.4	-267.4	-26.2	149.6	-254.8	-25.1
	18	-202.4	-267.4	-26.3	149.6	-254.7	-25.1
	19	-202.4	-267.4	-26.3	149.7	-254.8	-25.1
	20	-202.5	-267.3	-26.3	149.6	-254.7	-25.0
	21	-202.5	-267.3	-26.3	149.7	-254.6	-25.1
	22	-202.4	-267.3	-26.2	149.7	-254.6	-25.2

Test Condition	Target Locations for Subject 09: Elbow x	y	z	Wrist x	y	z
1	159.7	-239.3	461.4	-38.2	-193.8	562.4
2	162.5	-243.5	471.9	-30.6	-182.2	570.1
3	154.4	-261.7	462.7	-32.9	-188.5	565.5
4	156.8	-244.0	467.7	-37.3	-185.1	566.1
5	169.5	-239.0	465.0	-22.9	-176.9	563.7
6	167.2	-244.0	470.7	-23.5	-171.1	563.8
7	163.8	-254.7	469.9	-29.4	-195.2	568.9
8	170.2	-239.7	467.7	-22.1	-174.4	564.4
9	160.8	-246.6	470.5	-29.0	-175.0	566.9
10	158.3	-247.7	456.9	-26.2	-177.7	563.8
11	158.7	-231.3	445.0	-24.5	-181.1	563.0
12	158.8	-225.9	457.7	-31.6	-175.8	563.8
13	161.4	-242.5	459.2	-25.3	-176.5	563.6
14	159.1	-241.8	458.7	-25.8	-172.6	563.6
15	157.1	-232.1	448.6	-25.5	-166.9	559.5
16	156.7	-230.2	436.1	-17.2	-155.1	554.0
17	155.2	-222.6	440.8	-23.2	-160.4	557.2
18	152.4	-218.5	445.9	-34.0	-178.7	561.0
19	165.8	-235.2	453.4	-22.5	-182.6	563.0
20	150.2	-242.1	443.6	-25.5	-168.5	558.9
21	165.1	-234.9	457.6	-20.5	-167.5	562.3
22	161.3	-224.1	460.9	-29.6	-168.8	563.9

Test Condition	Target Locations for Subject 09: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	206.1	47.7	732.1	124.7	44.5	615.5	32.8	-95.9	388.6
2	210.3	49.7	734.1	125.9	44.8	621.2	21.7	-93.5	391.4
3	209.2	23.2	728.7	124.3	18.9	615.0	9.7	-115.8	399.3
4	211.8	42.2	737.2	125.5	39.0	625.7	11.5	-92.9	394.2
5	212.7	43.6	747.5	122.5	43.5	640.9	13.1	-89.1	396.8
6	220.7	41.0	743.8	125.5	38.2	641.0	10.4	-93.2	393.6
7	215.8	32.4	743.1	122.7	29.2	636.1	22.5	-100.6	388.7
8	210.5	47.3	744.4	118.5	44.3	636.8	28.4	-91.9	385.9
9	211.7	38.9	740.3	125.4	34.4	627.2	28.2	-97.1	385.4
10	210.1	31.5	738.2	123.7	29.0	625.2	21.6	-101.4	387.2
11	186.3	48.9	725.6	116.4	45.9	601.8	36.9	-87.4	384.1
12	203.4	55.3	733.3	126.2	53.7	613.1	33.5	-83.0	385.6
13	207.1	43.0	732.5	126.8	40.0	614.3	35.3	-96.9	387.3
14	205.2	43.1	730.8	125.6	37.8	611.7	37.8	-103.3	385.3
15	189.5	49.3	726.7	116.6	44.1	603.6	41.4	-91.6	384.0
16	165.0	48.4	717.2	107.9	44.5	583.8	41.7	-91.2	388.4
17	172.2	51.1	725.3	109.7	49.2	595.1	43.4	-88.2	387.8
18	170.9	60.2	725.4	110.5	59.4	595.8	33.0	-77.1	390.0
19	186.5	53.3	728.6	115.9	49.8	604.7	38.1	-87.0	392.9
20	180.6	32.4	718.9	116.7	29.5	591.7	34.9	-100.8	393.7
21	205.8	46.1	737.6	121.5	45.4	623.7	20.8	-82.6	388.3
22	206.7	59.2	733.0	126.2	57.9	617.3	30.8	-78.9	384.6

Test Condition	Target Locations for Subject 09: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-364.8	-181.5	313.6	0.0	0.0	0.0	-765.4	-198.5	82.7
2	-378.1	-161.7	317.1	0.0	0.0	0.0	-764.7	-164.4	96.1
3	-396.1	-183.0	315.4	0.0	0.0	0.0	-769.5	-159.8	112.5
4	-377.0	-177.3	320.0	-618.9	-154.3	4.9	-764.7	-172.3	83.3
5	-374.2	-154.4	320.0	-620.1	-148.7	6.3	-766.0	-168.4	84.5
6	-373.3	-174.8	319.9	-621.2	-158.0	7.4	-765.0	-176.1	90.5
7	-363.6	-183.5	319.8	-613.7	-179.2	6.2	-764.7	-187.9	85.2
8	-365.3	-170.7	318.6	-613.3	-163.5	3.2	-764.8	-178.9	86.1
9	-359.1	-185.2	314.1	-613.0	-179.2	5.1	-764.7	-191.1	82.6
10	-369.6	-188.4	314.4	0.0	0.0	0.0	-766.0	-196.5	95.6
11	-359.6	-188.0	306.5	-615.1	-160.8	2.5	-767.7	-164.5	78.8
12	-360.8	-158.7	314.2	0.0	0.0	0.0	-763.5	-173.0	83.3
13	-363.2	-177.4	313.8	0.0	0.0	0.0	-761.4	-202.2	84.9
14	-363.4	-180.1	314.4	0.0	0.0	0.0	-761.0	-204.2	84.9
15	-360.7	-172.3	308.4	0.0	0.0	0.0	-763.0	-184.0	84.3
16	-362.4	-169.1	312.5	-616.2	-151.8	6.1	-764.6	-165.3	82.7
17	-353.1	-184.5	309.7	0.0	0.0	0.0	-759.0	-214.0	83.2
18	-359.9	-160.8	312.1	0.0	0.0	0.0	-763.9	-173.6	85.3
19	-363.7	-162.2	314.3	-615.0	-150.7	7.1	-762.4	-167.3	86.1
20	-365.5	-173.2	310.7	0.0	0.0	0.0	-765.0	-177.6	90.3
21	-371.8	-168.4	314.8	-620.5	-150.3	7.8	-765.7	-160.6	85.9
22	-365.0	-157.7	315.8	0.0	0.0	0.0	-762.1	-182.4	83.9

Test Condition	Target Locations for Subject 09:								
	Probe1- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	533.6	-385.7	834.5	639.5	63.2	451.1	639.5	63.2	451.1
2	503.8	-375.3	912.4	588.8	8.1	298.1	588.8	8.1	298.1
3	484.6	-414.6	910.8	597.8	14.6	299.4	512.7	65.9	195.1
4	514.5	-400.1	868.5	591.4	14.4	307.5	591.4	14.4	307.5
5	485.0	-411.4	884.1	571.5	43.7	302.9	571.5	43.7	302.9
6	532.5	-363.9	913.9	577.3	13.0	311.7	577.3	13.0	311.7
7	558.1	-385.9	823.1	577.5	91.3	327.2	577.5	91.3	327.2
8	514.1	-397.4	870.9	572.2	44.6	306.9	572.2	44.6	306.9
9	464.5	-384.8	957.9	614.2	4.1	372.4	614.2	4.1	372.4
10	425.8	-456.3	882.4	586.5	27.0	301.3	586.5	27.0	301.3
11	493.8	-353.4	896.8	611.2	38.3	304.1	611.2	38.3	304.1
12	436.9	-372.8	953.7	616.3	57.8	326.8	616.3	57.8	326.8
13	452.7	-421.4	897.0	622.2	36.3	338.1	622.2	36.3	338.1
14	493.8	-399.8	870.6	601.1	19.0	296.5	601.1	19.0	296.5
15	450.4	-399.3	892.6	632.4	57.3	343.3	632.4	57.3	343.3
16	434.4	-395.3	879.8	627.7	3.9	326.5	627.7	3.9	326.5
17	419.4	-384.1	917.7	606.2	60.6	302.3	606.2	60.6	302.3
18	449.6	-387.4	864.0	621.1	41.7	327.5	621.1	41.7	327.5
19	424.4	-423.5	874.0	625.1	44.3	327.4	625.1	44.3	327.4
20	381.8	-423.9	933.3	613.4	43.5	300.5	613.4	43.5	300.5
21	517.3	-367.9	887.9	586.7	25.8	302.9	586.7	25.8	302.9
22	426.6	-416.4	902.1	608.5	23.0	327.6	608.5	23.0	327.6
Test Condition	(probe target 2)			(probe target 2)			(probe target 2)		
	x	y	z	x	y	z	x	y	z
1	412.8	-266.7	788.9	464.6	56.6	465.9	464.6	56.6	465.9
2	399.1	-259.1	833.1	440.3	24.9	393.4	440.3	24.9	393.4
3	388.4	-292.2	829.2	446.2	18.7	391.3	384.0	47.2	317.5
4	402.8	-276.7	808.2	438.7	28.4	397.1	438.7	28.4	397.1
5	386.8	-280.4	820.0	424.6	44.8	401.9	424.6	44.8	401.9
6	419.7	-254.6	834.5	429.7	26.3	407.9	429.7	26.3	407.9
7	426.6	-274.2	787.0	425.9	62.3	412.3	425.9	62.3	412.3
8	405.6	-272.2	812.1	423.1	43.6	403.0	423.1	43.6	403.0
9	377.1	-267.9	859.6	447.4	20.9	428.1	447.4	20.9	428.1
10	352.4	-311.0	814.9	436.8	29.0	395.9	436.8	29.0	395.9
11	375.4	-248.3	820.7	460.2	43.4	395.2	460.2	43.4	395.2
12	358.0	-251.3	853.7	459.4	59.4	409.0	459.4	59.4	409.0
13	368.3	-285.0	823.6	461.8	42.6	411.8	461.8	42.6	411.8
14	386.1	-275.5	809.4	450.9	26.2	390.0	450.9	26.2	390.0
15	354.4	-270.9	821.0	468.7	53.4	408.7	468.7	53.4	408.7
16	331.8	-270.3	810.3	470.3	24.1	403.2	470.3	24.1	403.2
17	327.4	-258.8	834.2	454.1	58.8	393.2	454.1	58.8	393.2
18	344.9	-258.7	805.5	462.9	53.6	404.6	462.9	53.6	404.6
19	339.6	-281.4	812.1	465.6	48.2	405.3	465.6	48.2	405.3
20	314.3	-289.3	840.8	461.2	42.1	391.3	461.2	42.1	391.3
21	399.7	-255.4	819.4	436.4	37.8	396.0	436.4	37.8	396.0
22	351.7	-275.7	827.8	449.6	41.7	404.4	449.6	41.7	404.4

Test Condition	Target Locations for Subject 09: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	543.6	57.4	211.5	543.6	57.4	211.5	510.5	22.9	140.5
2	516.0	61.3	194.1	516.0	61.3	194.1	484.4	11.5	127.4
3	537.3	73.9	223.3	537.3	73.9	223.3	489.8	93.1	157.6
4	526.0	71.1	215.0	526.0	71.1	215.0	475.5	49.7	138.0
5	603.3	31.6	388.5	506.7	84.4	221.4	564.5	64.0	328.4
6	610.9	29.3	424.3	506.9	70.3	221.9	564.5	64.0	328.4
7	615.9	-6.4	458.8	525.3	69.0	229.5	474.9	73.0	141.9
8	615.4	72.0	422.5	512.8	55.5	216.2	463.7	37.8	125.3
9	530.2	51.8	212.5	530.2	51.8	212.5	493.8	36.7	135.8
10	631.5	1.3	491.4	523.1	54.8	212.0	575.9	77.6	301.1
11	514.2	31.0	167.6	514.2	31.0	167.6	484.3	22.9	98.3
12	638.4	47.1	398.6	533.1	64.7	193.5	472.9	59.7	102.4
13	515.6	52.0	179.3	515.6	52.0	179.3	492.1	49.5	112.5
14	523.6	52.9	182.0	523.6	52.9	182.0	499.6	37.9	112.7
15	557.9	62.6	203.3	557.9	62.6	203.3	518.1	64.6	126.6
16	551.9	40.3	191.5	551.9	40.3	191.5	529.6	80.8	135.8
17	527.4	56.5	180.9	527.4	56.5	180.9	484.5	59.0	100.1
18	528.9	54.5	179.7	528.9	54.5	179.7	521.0	85.1	140.5
19	554.2	55.2	205.7	554.2	55.2	205.7	520.3	73.2	136.7
20	528.0	63.9	174.3	528.0	63.9	174.3	488.3	41.6	98.1
21	631.8	50.8	457.5	535.5	89.0	221.6	583.5	69.3	315.5
22	509.0	35.5	187.3	509.0	35.5	187.3	601.7	78.3	336.1
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	404.3	50.8	321.0	404.3	50.8	321.0	376.3	32.6	253.9
2	386.9	55.4	316.5	386.9	55.4	316.5	356.1	24.1	249.4
3	397.3	46.8	328.4	397.3	46.8	328.4	352.0	54.9	260.6
4	388.4	55.8	328.1	388.4	55.8	328.1	345.2	43.6	260.2
5	433.9	43.8	437.6	374.5	68.8	338.6	394.0	54.1	375.6
6	437.3	38.1	456.7	375.0	54.0	339.0	394.0	54.1	375.6
7	440.8	12.6	474.6	382.4	52.5	337.5	343.9	53.9	263.7
8	439.6	63.6	456.3	379.5	48.9	335.7	343.8	38.3	256.4
9	393.7	42.2	324.9	393.7	42.2	324.9	361.5	34.4	253.7
10	455.9	16.6	488.9	389.3	42.7	327.6	409.5	55.3	358.3
11	396.3	40.9	297.6	396.3	40.9	297.6	366.9	31.9	229.5
12	466.0	56.0	438.5	398.2	65.8	309.8	356.2	57.5	235.4
13	395.8	49.3	308.1	395.8	49.3	308.1	364.1	45.8	235.5
14	400.3	41.4	308.0	400.3	41.4	308.0	368.8	36.9	233.2
15	419.4	53.4	313.4	419.4	53.4	313.4	382.3	53.2	239.9
16	420.1	43.9	310.4	420.1	43.9	310.4	394.7	64.8	249.0
17	401.6	55.8	305.1	401.6	55.8	305.1	365.1	55.7	229.8
18	404.5	56.5	304.6	404.5	56.5	304.6	386.8	71.4	253.6
19	418.4	53.2	319.1	418.4	53.2	319.1	386.1	62.0	252.1
20	400.8	55.2	295.8	400.8	55.2	295.8	368.4	39.2	227.5
21	455.1	53.5	470.6	393.1	72.2	328.9	414.9	60.5	367.5
22	387.2	47.7	314.9	387.2	47.7	314.9	427.5	68.8	371.9

Test Condition	Target Locations for Subject 09: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	510.5	22.9	140.5	494.2	70.8	105.4	494.2	70.8	105.4
2	484.4	11.5	127.4	474.7	136.1	119.8	474.7	136.1	119.8
3	489.8	93.1	157.6	507.3	-3.4	185.3	507.3	-3.4	185.3
4	475.5	49.7	138.0	489.5	78.8	136.7	489.5	78.8	136.7
5	463.7	71.8	145.1	542.0	68.8	272.6	495.9	52.3	144.3
6	463.7	71.8	145.1	542.0	68.8	272.6	495.9	52.3	144.3
7	474.9	73.0	141.9	480.9	55.0	100.1	480.9	55.0	100.1
8	463.7	37.8	125.3	496.7	87.1	125.5	496.7	87.1	125.5
9	493.8	36.7	135.8	500.6	92.7	122.5	500.6	92.7	122.5
10	486.4	42.8	134.1	489.9	84.9	119.5	489.9	84.9	119.5
11	484.3	22.9	98.3	504.1	70.4	102.0	504.1	70.4	102.0
12	472.9	59.7	102.4	484.9	90.8	83.7	484.9	90.8	83.7
13	492.1	49.5	112.5	485.9	72.9	80.0	485.9	72.9	80.0
14	499.6	37.9	112.7	492.1	58.2	83.9	492.1	58.2	83.9
15	518.1	64.6	126.6	493.9	59.4	81.7	493.9	59.4	81.7
16	529.6	80.8	135.8	510.0	49.0	101.3	510.0	49.0	101.3
17	484.5	59.0	100.1	492.7	73.2	81.4	492.7	73.2	81.4
18	521.0	85.1	140.5	522.4	63.1	141.2	522.4	63.1	141.2
19	520.3	73.2	136.7	493.6	74.4	86.9	493.6	74.4	86.9
20	488.3	41.6	98.1	509.5	52.9	108.3	509.5	52.9	108.3
21	475.5	69.0	126.0	511.2	53.4	150.3	511.2	53.4	150.3
22	473.8	60.2	111.2	512.6	51.3	132.7	512.6	51.3	132.7
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	376.3	32.6	253.9	340.1	50.5	189.1	340.1	50.5	189.1
2	356.1	24.1	249.4	327.7	83.8	200.1	327.7	83.8	200.1
3	352.0	54.9	260.6	336.2	1.2	234.4	336.2	1.2	234.4
4	345.2	43.6	260.2	331.3	57.3	219.6	331.3	57.3	219.6
5	336.6	54.2	266.9	365.0	52.5	309.0	339.0	42.3	222.9
6	336.6	54.2	266.9	365.0	52.5	309.0	339.0	42.3	222.9
7	343.9	53.9	263.7	334.1	41.4	197.3	334.1	41.4	197.3
8	343.8	38.3	256.4	341.6	65.6	210.1	341.6	65.6	210.1
9	361.5	34.4	253.7	346.5	63.8	205.8	346.5	63.8	205.8
10	355.0	36.3	253.1	339.3	54.8	207.6	339.3	54.8	207.6
11	366.9	31.9	229.5	352.8	53.7	192.3	352.8	53.7	192.3
12	356.2	57.5	235.4	341.7	68.9	185.1	341.7	68.9	185.1
13	364.1	45.8	235.5	342.5	51.8	181.3	342.5	51.8	181.3
14	368.8	36.9	233.2	345.7	43.5	180.3	345.7	43.5	180.3
15	382.3	53.2	239.9	347.2	47.8	179.2	347.2	47.8	179.2
16	394.7	64.8	249.0	356.8	46.0	189.6	356.8	46.0	189.6
17	365.1	55.7	229.8	347.5	59.3	180.8	347.5	59.3	180.8
18	386.8	71.4	253.6	357.0	60.0	212.2	357.0	60.0	212.2
19	386.1	62.0	252.1	346.8	59.9	184.2	346.8	59.9	184.2
20	368.4	39.2	227.5	355.2	42.0	194.7	355.2	42.0	194.7
21	350.1	64.6	254.0	351.5	45.7	225.3	351.5	45.7	225.3
22	350.3	59.7	240.0	352.5	50.1	208.9	352.5	50.1	208.9

Reference Data Target locations for Subject 10

	x	y	z
Origin	-74.3	-250.6	189.6
Reference	143.6	-262.0	131.2
Manubrium	86.8	9.4	723.2
Xyphoid	3.6	1.4	574.1
C7	231.1	3.5	788.9
T4	266.3	1.7	682.3
S1	128.5	-13.2	290.1
Left ASIS	-31.8	-113.1	404.8
Left Lateral Femoral Condyle	-428.7	-194.7	382.3
Left Lateral Malleolis	-539.5	-143.7	-15.0
Left Lateral Foot	-634.9	-136.3	-58.9

Test data for Subject 10 follows (coordinates in millimeters):

Subject
10

Probe Length
386.5

InterASIS Dist.
237

InterPSIS width
120

Heel to foot target dist.
153

Test Condition	Target Locations for Subject 10: Origin			ref 2		
	x	y	z	x	y	z
1	-149.4	-295.1	-24.0	201.7	-320.3	-22.7
2	-149.5	-295.1	-24.1	201.9	-319.8	-22.5
3	-149.4	-295.0	-24.0	201.9	-320.3	-22.6
4	-149.4	-295.1	-24.0	202.0	-320.3	-22.6
5	-149.5	-295.2	-23.9	201.9	-320.3	-22.6
6	-149.3	-295.1	-23.9	201.9	-320.4	-22.8
7	-149.4	-295.1	-24.0	201.9	-320.3	-22.7
8	-149.4	-295.0	-24.0	201.8	-320.3	-22.7
9	-149.4	-295.1	-24.1	201.9	-320.3	-22.7
10	-149.4	-295.1	-24.0	202.0	-319.9	-22.7
11	-149.5	-295.1	-24.1	201.9	-320.3	-22.6
12	-149.4	-295.0	-24.0	201.9	-319.9	-22.5
13	-149.4	-295.2	-24.0	201.7	-320.4	-22.6
14	-149.5	-295.0	-24.1	201.8	-320.5	-22.6
15	-149.4	-295.1	-24.1	201.8	-320.3	-22.7
16	-149.4	-295.1	-24.1	201.8	-320.3	-22.7
17	-149.4	-295.1	-24.0	201.9	-320.4	-22.7
18	-149.4	-295.1	-24.1	201.9	-319.9	-22.7
19	-149.4	-295.2	-24.1	201.9	-320.3	-22.7
20	-149.4	-295.1	-24.1	201.8	-320.3	-22.7
21	-149.5	-295.0	-24.1	201.8	-320.3	-22.8
22	-149.4	-295.0	-24.0	201.9	-319.9	-22.7

T10 location was estimated from rigid thorax location and orientation

Test Condition	Target Locations for Subject 10: Elbow			Wrist		
	x	y	z	x	y	z
1	184.8	-286.6	448.8	2.9	-166.2	593.9
2	0.0	0.0	0.0	0.0	0.0	0.0
3	205.1	-272.7	476.2	-1.8	-177.0	605.9
4	199.5	-277.3	462.0	1.7	-169.4	596.2
5	201.2	-270.7	467.0	2.3	-166.7	603.5
6	220.0	-269.6	484.0	10.6	-166.5	603.8
7	211.1	-271.2	477.3	1.3	-174.3	604.8
8	208.7	-275.7	480.6	5.8	-170.3	608.3
9	203.1	-273.9	478.1	2.9	-163.3	605.9
10	209.1	-268.9	482.7	6.6	-158.2	604.8
11	190.6	-276.3	451.6	-4.4	-177.2	596.9
12	204.2	-269.7	463.4	7.7	-159.1	595.9
13	203.8	-274.5	468.9	4.8	-166.6	601.9
14	201.8	-271.1	473.5	3.2	-162.4	604.7
15	196.9	-276.1	457.8	-4.4	-178.7	597.4
16	198.7	-283.0	464.7	0.6	-176.1	599.3
17	194.1	-282.0	461.0	-1.1	-173.5	599.0
18	199.5	-279.5	467.5	-2.5	-178.4	602.4
19	197.0	-278.4	452.4	2.4	-174.4	595.5
20	198.7	-277.5	464.2	2.4	-169.8	600.6
21	207.8	-274.6	465.9	5.1	-173.3	598.3
22	196.4	-273.1	466.8	1.0	-164.8	602.6

Test Condition	Target Locations for Subject 10: Manumbrium			Xyphoid			Left ASIS		
	x	y	z	x	y	z	x	y	z
1	243.8	-25.1	736.9	156.2	-27.3	587.8	114.0	-146.1	410.8
2	298.0	-4.1	754.2	170.8	-13.8	627.6	94.6	-124.1	408.1
3	294.7	-0.2	748.5	166.9	-4.7	620.0	86.0	-117.8	412.9
4	281.4	-13.0	757.0	168.8	-12.6	619.5	97.9	-122.2	410.6
5	294.6	-5.0	751.4	171.2	-7.6	624.0	96.6	-118.4	408.8
6	348.5	-7.4	757.8	195.2	-8.0	654.0	100.4	-115.6	409.9
7	298.7	-3.1	758.3	168.6	-7.7	631.2	102.5	-115.3	407.7
8	290.0	-6.1	759.7	163.6	-12.0	629.9	104.1	-112.9	406.6
9	289.0	-4.6	757.6	164.3	-8.1	624.1	111.0	-115.3	403.5
10	293.7	-3.0	756.7	168.0	-8.5	622.9	104.2	-115.3	404.9
11	242.1	-4.0	735.6	153.8	-11.2	581.9	118.2	-119.3	402.9
12	265.4	1.0	747.4	162.4	-0.6	601.4	114.2	-119.2	404.7
13	265.0	-0.7	749.4	158.3	-7.3	602.6	114.8	-121.3	404.4
14	268.1	-5.8	751.6	157.7	-9.2	605.3	114.9	-119.7	403.4
15	249.9	-9.1	744.3	153.1	-12.1	591.3	118.2	-120.8	402.2
16	243.3	-9.3	742.2	149.1	-16.1	585.0	120.8	-127.8	402.3
17	244.5	-12.5	742.1	150.3	-17.8	586.1	116.6	-126.6	402.1
18	261.2	-8.6	748.4	155.6	-15.6	597.8	115.7	-124.8	403.4
19	247.6	-8.0	736.7	155.9	-12.8	585.4	116.3	-124.7	405.1
20	257.1	-7.0	743.3	154.3	-12.4	590.8	113.9	-125.8	404.5
21	281.4	-8.5	752.9	163.4	-8.5	615.8	105.2	-121.1	405.5
22	265.8	-1.6	749.3	159.5	-5.4	601.5	114.1	-123.0	404.4

Test Condition	Target Locations for Subject 10: Knee			Ankle			Foot		
	x	y	z	x	y	z	x	y	z
1	-294.4	-205.1	322.3	-585.2	-152.9	13.0	-667.9	-170.5	63.2
2	-290.4	-200.2	328.6	-576.3	-157.1	12.6	0.0	0.0	0.0
3	-314.0	-196.2	346.3	-672.9	-165.3	47.5	0.0	0.0	0.0
4	-297.6	-176.9	336.4	-577.2	-146.6	15.0	-675.4	-157.3	54.9
5	-293.5	-195.7	331.2	-575.1	-152.2	12.0	0.0	0.0	0.0
6	-288.0	-197.2	329.1	-673.4	-166.3	48.3	0.0	0.0	0.0
7	-289.5	-190.7	323.7	-579.2	-140.5	11.4	-678.3	-145.2	56.9
8	-287.7	-190.4	329.0	-575.7	-150.3	12.8	0.0	0.0	0.0
9	-288.6	-185.2	328.5	-574.3	-148.7	12.9	0.0	0.0	0.0
10	-289.6	-196.7	329.0	-572.7	-152.7	11.4	-672.8	-153.4	48.0
11	-291.0	-184.7	319.1	-585.5	-146.6	12.7	-679.8	-168.7	68.3
12	-287.3	-191.7	323.7	-578.5	-152.2	12.2	-676.5	-158.3	54.7
13	-294.0	-182.2	322.4	-588.5	-152.6	14.6	-680.9	-173.8	69.5
14	-292.0	-190.0	322.5	-584.5	-153.9	12.8	-677.9	-175.8	67.8
15	-286.0	-199.4	325.9	-674.5	-172.0	48.5	0.0	0.0	0.0
16	-289.9	-196.5	319.7	-582.9	-154.6	12.0	-677.2	-164.7	55.7
17	-291.1	-199.8	321.6	-582.6	-154.1	12.3	-677.9	-155.8	56.6
18	-288.3	-206.4	323.0	-578.2	-158.0	10.9	0.0	0.0	0.0
19	-296.4	-173.9	334.7	-575.5	-149.8	14.4	0.0	0.0	0.0
20	-292.3	-213.4	319.5	-673.8	-165.6	46.1	0.0	0.0	0.0
21	-298.9	-182.3	326.9	-585.4	-151.9	13.0	-677.9	-173.6	66.8
22	-287.1	-198.2	323.5	0.0	0.0	0.0	0.0	0.0	0.0

Test Condition	Target Locations for Subject 10: Probe1- Acromion			Prb1.T10, at/above			Prb1.T10- at/below		
	x	y	z	x	y	z	x	y	z
1	503.0	-477.5	918.4	0.0	0.0	0.0	0.0	0.0	0.0
2	547.0	-468.3	938.6	0.0	0.0	0.0	0.0	0.0	0.0
3	641.6	-400.5	901.3	0.0	0.0	0.0	0.0	0.0	0.0
4	605.6	-441.1	878.2	0.0	0.0	0.0	0.0	0.0	0.0
5	603.5	-444.8	873.7	0.0	0.0	0.0	0.0	0.0	0.0
6	710.9	-410.8	857.6	0.0	0.0	0.0	0.0	0.0	0.0
7	624.8	-427.6	913.9	0.0	0.0	0.0	0.0	0.0	0.0
8	624.9	-441.6	895.4	0.0	0.0	0.0	0.0	0.0	0.0
9	648.5	-406.0	892.1	0.0	0.0	0.0	0.0	0.0	0.0
10	643.6	-391.9	929.4	0.0	0.0	0.0	0.0	0.0	0.0
11	522.5	-407.8	970.3	0.0	0.0	0.0	0.0	0.0	0.0
12	556.7	-471.2	876.0	0.0	0.0	0.0	0.0	0.0	0.0
13	538.4	-461.3	926.0	0.0	0.0	0.0	0.0	0.0	0.0
14	578.5	-440.2	933.6	0.0	0.0	0.0	0.0	0.0	0.0
15	574.1	-449.9	890.3	0.0	0.0	0.0	0.0	0.0	0.0
16	515.6	-450.1	962.8	0.0	0.0	0.0	0.0	0.0	0.0
17	582.8	-460.9	862.2	0.0	0.0	0.0	0.0	0.0	0.0
18	588.2	-423.2	925.2	0.0	0.0	0.0	0.0	0.0	0.0
19	524.9	-433.7	957.4	0.0	0.0	0.0	0.0	0.0	0.0
20	549.4	-474.8	887.9	0.0	0.0	0.0	0.0	0.0	0.0
21	601.8	-432.5	914.3	0.0	0.0	0.0	0.0	0.0	0.0
22	574.7	-425.1	931.5	0.0	0.0	0.0	0.0	0.0	0.0
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	407.3	-354.3	835.0	0.0	0.0	0.0	0.0	0.0	0.0
2	459.2	-341.0	852.9	0.0	0.0	0.0	0.0	0.0	0.0
3	511.7	-302.1	832.3	0.0	0.0	0.0	0.0	0.0	0.0
4	481.3	-331.5	818.4	0.0	0.0	0.0	0.0	0.0	0.0
5	483.5	-328.9	815.4	0.0	0.0	0.0	0.0	0.0	0.0
6	575.1	-314.7	798.7	0.0	0.0	0.0	0.0	0.0	0.0
7	506.8	-318.8	839.5	0.0	0.0	0.0	0.0	0.0	0.0
8	506.9	-328.0	829.6	0.0	0.0	0.0	0.0	0.0	0.0
9	516.5	-307.8	827.9	0.0	0.0	0.0	0.0	0.0	0.0
10	518.2	-296.8	849.3	0.0	0.0	0.0	0.0	0.0	0.0
11	419.0	-308.0	867.3	0.0	0.0	0.0	0.0	0.0	0.0
12	452.0	-341.3	818.4	0.0	0.0	0.0	0.0	0.0	0.0
13	444.2	-334.5	847.6	0.0	0.0	0.0	0.0	0.0	0.0
14	471.9	-326.0	851.5	0.0	0.0	0.0	0.0	0.0	0.0
15	458.0	-334.1	825.1	0.0	0.0	0.0	0.0	0.0	0.0
16	428.3	-331.2	866.6	0.0	0.0	0.0	0.0	0.0	0.0
17	462.2	-343.2	810.3	0.0	0.0	0.0	0.0	0.0	0.0
18	470.0	-319.0	846.2	0.0	0.0	0.0	0.0	0.0	0.0
19	425.5	-324.6	860.5	0.0	0.0	0.0	0.0	0.0	0.0
20	447.8	-345.1	824.8	0.0	0.0	0.0	0.0	0.0	0.0
21	484.4	-323.6	838.6	0.0	0.0	0.0	0.0	0.0	0.0
22	461.6	-317.7	849.7	0.0	0.0	0.0	0.0	0.0	0.0

Test Condition	Target Locations for Subject 10: Prb1.T12, at/above			Prb1.T12, at/below			Prb1.L3, at/above		
	x	y	z	x	y	z	x	y	z
1	687.5	-66.3	292.1	687.5	-66.3	292.1	655.4	-98.8	222.9
2	700.0	-57.8	352.1	700.0	-57.8	352.1	643.3	-60.7	273.4
3	708.5	-43.5	358.0	590.2	-59.5	183.5	661.4	-40.3	316.8
4	693.9	-39.7	316.1	693.9	-39.7	316.1	631.7	-63.8	217.1
5	684.8	-64.0	319.1	684.8	-64.0	319.1	623.2	-73.3	218.6
6	688.3	-52.4	309.4	688.3	-52.4	309.4	624.9	-57.9	226.2
7	674.4	-49.6	296.5	674.4	-49.6	296.5	629.5	-40.6	215.1
8	680.5	-60.9	310.1	680.5	-60.9	310.1	628.7	-68.8	214.3
9	690.8	-62.6	317.6	690.8	-62.6	317.6	628.6	-53.2	191.7
10	683.8	-37.4	303.5	683.8	-37.4	303.5	640.8	-9.1	216.9
11	694.5	-78.0	301.6	694.5	-78.0	301.6	687.8	-51.8	277.9
12	688.4	-69.7	303.2	688.4	-69.7	303.2	658.9	-73.4	232.5
13	691.9	-78.2	306.8	691.9	-78.2	306.8	658.9	-64.3	217.9
14	684.3	-77.1	295.0	684.3	-77.1	295.0	656.6	-94.0	224.1
15	710.2	-69.5	326.0	710.2	-69.5	326.0	698.1	-23.8	409.4
16	712.4	-52.5	317.4	712.4	-52.5	317.4	703.3	-25.7	320.9
17	715.3	-87.7	336.0	715.3	-87.7	336.0	683.3	-114.4	280.9
18	716.9	-68.8	341.2	716.9	-68.8	341.2	667.2	-112.3	250.0
19	698.6	-92.1	313.7	698.6	-92.1	313.7	664.5	-90.5	232.5
20	699.9	-87.0	313.6	699.9	-87.0	313.6	673.7	-81.2	245.0
21	685.7	-74.1	306.7	685.7	-74.1	306.7	648.4	-52.8	222.5
22	695.9	-78.9	316.3	695.9	-78.9	316.3	658.5	-79.7	230.8
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	541.0	-50.5	388.6	541.0	-50.5	388.6	499.1	-75.7	302.7
2	535.8	-40.5	416.7	535.8	-40.5	416.7	477.0	-43.7	333.1
3	542.1	-30.5	417.0	473.3	-38.8	314.4	490.3	-30.7	354.6
4	537.9	-30.9	399.1	537.9	-30.9	399.1	479.1	-44.6	304.2
5	530.4	-42.2	402.0	530.4	-42.2	402.0	472.4	-47.6	307.8
6	534.4	-34.0	398.0	534.4	-34.0	398.0	470.9	-38.2	310.5
7	526.2	-33.8	392.4	526.2	-33.8	392.4	478.0	-28.8	304.9
8	529.8	-40.6	402.1	529.8	-40.6	402.1	477.5	-44.2	303.6
9	535.7	-43.1	401.7	535.7	-43.1	401.7	486.0	-38.2	296.0
10	534.4	-29.2	397.1	534.4	-29.2	397.1	485.2	-12.7	302.5
11	544.0	-52.1	389.9	544.0	-52.1	389.9	518.5	-38.4	326.7
12	539.5	-44.2	396.6	539.5	-44.2	396.6	500.9	-47.8	308.4
13	540.6	-53.7	397.2	540.6	-53.7	397.2	501.9	-46.9	298.6
14	537.6	-53.5	389.9	537.6	-53.5	389.9	500.8	-62.8	302.1
15	551.8	-47.8	401.7	551.8	-47.8	401.7	523.0	-26.2	396.2
16	554.8	-42.6	397.1	554.8	-42.6	397.1	528.6	-28.3	348.1
17	555.1	-62.1	406.9	555.1	-62.1	406.9	516.5	-76.3	328.2
18	553.9	-49.7	409.6	553.9	-49.7	409.6	506.4	-73.2	312.9
19	544.8	-61.3	396.5	544.8	-61.3	396.5	506.7	-61.7	306.6
20	545.9	-59.6	396.0	545.9	-59.6	396.0	510.8	-59.3	311.1
21	535.5	-50.2	399.0	535.5	-50.2	399.0	492.0	-41.1	305.3
22	541.7	-50.6	399.0	541.7	-50.6	399.0	500.2	-53.0	306.4

Test Condition	Target Locations for Subject 10: Prb1.L3, at/below			Prb.S1, at/above			Prb1.S1, at/below		
	x	y	z	x	y	z	x	y	z
1	655.4	-98.8	222.9	646.4	-71.2	213.6	576.7	-56.3	64.9
2	643.3	-60.7	273.4	633.9	-16.2	247.6	573.1	-5.3	85.9
3	561.8	-30.1	121.4	632.1	-34.4	277.2	573.1	-29.9	115.2
4	631.7	-63.8	217.1	621.3	5.9	179.8	621.3	5.9	179.8
5	623.2	-73.3	218.6	619.7	-19.8	186.5	619.7	-19.8	186.5
6	624.9	-57.9	226.2	617.8	9.2	183.5	617.8	9.2	183.5
7	629.5	-40.6	215.1	643.5	19.0	246.8	643.5	19.0	246.8
8	628.7	-68.8	214.3	649.9	-31.8	296.8	649.9	-31.8	296.8
9	628.6	-53.2	191.7	653.6	-56.3	296.7	653.6	-56.3	296.7
10	640.8	-9.1	216.9	652.3	-22.0	290.4	652.3	-22.0	290.4
11	687.8	-51.8	277.9	639.2	-34.4	167.8	580.7	-31.0	64.7
12	658.9	-73.4	232.5	660.1	-0.9	289.9	660.1	-0.9	289.9
13	658.9	-64.3	217.9	662.4	-41.5	295.7	576.4	-48.8	68.1
14	656.6	-94.0	224.1	648.1	-53.9	208.3	577.8	-42.7	65.8
15	698.1	-23.8	409.4	667.7	-49.4	294.5	580.1	-44.7	63.6
16	703.3	-25.7	320.9	666.2	-25.9	252.7	581.2	-52.8	63.2
17	683.3	-114.4	280.9	657.8	-49.1	219.6	579.8	-34.5	62.0
18	667.2	-112.3	250.0	653.1	-53.7	215.4	580.7	-50.4	69.2
19	664.5	-90.5	232.5	644.4	-33.1	190.4	576.2	-48.1	65.5
20	673.7	-81.2	245.0	667.0	-27.1	285.2	575.6	-45.5	65.1
21	648.4	-52.8	222.5	628.9	-21.2	180.5	572.6	-21.3	73.0
22	658.5	-79.7	230.8	660.8	-13.7	295.6	660.8	-13.7	295.6
Test Condition	**(probe target 2)**			**(probe target 2)**			**(probe target 2)**		
	x	y	z	x	y	z	x	y	z
1	499.1	-75.7	302.7	473.0	-58.4	260.3	436.1	-54.1	172.7
2	477.0	-43.7	333.1	458.0	-17.1	284.6	429.1	-13.1	183.6
3	428.4	-26.2	237.7	458.0	-20.9	304.2	420.7	-25.1	204.2
4	479.1	-44.6	304.2	459.4	-5.2	249.0	459.4	-5.2	249.0
5	472.4	-47.6	307.8	456.7	-17.8	255.4	456.7	-17.8	255.4
6	470.9	-38.2	310.5	455.3	-0.8	253.2	455.3	-0.8	253.2
7	478.0	-28.8	304.9	465.9	9.2	282.6	465.9	9.2	282.6
8	477.5	-44.2	303.6	476.4	-22.3	308.2	476.4	-22.3	308.2
9	486.0	-38.2	296.0	479.4	-36.2	307.2	479.4	-36.2	307.2
10	485.2	-12.7	302.5	475.9	-16.4	306.1	475.9	-16.4	306.1
11	518.5	-38.4	326.7	478.0	-21.7	238.9	440.8	-27.5	171.7
12	500.9	-47.8	308.4	485.1	-10.2	303.6	485.1	-10.2	303.6
13	501.9	-46.9	298.6	487.3	-31.8	305.7	435.7	-37.8	174.7
14	500.8	-62.8	302.1	479.2	-38.9	260.0	437.2	-34.7	173.1
15	523.0	-26.2	396.2	492.6	-34.3	306.8	440.9	-32.8	171.0
16	528.6	-28.3	348.1	492.6	-24.7	283.3	440.9	-40.8	170.6
17	516.5	-76.3	328.2	488.0	-34.5	266.2	440.5	-27.7	170.5
18	506.4	-73.2	312.9	484.3	-38.6	265.8	438.4	-39.0	174.5
19	506.7	-61.7	306.6	473.5	-23.2	251.1	436.2	-38.6	173.5
20	510.8	-59.3	311.1	490.5	-21.8	301.2	435.8	-33.9	173.6
21	492.0	-41.1	305.3	465.5	-19.5	248.4	431.8	-20.4	178.4
22	500.2	-53.0	306.4	484.2	-17.6	307.5	484.2	-17.6	307.5

APPENDIX F

UMTRI Thorax Points

The following coordinate pairs were interpo;ated from the skin point locations on the UMTRI drawing [15]. Coordinates are given in millimeters.

Table 23: Thorax Point Coordinates

X	Z
15.0	56.0
34.0	241.6
0.0	352.0
-115.0	284.6
-169.5	175.5
-201.9	57.9
-175.0	-3.1
0.0	0.0
15.0	56.0

APPENDIX G

Individual Subject Rotation Centers

Subject 01
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-63.1	-3.7	-101.9	11.4	-68.8	-3.0	-125.1	-1.5	-181.9	-1.5
-85.6	-4.2	-114.4	24.4	-31.1	-1.4	-73.5	23.9	-100.7	57.7
-71.3	-4.5	-97.5	35.1	-81.7	-5.5	-110.7	33.8	-119.6	80.5
-72.6	-4.8	-136.8	28.3	-72.9	-5.1	-106.2	29.9	-149.9	59.7
-69.7	-6.8	-102.4	30.5	-72.1	-7.8	-90.7	22.5	-119.7	74.0
-63.0	-6.6	-87.5	22.4	-68.7	-7.7	-94.3	19.2	-99.1	61.5
-54.1	-5.6	-87.9	19.7	-64.8	-7.1	-88.1	19.4	-107.8	56.4
-54.6	-2.6	-77.2	20.6	-82.6	-4.6	-86.5	28.8	-100.8	55.7
2.0	0.1	-60.6	30.0	-22.8	-1.5	-33.3	26.9	-84.2	67.5
-54.0	1.2	-12.2	26.8	-47.1	0.7	-114.4	-17.1	-39.9	61.7
-43.9	2.4	-107.0	-3.6	-44.0	0.7	-97.1	-22.7	-216.9	-67.7
-51.0	0.8	-87.5	-2.9	-75.6	-0.7	-126.3	-9.7	-188.2	-29.5
-46.5	-0.6	-80.9	5.9	-50.0	-0.5	-87.8	8.4	-118.9	23.2
-59.2	-0.2	-88.4	14.9	-83.9	-2.6	-113.5	20.0	-128.7	52.3
-23.6	1.3	-58.7	8.6	-87.0	1.3	-127.1	5.8	-164.4	12.4
-52.5	-0.9	-79.4	24.2	-77.4	-2.7	-110.0	17.0	-128.8	46.6
-64.9	1.5	-94.5	14.0	-75.9	-5.5	-96.0	13.1	-107.9	40.1
-53.8	-1.1	-83.2	21.0	-73.1	-5.6	-99.0	10.5	-115.7	36.0
-55.1	-2.8	-74.8	16.3	-70.0	-5.2	-93.9	10.4	-109.7	34.8
-50.7	-2.9	-75.6	14.4	-84.7	-1.7	-95.9	13.9	-102.0	35.2
-44.1	-2.5	-67.1	14.8	-41.0	-1.3	-53.6	12.2	-62.6	31.7
-39.6	-0.1	-51.4	17.2	-22.9	0.3	-50.3	-7.2	-84.0	-27.7
-3.8	0.0	-17.9	14.3	-19.3	0.3	-31.2	-12.4	-46.9	-41.6
-53.3	0.5	-79.2	-2.6	-56.9	-0.6	-77.8	-1.1	-99.1	-2.6
-49.8	0.2	-59.4	-1.5	-31.4	-0.4	-44.5	16.2	-52.9	42.1
-45.2	-1.2	-60.4	8.4	-68.7	-2.2	-78.8	27.1	-79.8	67.1
-59.2	-0.9	-67.9	18.1	-63.1	0.9	-67.9	14.7	-68.9	36.5
-51.8	-1.5	-61.9	28.1	-62.4	-2.2	-75.8	24.1	-80.0	61.7
-65.8	0.7	-68.0	17.3	-64.3	-4.7	-69.5	19.8	-69.8	54.1
-53.2	-1.7	-66.0	24.6	-61.8	-4.8	-72.8	17.3	-77.7	50.2
-54.8	-3.5	-60.1	19.6	-58.5	-4.4	-67.4	17.2	-71.2	49.1
-50.0	-3.5	-61.5	17.6	-67.9	-1.4	-56.8	21.3	-45.1	52.0
-42.9	-3.0	-52.4	18.0	-25.3	-0.8	-18.5	19.4	-12.5	47.7
-37.4	-0.5	-27.9	21.1	-55.2	1.5	-118.8	63.0	-88.5	132.3
2.0	0.0	7.0	18.3	-102.2	-16.0	-110.6	55.9	-88.2	123.2
-92.3	2.1	-44.9	72.4	-95.6	-15.4	-120.7	4.2	-194.8	-0.4
-55.7	-8.4	-53.9	63.2	-90.2	-14.3	-87.1	36.7	-71.8	95.2
-45.9	-7.2	-151.5	8.4	-80.0	-4.6	-92.1	31.4	-83.1	88.0
-31.2	-4.9	-46.8	42.1	-125.2	-9.8	-83.1	32.4	-73.2	88.1
-48.6	-3.9	-50.0	36.9	-113.4	-9.2	-143.6	20.4	-19.6	132.9
-59.9	-5.0	-33.4	39.2	-100.2	-12.0	-87.3	44.3	36.1	119.0
-62.1	-5.4	-69.7	27.4	-95.6	-11.8	-122.6	48.5	-145.0	59.3
-100.7	5.5	-82.9	43.7	-91.7	-11.1	-117.7	44.2	-81.7	97.7
-61.6	-7.2	-71.6	52.2	-133.1	-8.9	-99.2	32.6	-105.9	107.8

Subject 01

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-54.2	-6.7	-77.3	46.7	-58.3	-4.5	-102.7	29.0	-112.4	117.4
-43.7	-5.4	-171.2	1.6	-52.7	1.5	-96.4	29.4	-106.0	101.7
37.1	2.8	-66.9	34.8	-104.2	-16.2	-99.1	46.3	-90.6	84.4
-87.3	1.5	-68.4	31.3	-97.6	-15.6	-42.7	42.5	-99.0	79.5
-60.5	-9.4	-56.3	32.5	-92.3	-14.5	-137.5	62.9	-92.1	79.1
-49.5	-8.1	-18.9	51.2	-79.1	0.3	-129.2	56.0	-69.8	101.2
-33.8	-5.5	34.3	46.6	-75.2	-13.6	-107.2	0.2	-30.9	92.7
-67.1	-5.2	-130.8	7.9	-68.0	-12.6	-99.7	36.8	-71.2	131.6
-74.9	-0.9	-64.6	40.7	-59.9	-11.0	-104.2	31.6	-111.9	130.2
-89.9	-0.2	-66.8	35.1	-56.2	0.1	-95.8	32.5	-111.7	121.5
-77.1	-6.3	-49.2	37.7	-119.4	-21.8	-8.7	59.7	-171.6	-9.9
-78.5	-6.6	-100.5	0.7	-109.2	-20.4	-129.7	6.0	-89.4	94.0
-82.5	4.7	-113.8	12.3	-102.2	-18.9	-63.9	48.3	-100.1	87.0
-73.3	-8.5	-117.8	17.1	-122.3	-9.8	-71.1	40.9	-91.0	87.2
-65.3	-8.0	-121.9	21.3	-110.4	-9.2	-58.7	42.7	-55.3	130.7
-55.1	-6.7	-49.0	18.8	-37.5	2.3	-99.9	18.4	2.2	117.1
15.3	1.1	-22.5	23.4	-97.9	-11.9	-96.4	19.6	-70.1	170.5
-80.0	-1.3	-95.8	32.9	-93.3	-11.7	-110.1	18.0	-69.2	157.4
-103.5	2.5	-101.8	27.0	-89.3	-11.0	-116.3	10.6	-179.2	11.4
-41.5	-6.2	-125.2	25.8	-129.9	-8.9	-103.9	11.8	-55.0	110.4
-33.0	-5.2	-83.9	18.7	-53.9	-4.3	-135.0	30.4	-69.4	100.5
-18.4	-2.9	-84.6	15.7	-86.2	-1.6	-129.2	25.9	-56.2	101.5
-80.8	-1.6	-71.9	17.0	-89.9	2.5	-92.7	20.3	-112.1	52.2
-77.3	-3.9	-45.6	26.3	-64.5	-10.1	-105.2	18.5	-124.6	45.4
-72.1	-4.1	16.3	24.1	-59.7	-9.6	-108.8	14.9	-98.1	65.9
-65.5	-3.7	-108.5	28.6	-53.6	-8.5	-102.2	15.1	-115.1	53.7
-70.7	-0.1	-136.4	23.5	-80.2	-1.8	-111.1	24.7	-100.3	53.4
-33.1	-0.3	-52.1	23.5	-78.3	-4.7	-45.8	23.7	-129.9	79.6
		-55.1	19.0	-75.7	-4.8	-117.6	28.0	-129.8	72.1
		-37.0	21.6	-72.8	-4.5	-130.4	21.6	-139.8	39.8
		-112.0	25.5	-87.1	-0.6	-71.6	23.8	-104.1	58.8
		-99.5	19.4	-47.1	-0.9	-77.3	18.6	-113.7	53.1
		-99.5	17.4			-67.4	19.3	-105.9	52.3
		-91.4	17.7			-114.5	25.1	-90.5	65.0
		-86.6	23.2			-101.3	19.7	-37.9	59.4
		-52.9	19.6			-104.0	17.3	-98.6	100.1
		191.8	14.4			-99.4	17.2	-131.6	65.0
		-125.5	-1.5			-102.7	23.4	-98.0	88.4
		-99.4	3.0			-65.3	20.5	-159.4	45.2
						992.0	-924.2	-73.5	67.2
						-104.0	2.7	-86.6	58.8
								-75.1	58.3
								67.7	77.5
								-131.9	60.2
								-113.6	51.5
								-120.6	47.9
								-115.3	47.0
								-110.1	52.5

Subject 01

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
								-76.8	47.4
								-41.9	668.9
								-121.2	47.1
								-224.9	37.0
								-141.4	32.1
								-244.9	19.0
								-124.5	30.9

Subject 01
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-77.2	72.9	-100.7	45.2	-34.4	66.6	-58.8	38.2	-96.3	2.5
-30.7	73.8	-58.9	47.6	12.7	74.8	-20.5	48.2	-58.8	19.0
12.4	70.7	-31.4	46.0	20.3	83.8	-36.1	57.4	-91.5	30.1
60.7	90.5	-38.5	52.0	-27.2	83.8	-58.5	56.3	-26.4	32.0
-42.3	73.2	-13.7	64.4	13.5	93.6	-24.4	67.2	-112.8	21.6
-2.8	75.2	-68.0	46.9	19.6	103.6	-38.7	76.8	-76.0	37.6
32.4	73.9	-32.9	49.8	87.0	97.3	16.1	73.3	-107.8	48.3
46.3	78.3	-10.6	49.0	69.6	94.5	40.7	65.8	-43.7	49.9
-4.6	52.3	-9.4	55.2	-29.2	72.8	-30.8	43.3	-33.8	9.5
29.8	104.5	-36.2	29.9	5.2	80.6	-1.3	52.1	-8.0	21.9
-53.5	81.9	0.3	75.7	9.4	87.5	-11.3	58.6	-31.8	29.0
-16.9	84.5	-56.5	53.4	60.1	78.8	35.4	54.4	13.8	31.7
15.7	83.9	-23.4	56.6	-4.3	55.6	1.3	30.7	7.1	6.8
21.3	91.3	-2.5	55.9	-0.7	110.4	84.1	23.5	-9.5	50.7
-27.7	68.1	0.8	64.0	-65.2	70.2	-40.5	80.1	16.7	77.2
-150.8	69.2	-21.6	42.8	-39.7	79.3	-57.0	27.4	-9.3	50.5
-63.2	89.0	-116.8	82.1	-86.0	77.3	-36.8	45.9	72.3	14.6
-70.6	62.7	-111.0	41.2	13.1	60.2	-77.3	34.1	-96.3	2.5
-91.2	54.6	-75.5	60.4	-74.4	68.5	-34.0	34.8	-112.5	12.0
-69.2	108.3	-128.4	42.5	-83.7	59.3	-77.6	23.5	-58.8	19.0
-104.9	76.5	-79.9	42.6	-88.3	73.7	-76.9	11.9	-81.3	26.1
-71.0	89.7	-121.5	24.9	-58.5	85.7	-73.9	54.5	-91.5	30.1
-122.1	78.5	-125.2	19.7	-110.4	111.6	-21.1	36.1	-108.5	35.0
-35.7	67.9	-163.6	27.9	-32.3	77.4	11.7	58.4	-26.4	32.0
-109.4	63.2	-120.3	62.1	10.8	89.8	-33.9	44.9	-53.6	37.3
-120.5	59.7	-225.2	62.2	-48.6	86.0	7.6	45.0	-92.8	6.1
-142.1	68.4	-70.6	43.6	69.5	68.3	-40.1	32.2	-96.5	60.4
-100.1	89.6	-21.0	63.2	-40.4	75.7	-40.7	19.3	-1.1	15.3
-167.9	90.5	-80.3	44.5	-51.3	65.1	-48.6	63.3		
-70.9	78.2	-36.3	45.0	-43.6	82.9	-35.6	43.4		
-17.9	92.1	-82.3	26.7	-31.4	93.8	-5.5	54.3		
-83.4	79.7	-86.0	21.4	-62.0	128.9	-57.8	39.8		
17.7	68.5	-108.8	28.8	-32.1	84.1	-57.7	25.4		
-75.7	63.7	-91.1	65.4	18.7	102.4	-61.3	69.9		
-87.5	59.9	-172.4	64.5	-50.6	95.4	23.6	32.3		
-100.2	68.0	-43.8	42.2	87.0	77.5	-24.6	67.1		
-72.3	92.6	13.5	60.2	-41.1	82.5	-67.7	45.9		
-125.0	91.9	-48.0	42.2	-53.2	70.4	-64.5	84.1		
-40.1	76.7	-8.4	43.3	-44.9	94.0	-0.5	40.9		
32.1	89.7	-56.0	25.5	-31.4	100.6				
-47.3	77.2	-59.6	20.2	11.2	71.8				
66.9	65.0	-70.6	25.9	3.4	67.8				
-45.2	61.5	-71.3	64.9	-13.5	52.0				
-57.4	57.3	-132.8	61.1	1.2	95.9				

Subject 01

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-60.2	63.6	-55.7	45.8	-66.1	45.3				
-47.7	92.7	-5.3	49.3	-99.5	21.4				
-83.0	88.6	-71.7	21.8	-56.2	77.0				
-57.6	78.6	-76.6	14.2	-0.5	66.5				
-74.4	80.0	-87.5	72.2						
-64.1	56.6	-121.9	52.9						
-81.5	50.0	-77.8	106.4						
-63.9	98.5	-8.6	77.6						
-116.4	52.6								
-122.8	28.7								
-142.3	21.2								
-106.5	79.7								
-140.7	83.0								
-9.2	103.0								

Subject 02
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-49.4	-9.2	-55.6	-3.0	-24.7	-4.0	-33.0	-6.3	-41.3	-9.4
-40.4	-6.1	-81.6	13.0	-55.5	-9.2	-70.5	19.6	-77.1	58.4
-64.7	-10.3	-107.7	1.6	-59.2	-9.9	-81.1	7.8	-94.5	36.8
-89.2	-15.5	-101.1	-3.0	-55.8	-10.2	-70.7	5.1	-80.9	30.0
-88.5	-16.6	-86.8	0.7	-51.6	-8.5	-70.4	6.1	-83.3	30.5
-68.7	-11.6	-76.4	7.1	-48.3	-8.4	-64.5	10.8	-74.7	40.4
-62.0	-11.1	-117.4	10.4	-69.7	-11.2	-67.2	23.2	-62.6	63.5
-65.1	-10.2	-23.5	38.2	-31.6	-4.7	-43.8	35.3	-49.1	81.0
-32.7	-3.9	-72.2	19.7	-31.0	-5.0	-42.7	27.8	-49.0	68.7
-32.5	-5.2	-99.9	15.4	-97.8	-14.1	-103.3	18.1	-100.5	58.3
-19.3	-2.4	-48.2	-2.6	-41.2	-4.1	-62.0	-16.0	-65.0	-21.4
-38.9	-5.2	-38.5	-2.9	-49.3	-6.9	-56.7	-12.1	-60.1	-44.5
-61.5	-9.2	-16.4	-8.2	-60.8	-6.7	-59.7	-19.0	-87.7	41.2
-64.2	-10.5	-55.4	9.7	-73.0	-10.4	-83.8	10.3	-104.2	21.4
-44.4	-6.4	-79.5	1.6	-75.7	-10.9	-93.0	0.6	-91.3	16.7
-41.5	-6.4	-76.9	-2.0	-70.9	-11.3	-83.0	-1.1	-95.6	14.9
-80.1	-9.8	-60.9	0.4	-70.3	-9.8	-85.0	-1.2	-86.1	25.2
5.7	0.7	-55.5	5.7	-66.0	-10.0	-78.4	3.2	-75.6	44.6
-38.9	-5.2	-78.6	7.5	-84.8	-11.7	-81.6	12.9	-64.0	59.2
-53.3	-6.3	-9.6	28.4	-58.1	-7.3	-64.0	21.5	-62.9	49.8
-52.3	-3.0	-48.2	14.9	-54.4	-7.6	-61.0	16.5	-110.9	37.1
-45.3	-4.4	-63.8	10.6	-108.5	-13.1	-112.9	7.8	-72.7	-2.1
-41.5	-5.7	-63.9	1.7	-27.7	-2.0	-50.3	-2.2	-61.3	-0.1
-33.8	-3.5	-51.7	-0.4	-38.3	-4.3	-50.1	-3.1	-56.5	-8.2
-63.0	-4.4	-39.6	-3.4	-43.8	-3.7	-50.1	-5.6	-93.6	6.6
-48.7	-5.4	-89.0	-0.3	-40.7	-2.2	-68.2	0.8	-79.1	45.4
-66.4	-8.3	-66.8	10.6	-57.7	-6.6	-72.0	14.6	-91.8	30.6
-68.2	-9.5	-85.6	4.3	-60.0	-7.0	-79.3	7.1	-82.7	25.9
-52.5	-6.3	-83.1	1.0	-57.7	-7.6	-72.5	5.0	-84.7	25.8
-49.5	-6.5	-71.0	3.1	-55.2	-6.2	-72.5	5.7	-78.2	32.7
-82.0	-8.2	-65.4	7.0	-52.8	-6.5	-68.3	8.6	-69.1	47.8
-14.3	-1.5	-86.0	9.6	-66.5	-7.3	-69.9	16.6	-59.4	59.0
-48.8	-5.3	-29.9	24.5	-43.9	-4.3	-55.1	23.0	-59.1	51.6
-61.4	-5.8	-60.9	14.5	-42.3	-4.7	-53.6	18.9	-94.7	43.5
-43.0	-8.4	-74.9	11.8	-81.9	-7.7	-91.9	13.7	-74.2	53.4
-86.4	-15.8	-52.2	7.5	-46.6	-7.3	-55.5	9.6	-61.4	35.1
-86.1	-17.0	-78.4	26.5	-59.8	-7.6	-57.2	11.8	-53.3	40.0
-63.1	-11.2	-106.1	12.6	-74.3	-11.8	-84.4	29.8	-84.1	77.2
-56.5	-10.7	-99.5	6.6	-77.5	-12.4	-94.0	20.2	-98.5	62.4
-32.9	-6.6	-84.0	12.9	-71.7	-12.6	-83.7	16.0	-87.8	54.4
-78.6	-14.9	-73.8	17.6	-71.2	-11.1	-85.6	19.3	-90.1	59.2
-79.6	-16.2	-115.2	26.3	-66.1	-11.1	-78.9	21.6	-82.7	63.1
-52.3	-9.6	-17.8	53.0	-88.4	-13.6	-82.1	33.3	-72.7	81.7
-46.7	-9.1	-68.7	33.4	-56.7	-8.1	-63.4	44.3	-61.8	95.4
-17.1	-3.7	-40.0	17.5	-52.5	-8.2	-60.6	36.6	-61.4	84.6
-73.1	-15.9	-63.7	39.5	-118.1	-16.2	-114.8	32.1	-102.5	82.5
		-94.6	23.3	-35.6	-5.8	-42.5	19.0	-50.0	79.6
		-89.4	15.9	-65.7	-10.9	-37.7	25.2	-47.2	52.6

Subject 02

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
		-70.5	24.7	-69.2	-11.5	-74.4	38.4	-32.5	63.9
		-62.3	27.8	-64.3	-11.7	-83.9	28.8	-73.8	89.9
		-1.1	67.1	-62.1	-10.1	-74.6	23.7	-87.0	76.3
		-53.9	46.4	-57.7	-10.0	-74.5	28.3	-77.6	67.2
		-10.0	5.7	-80.3	-12.9	-69.0	29.8	-77.8	73.9
		-82.2	10.6	-44.5	-6.6	-71.5	42.4	-72.3	76.2
		-77.2	3.3	-41.9	-6.8	-51.2	54.5	-62.0	94.7
		-40.7	19.0	-110.7	-15.9	-49.7	45.7	-51.0	108.4
				-82.7	-16.0	-102.8	42.8	-51.5	97.1
				-73.3	-15.4	-103.7	9.8	-88.9	97.8
				-65.4	-13.2	-97.5	20.5	-95.3	95.3
						-78.1	28.1	-122.9	67.7
						-92.3	12.2	-98.7	53.4
						-77.0	8.1	-108.3	63.1
						-78.4	10.6	-91.2	70.2
						-69.5	16.1	-75.2	106.9
						-74.2	33.7	-56.2	135.5
						-41.1	40.3	-55.1	111.6
								-121.5	110.1
								-157.0	81.6
								-124.2	63.2
								-117.4	82.6
								-101.3	124.9
								-81.2	158.1
								-76.7	128.5
								-73.3	77.8
								-93.9	52.3
								-77.2	42.2
								-78.9	46.3
								-69.6	55.8
								-54.7	85.9
								-37.9	109.1
								-38.8	91.3
								-102.2	85.3

Subject 02
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-70.4	90.7	-71.4	67.4	-50.6	102.8	-52.4	79.0	-98.3	71.5
-78.9	113.2	-85.3	90.7	-70.1	117.4	-78.2	94.1	-53.3	57.7
-53.6	111.0	-60.8	85.8	-32.5	107.7	-42.5	82.8	-32.5	66.1
-32.7	121.7	-35.6	96.9	-23.9	115.0	-28.1	90.6	-26.8	112.6
-31.2	165.6	-29.3	142.9	-29.5	156.9	-27.9	134.4	-83.2	44.7
-89.0	108.9	-102.4	83.9	-51.6	95.0	-67.1	70.0	-81.1	166.0
-51.3	201.7	-73.8	162.8	-17.9	163.7	-44.6	132.4	-59.9	99.0
-52.4	211.3	-69.5	173.5	-9.6	166.0	-30.6	135.3	-43.5	102.6
-54.2	193.9	-68.7	161.2	-40.6	153.5	-55.9	125.4	-65.1	95.8
-78.7	39.8	-83.6	11.9	-111.4	50.1	-127.4	17.1	-50.6	171.6
-140.0	91.0	-157.7	71.5	-135.0	80.1	-148.0	52.3	-174.1	-31.4
-24.4	77.7	-23.3	53.6	-75.4	125.4	-89.1	104.2	-206.1	17.6
-49.9	108.2	-56.5	86.5	-29.1	111.8	-42.5	87.1	-58.5	62.7
-20.7	104.9	-31.1	80.1	-19.7	118.9	-25.2	94.7	-31.3	70.7
-4.9	117.3	-9.4	92.8	-23.6	173.5	-22.3	153.1	-21.7	135.8
12.5	170.6	15.3	149.8	-37.1	175.4	-59.2	146.0	-68.2	122.7
-40.6	101.3	-62.2	76.9	-99.6	58.5	-108.8	29.7	-45.1	127.1
7.4	215.0	-18.9	180.5	-119.2	83.3	-125.1	57.3	-73.4	114.3
-102.4	49.0	-106.5	23.5	-85.5	35.4	-80.1	-0.5	-132.4	-5.5
-154.0	93.8	-167.6	74.8	-4.7	94.4	-58.1	90.6	-152.4	29.1
-141.2	37.2	-142.3	7.9	-43.4	113.3	-22.2	77.8	-84.2	68.0
-15.5	80.7	-24.6	57.9	-3.4	101.9	-12.0	86.8	-40.7	53.6
-42.8	108.4	-54.9	86.6	-1.4	110.4	-3.1	135.0	-22.2	63.0
-15.1	105.5	-31.4	80.8	3.4	157.5	-38.3	61.4	-10.0	112.5
-1.3	117.2	-10.8	92.8	-7.2	85.2	-10.2	134.6	-66.9	37.7
16.8	168.2	10.6	145.3	0.5	154.9	5.8	137.8	-61.5	174.6
-29.2	102.9	-58.9	78.3	-131.4	57.3	-30.9	125.7	-43.9	98.2
14.3	208.1	-14.9	176.1	-150.8	83.6	-141.4	26.7	-25.9	102.0
-109.6	44.8	-21.6	170.5	-142.6	32.9	-158.7	57.5	-52.0	94.7
-163.9	90.9	-110.5	18.5	2.9	122.3	-8.4	96.3	-180.8	-17.0
-157.7	29.2	-177.6	72.4	-86.9	76.1	-96.1	47.9	-208.6	26.6
18.2	150.3	-155.9	-4.3	-100.2	93.6	-107.3	67.8	-46.4	59.6
-68.8	-65.2	5.4	119.7	-121.7	29.1	-73.2	37.3	-17.0	69.5
-109.8	-71.4	-55.4	-131.7	-73.2	69.1	-104.1	61.8	-124.2	11.8
-77.9	62.4	-81.0	37.0	-76.5	29.1	-112.7	78.2	-138.8	39.2
-108.7	94.6	-115.9	73.6	-115.6	28.5	-148.3	38.7	-88.9	-10.5
-95.0	5.3	-101.8	-39.3	-92.8	88.6	-88.9	58.5	35.1	49.2
-87.3	61.0	-87.2	33.9	-103.3	103.3	-24.3	-21.7	-134.5	30.1
-82.6	11.0	-82.6	-30.9	-119.4	75.1	-59.2	-18.4	-145.7	52.6
-118.1	29.4	-115.5	-21.2	-83.4	87.2	-80.6	60.3	-113.1	22.2
-117.8	20.7	-89.2	52.9	-25.4	22.4	-88.7	75.5	-98.1	32.5
-109.1	21.6	-118.0	86.3	-57.6	21.6	-88.1	34.6	-105.9	50.6
-83.6	77.8	-110.2	20.8	-70.7	86.6	-60.2	55.1	-135.7	-12.9
-108.8	106.7	-95.9	57.2	-81.3	101.0	13.0	104.3	-71.0	24.7
-98.9	52.5	-54.2	-20.5	-73.3	67.1	-12.4	23.3	19.6	78.6
-91.8	82.6	-58.5	-7.4	-55.3	83.1	-19.2	49.2	-6.5	-21.3
-54.1	11.2	-65.1	-14.7	6.3	130.0	-32.8	47.4	-1.0	12.5
-67.6	26.6	-76.0	-10.7	-18.6	56.2	5.2	30.9	-25.2	11.2

Subject 02

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-67.6	18.4	-75.7	54.2	-34.4	79.5	-35.1	26.9	-32.0	-11.1
-74.7	21.0	-101.1	85.6	-41.5	77.5	-66.5	71.0	-76.2	45.6
-70.2	78.9	-80.9	24.2	-10.8	62.9	-73.2	84.1	-81.7	60.8
-94.6	107.3	-77.1	57.4	-40.5	57.8	-58.1	59.1	-71.7	28.3
-73.2	52.1	26.3	97.6	-61.1	96.0	-46.1	67.9	-49.3	40.7
-73.8	82.7	-28.8	19.2	-70.0	108.6	9.0	50.1	-86.2	66.2
20.7	124.3	-16.6	43.9	-54.4	86.6	-30.5	55.1	-94.5	85.8
-33.6	46.9	-21.6	38.8	-45.5	94.3	-76.6	88.9	-50.2	69.1
-30.1	71.8	-12.8	21.8	-17.1	82.7	-85.4	104.1	-125.8	14.5
-30.5	66.3	-40.0	31.3	-52.1	85.3	-71.0	97.9	-137.2	37.3
-24.5	49.3	-60.2	67.4	-73.1	112.0	-51.5	92.7	-100.7	-1.3
-45.1	58.6	-79.7	95.9	-84.4	126.1	-100.5	45.2	-130.8	78.1
-57.7	91.4	-50.5	51.0	-72.1	119.6	-110.7	64.1	-142.9	102.8
-77.5	117.2	-55.7	72.5	-55.8	116.7	-81.8	34.5	-101.7	92.9
-49.8	76.3	-7.6	32.8	-86.7	72.9	-121.8	99.1	-110.0	52.0
-56.2	97.0	-23.3	55.2	-99.8	90.4	-134.8	120.1	-119.6	73.0
-25.6	61.6	-63.3	83.0	-121.4	21.7	-103.6	118.5	-80.0	51.7
-43.0	81.7	-89.8	118.5	-73.3	64.7	-92.6	75.7	-100.2	54.8
-62.8	105.6	-46.4	77.7	-110.5	122.1	-103.4	94.0	-109.7	75.8
-88.5	136.0	-57.5	96.3	-128.2	141.9	-68.1	77.4	-66.2	55.0
-52.1	100.1	-95.2	41.8	-100.0	144.3	-85.7	78.2	-109.3	54.7
-61.8	118.4	-132.3	79.9	-77.6	100.8	-96.6	96.3	-117.8	73.9
-89.3	-67.9	-140.0	-26.2	-92.3	118.2	-58.3	80.3	-82.7	54.9
-86.4	67.2	-107.9	42.2	-56.7	103.8	-94.3	78.3	-129.1	103.9
-119.5	101.0	-49.1	12.6	-73.8	102.8	-103.6	94.8	-78.4	93.3
-115.8	11.8	-107.0	106.6	-88.5	120.0	-120.6	77.4	-83.3	59.2
-99.9	68.6	-164.3	167.9	-51.3	106.3	-73.7	80.3	-96.6	86.4
-44.6	42.1	-131.2	162.5	-82.6	103.0	-114.9	121.1	-22.2	62.9
-98.5	131.1	-86.6	72.7	-95.2	118.7	-71.5	118.4		
-151.7	181.7	-124.6	115.4	-98.0	102.5	-79.1	81.7		
-126.7	187.9	-107.9	53.4	-66.5	106.3	-96.0	106.3		
-76.2	97.4	-92.7	88.3	-105.8	143.3	-26.3	89.8		
-112.6	134.9	-85.4	76.4	-63.6	143.9				
-83.0	78.1	-123.6	119.7	-72.5	105.3				
-83.4	113.1	-103.2	63.6	-95.4	129.0				
-77.0	100.5	-90.6	93.9	-28.7	116.5				
-113.5	138.2	-84.7	79.9						
-84.2	87.1	-118.3	119.9						
-84.4	117.9	-96.1	75.5						
-76.5	104.3	-88.2	96.6						
-108.7	139.0	-132.6	144.1						
-80.5	99.3	-108.9	126.3						
-82.0	121.0	-91.1	124.7						
-122.6	160.9	-78.3	84.0						
-81.8	145.1	-69.7	46.1						
-86.2	149.8	-140.0	148.1						
-74.6	108.3	-82.1	124.8						
-56.8	70.5								
-135.1	163.6								

Subject 03
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-73.8	6.0	-77.5	31.1	-71.6	5.7	-82.9	27.2	-88.3	52.7
-92.4	11.6	-85.1	39.5	-69.7	-0.2	-36.7	30.9	-38.2	61.1
-75.5	1.0	-89.5	22.7	-72.3	3.1	-87.3	20.5	-97.9	46.9
-72.8	4.0	-93.9	28.6	-75.2	-0.1	-99.0	26.0	-115.4	54.2
-90.9	1.0	-99.2	17.1	-72.7	-2.5	-87.8	13.9	-96.5	32.4
-73.5	-1.7	-87.6	18.8	-76.6	-1.0	-90.4	16.2	-101.8	40.9
-71.1	0.6	-77.9	21.5	-74.5	1.0	-85.0	19.7	-88.8	45.3
-72.7	3.3	-78.7	32.3	-71.1	0.1	-81.8	31.2	-82.4	65.2
-67.3	1.5	-75.7	20.1	-91.9	2.3	-81.0	18.5	-86.5	41.8
-87.4	4.5	-101.5	25.5	-84.9	3.5	-106.7	24.4	-114.1	51.5
-76.6	5.1	-89.8	35.3	-56.2	6.2	-99.2	34.6	-103.2	69.7
-134.5	26.1	-155.7	32.2	-24.5	3.5	-79.9	11.4	-102.5	17.5
-84.4	9.8	-99.7	20.3	-60.9	1.8	-45.2	8.0	-65.3	13.1
-100.8	16.1	-116.1	23.3	-60.3	4.5	-84.4	12.3	-103.4	26.9
-82.8	4.0	-102.8	15.5	-65.5	2.0	-93.9	14.7	-122.6	28.3
-82.1	7.3	-110.0	19.6	-64.8	-0.2	-84.9	6.2	-102.9	11.9
-95.6	4.3	-111.7	10.7	-67.3	1.3	-87.4	9.6	-105.8	23.7
-80.1	0.9	-98.9	12.6	-64.2	2.9	-82.4	12.0	-94.3	26.2
-78.9	3.4	-92.1	14.3	-62.0	2.0	-79.2	21.2	-88.6	44.0
-81.6	6.5	-95.2	23.0	-77.7	4.4	-78.8	10.2	-93.1	21.2
-76.3	4.3	-91.5	12.7	-70.5	5.2	-101.0	14.7	-120.2	28.3
-93.6	8.1	-116.6	17.1	-45.8	4.3	-94.0	22.5	-110.1	44.6
-85.7	8.7	-107.3	24.9	-2.7	0.3	-48.0	19.2	-47.8	38.9
-51.0	4.6	-49.8	23.4	-55.3	0.6	4.0	17.3	10.3	39.5
-54.2	7.3	-41.9	24.9	-53.0	3.0	-67.2	18.2	-74.5	41.9
-60.9	1.4	-71.0	19.3	-60.4	0.7	-71.8	21.4	-84.1	45.8
-54.2	3.5	-70.4	23.1	-60.3	-1.2	-67.1	11.8	-71.6	27.3
-75.7	1.5	-80.2	13.9	-62.5	0.1	-72.9	15.0	-81.2	37.5
-61.4	-0.8	-72.0	16.7	-58.4	1.6	-66.1	17.8	-66.8	40.7
-57.0	1.1	-60.1	18.3	-56.4	0.8	-61.0	27.8	-59.3	59.2
-55.3	3.0	-57.7	27.4	-73.0	2.9	-60.8	16.1	-62.6	36.4
-52.4	1.7	-56.5	16.3	-64.5	3.6	-81.9	21.0	-86.0	44.6
-68.2	4.2	-77.8	20.1	-40.5	3.8	-73.0	29.7	-74.8	61.4
-56.0	4.3	-65.1	29.0	4.6	-0.6	-42.6	18.4	-42.5	37.7
-51.4	4.7	-49.7	23.3	-52.3	0.6	11.5	16.0	17.7	37.7
-54.9	7.4	-41.7	24.7	-49.0	2.8	-64.1	18.0	-71.5	41.6
-61.2	1.4	-70.9	19.3	-57.3	0.7	-67.8	21.0	-80.2	45.1
-54.6	3.5	-70.2	23.0	-57.7	-1.1	-64.0	11.6	-68.4	26.9
-75.9	1.6	-80.1	13.9	-59.6	0.1	-70.2	15.0	-78.6	37.3
-61.6	-0.8	-71.9	16.7	-55.1	1.5	-63.1	17.6	-63.9	40.5
-57.3	1.1	-60.0	18.2	-53.3	0.8	-57.7	27.6	-56.3	58.9
-55.6	3.1	-57.6	27.3	-69.5	2.7	-57.6	15.9	-59.5	36.1
-52.7	1.7	-56.4	16.3	-60.6	3.4	-78.3	20.6	-82.5	44.1
-68.5	4.3	-77.6	20.1	-97.9	5.3	-69.1	29.3	-71.3	60.9
-56.4	4.4	-64.9	28.9	-80.9	-2.3	-114.0	15.7	-125.9	29.7
-38.9	1.9	-52.5	17.5	-89.3	1.5	-101.0	12.8	-114.6	33.9
-57.1	-1.1	-78.5	13.4	-87.4	-2.4	-122.8	17.0	-146.7	38.3
-46.5	1.0	-81.2	17.1	-82.3	-4.9	-101.9	4.6	-113.9	14.8

Subject 03

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-76.2	-1.6	-90.4	5.6	-88.2	-3.4	-101.9	8.6	-115.8	28.2
-58.3	-3.2	-77.9	11.1	-88.1	-1.1	-97.3	12.3	-102.4	33.0
-52.3	-1.2	-64.0	12.9	-82.9	-2.0	-95.7	25.6	-96.6	57.1
-48.6	0.6	-62.5	24.5	-110.5	0.0	-93.9	10.5	-101.3	27.5
-45.9	-0.5	-59.6	9.9	-104.8	1.7	-128.7	15.6	-140.1	36.6
-66.2	1.3	-91.5	12.3	-73.8	4.6	-122.0	28.3	-127.9	60.3
-48.2	1.7	-74.8	25.6	-66.5	-6.2	-91.3	9.8	-107.1	16.9
-78.1	4.8	-88.0	16.8	-78.1	-7.3	-90.7	12.2	-107.1	38.3
-76.8	-7.3	-106.9	4.4	-72.3	-9.1	-90.7	-3.0	-101.8	3.8
-115.2	-11.3	-132.2	-14.9	-80.4	-8.4	-94.4	6.0	-110.4	28.5
-71.4	-9.4	-95.2	2.9	-77.6	-6.1	-85.6	12.0	-87.6	37.9
-65.7	-6.5	-75.2	6.2	-69.5	-6.3	-81.3	36.3	-78.8	80.7
-64.6	-3.3	-90.2	11.4	-90.2	-5.7	-76.9	8.7	-81.5	29.0
-53.6	-0.6	-100.9	16.2	-109.7	-2.0	-115.0	9.1	-156.3	41.7
-89.0	-4.9	-105.5	0.7	-98.8	-6.2	-158.4	12.8	-135.2	95.3
-64.0	-5.7	-86.3	8.7	-89.6	-8.5	-116.6	-2.0	-132.2	30.5
-58.1	-3.3	-71.1	11.4	-98.7	-7.3	-112.8	4.2	-193.1	34.4
-55.6	-1.1	-72.2	27.2	-101.5	-4.9	-109.1	8.8	-132.4	4.7
-50.4	-2.2	-66.4	7.6	-93.1	-5.6	-109.9	26.3	-129.7	23.6
-82.0	-1.1	-115.8	8.7	-135.4	-4.9	-106.2	6.2	-115.0	30.1
-78.0	-0.5	-94.4	29.6	-133.0	-2.6	-159.2	10.9	-109.9	61.9
-75.8	2.6	-96.8	12.1	-70.4	-1.4	-154.8	29.7	-115.4	22.7
-95.3	-0.9	-105.6	16.1	-73.8	1.9	-90.9	11.1	-174.1	32.4
-75.1	-3.3	-108.2	5.0	-76.5	-1.4	-107.4	13.7	-159.9	67.2
-72.9	-0.8	-92.6	9.6	-73.5	-3.8	-91.5	3.1	-106.2	29.0
-75.4	1.9	-82.7	11.5	-78.0	-2.3	-93.4	7.6	-133.9	30.6
-68.9	0.1	-85.6	22.5	-75.9	-0.3	-88.0	10.8	-104.9	9.8
-92.8	2.9	-80.8	8.8	-72.0	-1.2	-85.2	23.0	-108.6	24.4
-80.8	3.8	-115.1	11.9	-95.8	0.8	-83.8	8.7	-94.7	28.4
-72.6	-11.6	-101.8	23.9	-88.3	2.2	-115.1	13.2	-88.4	51.5
-72.8	-12.3	-72.0	4.1	-71.6	-11.7	-107.4	24.6	-92.8	22.4
-46.2	-7.5	-101.4	-19.2	-50.5	-8.3	-72.1	2.9	-129.1	30.2
-67.3	-9.9	-59.7	13.0			-45.0	4.9	-117.0	52.9
		-78.1	-5.3			-65.4	-15.4	-71.6	23.4
								-19.1	38.4
								-62.9	21.6
								-81.3	-26.0

Subject 03
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-141.1	24.1	-20.7	33.2	7.8	102.5	-27.6	83.7	-31.3	47.4
-43.5	87.8	-7.9	81.7	-11.1	114.9	-36.9	97.0	-57.2	79.9
-108.8	119.7	-67.9	68.6	51.6	131.2	-22.7	109.4	-61.6	65.0
-7.4	128.8	-128.2	99.0	31.2	89.5	19.8	70.6	-62.1	79.0
13.5	81.9	-44.5	125.3	13.1	102.4	16.9	83.3	-45.9	105.1
-48.5	123.2	-98.4	70.4	83.7	120.8	24.1	97.7	-77.8	87.8
70.8	131.6	-93.1	96.0	-67.5	56.6	59.2	100.6	9.7	52.2
31.0	64.2	-64.0	103.3	-93.4	49.4	-66.7	23.6	19.1	64.6
-176.0	-2.4	4.5	62.1	-71.7	81.3	-76.2	20.2	45.8	87.8
-163.3	-5.7	-38.5	98.3	-90.3	60.9	-57.8	52.6	-24.0	48.2
15.6	58.6	15.0	101.0	-127.4	54.8	-80.0	28.1	-15.8	74.7
-129.5	33.4	17.5	47.7	-97.4	89.0	-94.2	25.5	68.8	130.2
-74.6	37.8	33.8	96.8	8.1	65.0	-71.0	61.6	35.9	47.5
-119.7	-10.9	23.8	61.5	-55.0	24.7	-61.5	49.6	-0.3	77.2
-99.3	29.6	-5.6	40.8	-30.8	51.0	-69.2	51.7	-87.6	99.2
-84.3	63.6	-125.6	6.3	-36.7	77.2	-52.2	79.4	-74.1	-22.5
-129.6	49.5	-71.7	10.9	-54.1	75.0			-59.4	-14.2
-180.1	44.6	-108.8	-35.4	-38.3	105.3			-44.6	17.9
-150.5	83.8	-81.8	6.4					-42.3	77.0
-161.8	5.1	-71.6	38.5					-92.3	21.4
-29.3	48.8	-124.7	21.4					-81.0	30.3
-39.1	97.1	-151.5	19.0					-67.5	54.4
-66.2	10.1	-132.5	59.7						
-83.7	47.3	10.3	94.3						
-80.3	29.7	-50.1	21.4						
-99.9	70.5	-48.1	72.1						
-95.0	76.9	-96.0	-22.7						
-50.7	63.3	-102.7	18.8						
-70.7	60.6	-91.5	-2.6						
-58.4	95.9	-97.3	43.4						
0.3	53.9	-123.1	54.8						
-38.8	88.3	-68.4	38.8						
		-77.8	39.5						
		-67.7	71.3						

Subject 04
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-88.4	-15.6	-113.6	-0.5	-42.8	-7.6	-71.8	7.7	-95.3	32.4
-80.2	-14.5	-89.0	-1.2	-72.3	-13.0	-81.4	3.4	-87.3	32.0
-48.9	-10.1	-79.7	10.4	-32.8	-6.5	-67.9	10.1	-158.5	197.7
-36.8	-7.8	-48.8	9.1	11.8	2.3	-3.9	11.1	-102.8	103.0
-53.8	-11.0	-87.4	2.1	-51.6	-10.0	-90.4	-4.4	-120.1	143.2
-72.8	-13.6	-84.9	51.4	-82.5	-15.4	-118.8	46.4	-93.9	134.1
-84.9	-16.6	-107.2	29.9	-52.1	-9.9	-119.4	27.3	-95.8	37.9
-83.8	-18.0	-116.0	40.0	-58.8	-12.4	-98.4	42.9	-19.4	25.0
-109.4	-22.7	-102.3	14.7	-68.0	-14.5	-83.8	17.4	-124.8	7.3
-85.3	-16.6	-119.8	9.6	-90.6	-18.6	-85.2	17.7	-124.9	109.4
-69.3	-14.1	-93.1	26.6	-70.6	-15.1	-99.4	26.4	-135.2	82.5
-41.6	-8.7	-81.6	26.4	-83.1	-14.5	-83.9	27.2	-116.2	106.6
-29.5	-6.4	-58.1	49.8	-54.9	-11.1	-71.1	47.8	-100.0	59.9
-46.6	-9.8	-101.6	29.2	-9.1	-1.8	-94.7	32.3	-95.8	61.2
-65.0	-12.4	-61.3	11.3	-75.8	-15.0	-75.0	6.7	-101.5	79.6
-78.4	-15.7	-29.2	10.1	-110.1	-20.9	-8.9	7.8	-90.5	78.7
-78.4	-17.2	-68.6	2.4	-77.5	-14.9	-99.1	-8.7	-73.8	107.3
-104.6	-22.1	-88.9	31.7	-79.2	-17.0	-133.6	43.4	-97.7	86.6
-78.7	-15.6	-101.2	42.2	-88.5	-19.1	-128.9	24.2	-89.9	38.0
-62.6	-13.0	-87.4	15.8	-113.2	-23.6	-106.3	40.7	-10.3	24.9
-48.1	-11.5	-104.4	10.2	-90.9	-19.7	-90.3	14.6	-118.7	6.2
-31.0	-7.6	-75.0	28.3	-115.5	-20.5	-91.7	14.9	-118.5	111.7
-55.2	-13.1	-64.3	28.2	-53.7	-12.5	-106.5	23.7	-131.0	83.6
-96.8	-24.0	-24.4	53.9	12.3	2.9	-90.0	24.8	-112.4	108.1
-135.1	-32.5	-73.8	31.0	-87.1	-21.3	-81.6	45.3	-95.4	60.5
-78.1	-18.4	-82.1	16.4	-99.5	-24.5	-104.7	29.2	-91.2	61.9
-108.7	-28.5	-39.2	15.7	-135.2	-32.3	-91.1	11.3	-97.1	80.7
		-92.7	4.6	-102.7	-25.4	1.3	16.0	-86.2	79.8
		-123.0	44.1	-123.4	-31.9	-127.7	-11.2	-66.3	109.5
		-132.3	54.2	-137.7	-35.8	-168.9	34.2	-91.6	88.0
		-112.0	20.1	-140.6	-36.7	-133.8	55.8	-117.0	49.3
		-137.0	13.0	-64.4	-16.7	-108.4	19.9	-10.8	36.8
		-101.9	39.0	-80.1	-20.9	-110.0	20.1	-162.9	6.8
		-85.2	37.8	-84.3	-22.1	-130.5	31.5	-173.1	161.9
		-1.1	26.9			-107.1	32.5	-168.0	104.5
		-127.0	73.4			-101.8	17.7	-139.0	130.2
		-100.8	29.0			-151.9	69.0	-118.1	73.7
		-131.6	20.3			-119.6	25.9	-112.6	75.4
		-64.0	54.3			-121.2	26.0	-120.1	97.8
		-143.5	77.5			-145.3	39.0	-105.1	95.5
		-113.8	29.6			-117.3	39.6	-93.2	154.4
		-114.1	-21.7			-95.0	89.1	-123.7	118.3
						-71.1	43.1	-105.4	74.0
						-73.7	43.0	15.8	65.9
						-96.3	56.6	-152.7	32.8
						-73.3	55.8	-163.0	130.0
						-45.3	12.1	-134.0	152.2
								-110.5	93.8

Subject 04

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
								-104.7	95.3
								-113.2	118.6
								-98.1	114.5
								-75.9	198.8
								-112.1	152.7
								-57.0	94.1
								75.9	89.5
								-90.0	57.3
								-54.8	201.2
								-121.8	148.2
								-102.0	167.4
								-75.4	109.6
								-70.2	111.0
								-79.8	134.1
								-67.7	129.0
								-12.9	224.7
								-58.4	175.1
								-103.3	104.6
								-39.4	46.5
								-109.5	28.5

Subject 04
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-6.6	111.2	-22.7	77.1	-30.2	111.9	-47.9	78.4	-61.7	45.6
2.1	106.6	9.9	74.5	17.8	113.1	27.4	80.8	38.1	48.7
3.4	110.3	-14.4	75.7	-34.6	123.2	-56.7	87.4	-81.8	50.3
-95.3	92.9	-50.3	71.0	16.8	84.9	-32.7	58.5	-93.4	82.4
-7.7	102.6	-8.4	72.1	41.7	96.8	30.0	68.7	-66.7	33.7
1.2	102.0	-40.4	70.4	8.4	97.7	-40.9	66.8	19.0	41.7
2.4	102.9	-13.4	99.9	36.2	117.8	-35.1	90.2	-82.5	36.0
-95.3	102.5	17.7	86.2	-29.0	129.5	36.9	87.0	-91.9	61.3
17.5	118.4	-5.0	95.9	17.6	123.0	-44.7	99.2	-51.3	56.9
29.2	132.4	-54.0	103.6	-33.2	138.7	-63.0	96.4	-55.2	57.4
-98.6	74.1	-9.2	91.5	42.2	135.1	13.3	92.7	36.3	57.0
-23.1	141.9	-43.4	100.3	22.3	59.3	-70.4	103.9	-72.6	62.7
-5.8	123.5	49.7	102.9	-14.6	94.4	56.4	102.8	-83.7	90.7
-10.5	136.8	-74.1	11.1	-21.8	49.0	-29.9	48.7	-83.3	63.5
-72.6	61.9	-90.6	37.8	24.3	59.5	-5.5	46.7	8.9	62.9
37.7	137.5	-110.8	-23.8	4.8	86.1	-45.4	72.4	-100.8	68.1
-62.6	57.1	-63.8	-8.2	-23.2	110.8	-44.1	73.2	-109.3	92.3
-21.2	54.4	-48.9	57.7	-23.2	111.4	-57.2	35.4	-72.6	94.4
-69.1	78.4	-12.7	63.1	-31.4	79.6	-29.7	31.3	63.5	70.6
-81.3	32.1	-67.4	70.6	11.0	72.7	-20.8	50.7	-19.3	1.3
-60.5	15.3	-76.7	32.8	4.9	89.0	68.8	65.6	-77.0	29.8
-44.1	37.0	-64.6	32.2	54.7	94.0	41.6	60.0	-54.8	6.8
-37.9	93.4	-42.5	41.7	29.1	96.3	78.0	70.5	76.4	39.9
-32.0	114.1	11.9	82.5	41.4	109.5	77.0	56.9	61.4	18.7
3.4	99.5	-12.5	64.1	24.5	101.9	53.0	61.2	148.7	22.1
-49.3	105.4	15.4	73.1	25.9	100.0	29.0	77.3	46.5	37.7
-55.2	71.0	54.8	67.5	18.3	112.6	10.8	78.7	15.8	39.2
-29.1	68.1	23.2	62.1	7.6	113.8	12.3	54.9	21.6	5.6
-22.1	76.1	14.5	66.2	6.6	93.5	38.5	53.4	44.3	9.4
-5.4	115.9	-29.8	73.5	37.3	89.7	35.1	63.3	43.7	23.6
-20.2	97.6	-31.0	49.1	30.8	98.5	-13.2	54.0	-33.6	1.5
-10.7	108.6	-16.3	49.9	-0.8	95.2	-54.3	81.6	-94.7	32.0
8.5	106.9	-9.6	53.5	2.9	119.6	-50.0	78.9	-47.5	34.3
2.5	98.2	-40.8	58.3	-27.7	120.8	-64.5	43.9	-104.1	59.4
6.7	99.9	-5.6	62.9	-26.4	117.7	-39.5	42.2	-87.0	43.4
-30.2	106.1	-59.7	70.6	-34.8	89.7	-28.9	58.6	-62.9	53.6
-32.6	83.8	-66.8	35.2	3.2	86.0	-61.1	84.0		
-13.2	82.8	-53.1	35.0	-1.1	98.8	-74.8	93.3		
-10.8	86.0	-35.1	43.3	0.3	94.6	-36.6	90.6		
-28.1	95.0	-38.4	37.4	-35.5	124.1				
-17.6	112.8	-65.4	59.0	-49.7	84.9				
15.2	112.3	-76.7	0.8	-23.4	128.9				
10.7	100.1	-29.2	16.1	-15.7	126.1				
-40.3	106.1	-99.4	46.1						
-44.3	74.8	-59.6	59.4						
-18.2	72.7	-101.3	61.5						
-14.0	79.2	-111.2	64.9						
-30.9	79.2	-139.7	7.9						

Subject 04

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
23.9	82.9	-87.0	23.4						
-45.7	96.4	-82.3	75.4						
-51.4	52.4	-99.7	21.1						
-17.0	41.8	-49.0	36.2						
-11.4	58.5								
-54.1	91.2								
-64.5	95.1								
-83.1	95.1								
-66.0	108.0								
-79.1	55.1								
-27.9	64.5								

Subject 05
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-39.7	5.2	-68.1	0.0	-12.1	-0.2	-77.8	28.7	-135.9	90.8
-42.0	-0.9	-57.8	3.3	-76.0	-1.0	-34.9	-9.3	-59.0	54.6
-51.8	-0.2	-60.0	15.6	-79.4	-1.9	-91.0	29.2	-93.9	63.9
-83.7	-0.5	-91.9	29.9	-86.7	-1.0	-92.9	14.6	-141.6	37.1
-75.6	-0.3	-93.2	21.4	-14.3	0.6	-86.7	31.4	-140.3	45.3
-40.3	4.2	-122.2	23.2	-4.5	0.3	-94.7	37.0	-102.7	36.5
-41.2	1.8	-95.7	16.8	-47.6	2.5	-41.8	-11.5	-84.2	69.1
-46.1	2.8	-81.7	31.6	-45.9	4.2	-30.0	-5.5	-90.3	77.7
-38.8	4.5	-79.3	37.2	-58.1	3.5	-73.2	12.5	-78.2	-38.4
-59.4	4.4	-68.5	3.1	-52.8	3.3	-92.6	4.7	-59.6	-17.7
-64.4	6.6	-61.9	1.6	-50.1	2.1	-90.4	4.1	-93.4	27.0
-58.2	4.1	-63.1	8.4	-54.2	1.7	-88.0	5.9	-143.4	2.4
-67.7	5.3	-66.3	9.7	-55.7	2.4	-75.6	4.8	-123.6	4.0
-62.8	3.8	-79.7	16.7	-49.9	4.1	-73.2	17.3	-122.7	9.1
-58.3	3.6	-94.4	16.6	-41.4	3.1	-76.9	19.5	-100.1	8.6
-52.8	4.1	-80.7	12.2	-61.0	1.9	-69.4	15.8	-85.0	38.5
-39.8	4.6	-94.5	13.3	-58.4	2.8	-64.8	11.3	-89.7	42.4
-67.3	6.6	-83.1	10.5	-102.6	4.3	-85.5	-0.8	-84.0	31.4
-41.9	3.2	-74.9	18.9	-133.3	10.8	-78.8	7.6	-84.7	22.7
-42.2	0.8	-72.9	20.3	-118.5	5.9	-117.4	23.7	-113.1	-7.2
-48.5	1.7	-59.0	15.7	-113.8	5.8	-165.7	25.8	-97.2	14.2
-65.7	3.2	-84.5	17.6	-100.3	3.1	-140.8	16.9	-121.3	48.9
-75.3	5.7	-71.2	6.5	-100.5	2.1	-138.8	19.0	-185.9	45.1
-64.0	2.8	-62.2	3.3	-107.2	3.6	-117.6	14.8	-155.3	32.6
-76.5	3.9	-63.9	11.5	-128.1	9.3	-109.4	25.5	-154.2	37.2
-69.1	2.3	-84.3	21.3	-111.3	7.3	-116.6	29.1	-128.0	31.5
-63.6	2.3	-105.1	23.0	-51.4	1.2	-129.4	33.2	-108.1	54.6
-57.4	2.9	-85.4	15.9	-46.8	1.9	-120.7	27.0	-114.1	60.0
-78.5	5.6	-102.6	17.1	-95.1	3.3	-80.0	14.2	-120.6	61.3
-54.6	-0.3	-87.8	13.4	-111.7	4.7	-72.5	24.2	-120.0	51.8
-65.1	0.8	-78.1	23.5	-106.4	4.7	-111.4	38.1	-103.8	29.3
-91.0	2.2	-76.0	25.8	-93.3	2.2	-153.5	48.8	-89.0	49.4
-87.4	1.8	-59.0	24.1	-94.2	1.3	-133.4	33.2	-112.7	73.8
-106.7	2.9	-91.6	23.9	-100.6	2.6	-131.3	35.4	-159.0	85.7
-91.0	0.9	-82.1	13.4	-120.0	7.8	-112.0	28.6	-140.4	64.2
-84.6	1.0	-86.3	24.3	-102.3	5.9	-104.9	37.4	-139.6	68.2
-80.7	2.2	-111.9	36.5	-47.8	2.0	-111.5	42.0	-118.8	58.4
-49.8	0.4	-151.5	47.5	-43.4	2.6	-120.3	52.4	-102.8	74.4
-58.0	1.5	-113.0	30.1	-84.2	4.4	-112.5	45.1	-107.6	80.7
-78.7	3.0	-135.6	32.8	-101.1	9.3	-56.8	7.6	-108.4	91.2
-76.2	2.6	-113.1	25.6	-97.2	5.9	-47.5	15.2	-108.6	82.0
-91.3	3.8	-100.9	36.3	-92.6	5.8	-84.7	29.4	-79.6	14.8
-80.5	1.9	-102.1	41.6	-83.7	3.5	-106.3	32.4	-63.5	17.1
-74.7	1.9	-130.7	46.1	-85.2	2.7	-101.2	24.1	-48.2	34.3
-69.8	2.8	-60.4	2.8	-89.7	3.9	-99.2	25.9	-98.3	50.6
-98.1	6.0	-62.0	11.7	-99.7	8.3	-86.6	21.5	-77.2	61.0
-43.5	-1.6	-84.4	22.2	-87.2	6.6	-83.1	30.7	-100.2	62.1
-42.5	-1.6	-108.3	24.4	-37.2	-0.7	-87.2	34.1	-97.0	49.5

Subject 05

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
		-85.6	16.2	-105.5	-1.8	-84.3	37.9	-96.4	53.2
		-104.6	17.5	-104.9	-2.9	-79.6	32.6	-82.9	46.8
		-88.2	13.5	-117.7	-1.8	-44.8	7.5	-73.8	64.7
		-77.7	24.5	-8.9	-0.1	-99.2	44.6	-76.4	69.7
		-75.4	27.2	-66.6	0.2	-100.6	29.1	-64.7	71.9
		-92.8	25.4	-68.1	-0.5	-93.1	42.5	-66.1	64.4
		-55.2	-7.0	-72.2	-1.3	-101.7	49.7	-50.5	20.8
		-62.8	-18.4	-77.8	-0.5	-18.7	-2.5	-22.3	55.6
		-87.0	28.6			5.8	10.0	-80.4	89.7
						-69.4	32.4	-115.1	75.6
						-96.2	21.3	-114.2	82.0
						-92.5	24.8	-88.2	66.3
						-73.0	19.1	-75.8	88.0
						-71.0	34.1	-80.0	97.5
						-76.1	39.4	-57.7	126.8
						-55.2	33.0	-60.2	109.3
								-29.2	-7.9
								1.3	25.1
								-135.3	113.8
								-64.7	69.9
								-95.9	48.8
								-95.2	55.6
								-72.5	45.9
								-63.6	73.7
								-66.9	81.8
								-34.5	97.1
								-38.2	81.0
								-44.8	73.6
								-47.3	85.3
								-61.8	231.5
								-138.2	-63.7
								-88.1	48.0
								-89.6	62.4

Subject 05
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-75.1	31.4	-57.8	9.2	-63.3	32.8	-40.8	6.2	-48.9	-42.4
-86.2	-22.4	-85.8	-42.6	-76.4	-31.2	-84.3	-64.2	-4.9	-28.4
-40.4	17.3	-47.6	-3.3	-20.1	20.1	-32.2	-6.6	-15.2	-26.9
-3.4	27.6	-14.8	7.1	21.4	20.9	8.3	-2.4	-51.9	30.4
-34.8	13.8	-42.1	-2.3	10.5	11.8	-2.8	-7.7	-114.6	-28.1
-65.6	63.1	-45.7	-50.4	-47.1	72.6	-47.6	53.4	-75.9	17.0
-71.0	28.0	-66.5	45.2	-53.2	33.6	-75.2	8.3	-33.0	13.7
-41.7	54.6	-83.6	8.0	-17.6	65.7	-41.0	43.6	-46.7	21.6
-15.1	59.6	-58.1	34.6	13.1	59.8	-8.0	38.0	-142.8	63.7
-38.6	56.0	-32.8	39.4	2.5	63.4	-20.6	43.1	-63.5	43.2
-41.4	39.1	-55.1	37.0	-32.5	55.3	-67.2	32.0	-90.1	61.1
78.2	90.3	-61.5	20.0	-108.0	117.8	-107.9	102.7	-22.5	50.6
-67.8	102.1	23.5	69.0	-128.7	59.8	-159.8	36.0	-49.4	4.6
-80.5	46.4	-63.5	87.4	-63.3	105.7	-95.8	85.2	-103.1	-22.2
-29.9	85.6	-94.6	26.6	-8.0	86.6	-34.6	65.4	-114.5	-57.0
9.8	85.9	-51.0	65.2	-35.1	103.8	-64.0	82.8	-55.3	32.3
-23.0	92.9	-13.6	65.2	-106.8	60.4	-84.1	31.2	-91.2	21.0
-108.9	-10.5	-45.6	71.2	-95.3	92.6	-64.3	72.3	-74.6	-7.2
-105.7	54.7	-88.9	30.5	-158.7	51.2	-131.4	20.0	50.4	13.8
-96.5	96.9	-72.2	80.6	-92.3	61.6	-49.1	33.8	-29.3	-22.0
-170.2	59.7	-156.2	34.8	-113.3	87.8	-88.2	66.1	-11.3	22.3
-92.5	58.8	-59.5	35.4	-105.0	56.7	-91.3	25.6	-50.2	-27.8
-109.6	81.5	-89.8	62.4	-96.8	37.9	-78.0	0.5	14.8	-17.8
-108.0	48.0	-98.2	22.6	-72.0	62.5	-60.7	38.3	-30.8	14.2
-107.2	30.8	-95.2	2.1	-91.8	57.6	-75.3	30.4	-48.9	-29.7
-89.7	56.1	-82.1	35.2	-120.8	10.8	-125.5	-30.5	-31.4	-59.2
-85.0	51.9	-71.3	29.0	-108.6	46.1	-101.2	17.7	-31.6	-4.1
-115.2	10.7	-113.4	-18.7	-185.2	-16.0	-96.2	-38.3	-31.8	-17.6
-107.4	50.2	-99.2	26.2	-108.6	1.8	-129.4	7.5	-47.8	-19.0
-188.9	-1.5	-188.9	-32.9	-128.9	39.1	-125.3	-26.6	-23.2	34.5
-104.8	5.2	-91.3	-23.5	-115.5	15.6	-114.5	-57.6	-77.2	-26.6
-120.3	35.8	-115.0	10.7	-107.5	-7.5	-87.6	-5.9	8.1	-12.2
-114.6	12.1	-116.9	-17.5	-79.0	25.3	-114.6	-29.4	-48.7	25.6
-114.2	-6.8	-114.9	-38.8	-104.3	8.2	-74.5	18.9	-70.7	-29.4
-95.1	22.8	-98.2	-0.8	-71.9	50.9	-55.9	59.4	-50.0	-66.6
-93.7	7.9	-95.7	-18.9	-60.3	83.6	-117.4	5.0	-45.0	0.8
-76.2	43.4	-76.2	17.3	-114.7	37.7	-39.6	19.1	-49.5	-13.9
-64.2	83.7	-60.0	61.5	-50.5	49.7	-78.5	52.7		
-129.4	42.7	-130.9	16.2	-77.6	78.3	-82.8	15.5		
-57.0	44.1	-47.8	18.6	-75.9	49.4	-69.4	-9.7		
-78.3	69.1	-76.4	45.9	-65.6	29.7	-54.0	29.3		
-83.7	39.5	-86.9	12.7	-44.7	56.2	-66.3	18.4		
-82.2	22.1	-84.0	-6.7	-57.0	48.2	59.0	35.5		
-66.9	48.4	-72.9	25.6	68.9	57.2	-26.0	17.7		
-55.7	40.6	-60.5	16.2	-25.6	47.2	-13.5	48.6		
38.3	88.0	-41.0	24.9	-15.6	73.2	-47.8	7.4		
-40.0	50.3	-24.5	62.5	-48.0	35.7	4.9	16.4		
-25.8	85.4	-74.9	25.7	-2.1	44.3	-28.7	43.3		

Subject 05

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-73.2	51.0	-11.5	26.0	-28.5	68.9	-38.4	16.0		
-16.5	51.0	-39.9	49.5	-35.5	47.3	-25.8	-4.0		
-39.5	72.9	-56.3	20.5	-25.2	30.5	-19.7	27.0		
-53.2	46.6	-53.1	3.5	-11.5	52.9	-20.9	17.3		
-51.1	31.0	-46.8	31.6	-13.9	44.7	-47.3	17.9		
-39.6	54.3	-28.2	23.6	-50.6	46.3	-30.8	58.1		
-22.0	47.5	-73.0	19.3	-38.5	81.2	-82.7	3.3		
-76.1	43.2	-55.7	66.6	-90.3	29.4	-8.7	17.5		
-63.2	89.0	-131.0	18.4	-23.0	43.6	-51.6	51.3		
-138.4	41.5	-41.8	21.2	-56.2	75.3	-59.7	15.0		
-54.0	44.3	-73.3	49.7	-58.6	45.9	-44.6	-10.1		
-78.9	72.1	-84.8	14.1	-46.4	24.7	-34.3	29.0		
-84.3	38.9	-81.5	-6.2	-27.2	53.6	-40.1	17.5		
-82.4	19.8	-70.5	27.5	-34.8	43.5	-137.7	-17.3		
-66.2	48.8	-56.4	18.2	-120.3	26.8	-84.2	10.7		
-53.2	40.4	-91.4	-15.7	-107.7	-5.7				
-94.4	13.7	-69.8	53.4	-70.0	40.6				
-81.1	75.8	-94.3	28.1						
-101.5	51.9	-101.8	-14.7						
-99.2	15.4	-97.3	-43.5						
-96.9	-10.4	-80.8	7.6						
-75.3	30.3	-66.5	-15.1						
-62.5	11.0	-10.5	46.1						
-18.6	45.1	-113.0	30.4						
7.8	67.9								
-84.4	52.6								

Subject 06
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-10.4	-0.5	-22.0	11.5	-44.1	-1.3	-53.8	10.8	-60.7	30.2
12.7	1.4	10.1	24.3	-4.7	-0.4	-5.6	26.9	-8.1	64.1
4.1	0.4	-11.7	26.8	-74.3	-5.5	-78.0	25.3	-75.5	66.2
-64.4	-0.1	-91.9	-9.1	-40.1	0.9	-41.9	36.2	-36.2	86.0
-69.1	-2.5	-90.2	-2.0	-39.6	-0.7	-68.5	-12.3	-84.0	-3.5
-65.4	-4.2	-78.6	8.2	-23.1	-1.2	-61.2	-0.6	-51.5	32.4
-68.6	-5.2	-94.6	5.1	-40.5	-2.6	-38.8	12.1	-86.9	30.9
-62.4	-2.8	-91.5	-2.9	-44.0	-0.8	-66.5	10.3	-117.7	-27.0
-29.6	-1.6	-35.9	23.3	-54.5	-1.0	-76.7	-6.7	-62.5	48.3
-69.7	-3.3	-105.4	8.0	-55.3	-1.6	-60.8	19.2	-124.1	24.3
-61.6	-4.6	-93.8	1.6	-36.3	-2.2	-92.2	9.4	-96.7	17.2
-60.2	-5.8	-87.1	4.1	-42.4	-3.4	-68.0	5.9	-92.5	24.8
-55.1	-3.7	-78.9	12.4	-46.9	-2.5	-69.8	7.3	-87.7	41.1
-56.7	-3.1	-80.5	15.8	-49.0	-2.5	-71.0	14.7	-81.9	56.0
-67.5	-2.6	-99.6	15.2	-76.5	-3.5	-70.2	21.3	-106.6	63.3
-68.7	-2.1	-107.7	7.9	-43.5	-1.7	-98.2	24.3	-88.0	55.5
-61.5	-2.4	-87.5	11.3	-36.2	-0.9	-71.3	21.6	-82.6	37.7
-88.2	-10.9	-90.3	11.5	18.8	1.9	-62.5	14.8	-14.3	21.2
-90.6	-12.2	-114.3	4.6	-12.5	-1.4	5.4	27.1	-7.4	61.7
-24.4	-2.7	-19.3	41.6	-23.1	-1.8	-39.2	21.4	-59.5	54.7
-79.1	-10.6	-144.1	9.5	-5.2	-0.6	-12.0	41.6	-10.9	90.8
-73.3	-11.3	-113.5	-1.1	-18.6	-2.4	-65.8	22.0	-97.2	53.4
-69.6	-8.8	-99.5	3.4	-18.7	-1.9	-39.3	15.5	-67.9	38.3
-75.4	-8.5	-90.3	17.9	-21.3	-2.2	-46.8	16.2	-69.0	44.8
-86.3	-10.0	-95.1	24.6	-62.6	-6.0	-43.5	28.1	-59.9	68.9
-88.7	-11.2	-97.5	15.8	-7.7	-0.7	-43.5	37.3	-55.9	86.4
-88.0	-8.4	-118.4	9.3	11.2	0.8	-82.9	40.2	-88.0	94.7
-29.0	-3.0	-126.5	-0.1	-73.2	-4.5	-40.6	39.7	-59.5	89.3
-100.0	-9.8	-34.8	41.9	-37.4	-3.5	-18.6	33.0	-40.0	73.7
-78.1	-9.8	-145.3	15.8	-59.7	-6.5	-95.5	11.7	-110.6	35.9
-73.0	-10.7	-117.9	4.4	-80.3	-5.0	-53.3	24.4	-62.5	62.3
-69.4	-8.2	-104.3	7.2	-97.7	-6.1	-87.6	19.0	-103.5	55.7
-74.6	-7.9	-97.0	21.2	-92.9	-6.8	-120.7	1.5	-160.6	7.1
-65.9	-8.9	-102.0	27.7	-54.3	-5.8	-91.2	39.0	-78.6	89.4
-72.0	-10.6	-138.8	28.9	-59.7	-7.5	-134.1	21.5	-156.1	58.7
-58.4	-8.5	-119.3	23.7	-71.3	-7.0	-90.6	13.7	-116.3	42.1
-56.5	-9.4	-69.1	25.2	-74.7	-7.2	-89.6	13.7	-108.7	46.2
-44.9	-6.2	-98.3	15.7	-117.0	-10.6	-95.5	25.5	-105.3	68.8
-46.8	-9.2	11.6	60.5	-70.5	-5.8	-94.2	34.0	-97.9	84.1
		-96.7	9.9	-63.4	-4.5	-132.5	37.0	-127.1	92.0
		-85.6	12.7	-6.9	-0.8	-99.1	36.6	-106.7	87.3
		-71.0	31.3	-40.5	-5.4	-91.5	30.9	-103.2	74.9
		-73.0	40.9	-32.8	-4.3	-19.4	33.6	-29.4	77.8
		-84.0	14.1	-43.4	-6.5	-67.5	24.7	-83.5	66.9
		-56.1	3.7	-52.7	-6.4	-69.6	18.3	-40.3	117.0
				-56.7	-6.8	-72.4	17.8	-141.0	74.4
				-112.4	-12.9	-75.7	33.2	-95.8	50.8
				-46.1	-8.8	-74.9	43.9	-91.5	54.6

Subject 06

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
				-38.8	-7.4	-123.1	46.9	-85.2	83.1
				-20.9	-4.0	-77.5	48.7	-78.8	100.6
						-84.3	16.3	-114.0	109.3
						-63.9	28.2	-86.3	106.6
						-82.8	-18.4	-72.9	96.5
								-99.4	76.4
								-108.6	55.1
								-104.8	104.7
								-93.5	129.7
								-150.6	141.1
								-110.7	148.5
								25.9	129.5
								-64.9	100.4
								-78.4	81.7
								-78.4	78.3
								-66.9	127.0
								-61.8	146.8
								-112.8	157.6
								-68.3	167.0
								-27.2	38.9

Subject 06
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-39.4	46.4	-10.1	12.6	-2.5	92.3	-16.3	64.9	-28.7	38.0
-15.9	69.8	13.6	38.6	-114.1	61.0	10.4	70.8	-8.4	44.4
-6.1	52.4	25.5	23.7	-31.2	104.9	-35.6	47.4	-77.4	36.6
-47.8	86.3	-57.7	58.5	-88.4	98.6	17.4	68.5	-57.8	49.6
-31.1	91.2	-55.8	61.7	-11.7	77.4	76.7	64.8	48.4	45.5
-16.3	129.9	-44.1	96.5	49.4	93.4	-83.5	58.4	25.2	56.6
-168.4	15.4	-67.2	11.5	-180.7	60.7	-113.6	57.2	-151.5	1.8
-109.5	48.6	-56.9	-9.5	-98.4	98.1	-110.1	25.9	-18.9	-6.1
-110.6	26.3	-91.0	-3.2	-158.7	93.0	-40.9	56.9	-71.3	-8.8
-101.9	37.8	-51.3	22.0	-103.5	89.8	-82.4	53.2	-6.2	9.5
-70.6	57.6	-44.0	8.0	-144.0	85.0	-102.0	51.4	39.0	20.6
-68.1	42.5	-189.6	116.7	-120.5	68.3	-105.5	38.8	-58.7	40.4
-149.6	132.4	-110.1	39.2	-66.8	92.8	-100.3	24.6	64.6	40.6
-130.7	75.4	-97.3	17.7	-104.5	89.7	-39.5	51.5	-17.2	29.9
-110.8	54.8	-64.6	33.0	-133.8	67.9	-75.9	48.2	-43.2	9.3
-84.5	67.1	-59.6	22.4	-84.9	85.6	-97.8	23.6	14.8	31.1
-83.9	56.2	-77.7	20.0	-115.6	80.3	-96.2	60.8	-15.0	31.4
-102.3	56.7	-174.4	115.0	-102.9	67.0	-94.6	29.6	-19.0	20.1
-129.2	133.9	-103.6	44.3	-54.9	89.2	-27.7	60.0	-153.4	27.3
-78.5	83.9	-94.3	22.2	-88.1	86.3	-67.5	56.5	-130.4	-21.3
-111.8	80.9	-63.6	35.9	-106.7	65.3	-46.6	69.6	-34.7	17.9
-99.5	59.8	-58.9	25.8	-73.7	93.5	35.7	69.6	-81.8	16.4
-75.8	71.0	-74.6	26.3	-107.9	88.5	-35.3	63.2	-138.6	39.0
-74.6	60.7	-104.7	25.8	-96.0	70.8	-50.2	46.8	-113.6	-11.7
-85.7	63.2	-68.7	40.8	-42.6	96.5	-3.1	66.9	-14.9	29.0
-151.5	159.3	-63.4	29.8	-79.1	93.2	-30.3	65.5	-63.9	27.4
-128.2	92.6	-86.6	34.3	-96.6	70.3	-31.9	51.0		
-107.3	63.3	-145.1	142.5	-35.9	98.3	-103.6	59.7		
-79.4	75.9	-21.6	95.1	0.0	100.2	-100.7	25.7		
-78.1	64.6	-86.4	79.7	-52.5	95.4	-27.8	59.5		
-94.4	70.8	-85.2	47.9	-59.0	80.4	-71.2	55.3		
-119.0	164.4	-58.6	56.5	-17.5	100.1	-99.9	88.8		
-61.3	128.5	-54.1	47.8	-44.7	98.2	-97.7	51.4		
-101.3	111.3	-62.5	61.9	-44.2	81.9	-25.3	82.5		
-93.4	80.2	-131.3	30.4	-57.7	90.7	-68.2	80.6		
-70.9	88.8	-84.4	47.0	-86.7	63.7	-99.8	57.3		
-69.1	79.8	-78.7	34.7	-25.4	96.0	-75.6	71.8		
-75.1	93.4	-99.0	68.3	-66.9	90.9	-45.4	58.2		
-119.0	66.3	-90.8	33.5	-59.8	119.3	-97.2	21.9		
-83.1	81.9	-58.0	47.1	-91.3	121.7	-21.5	58.0		
-81.3	68.5	-52.4	36.4	-85.5	91.5	-66.4	53.2		
-115.3	166.8	-64.2	45.4	-31.2	116.6	-76.2	35.7		
-92.5	102.2	52.8	-23.5	-67.9	115.3	-4.4	69.6		
-86.0	70.7	72.0	-48.2	-78.8	102.5	-46.3	66.0		
-61.9	82.3	-136.3	-2.1	-40.1	90.5				
-59.1	71.5	-79.1	26.9	-19.1	103.4				
-60.0	80.9	-71.8	11.0	-118.0	51.5				
10.7	-2.5	-121.3	23.5	-33.0	97.8				

Subject 06

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-113.6	37.9	-76.1	41.9	-91.8	89.9				
-72.8	63.2	-70.1	29.2	-72.4	63.6				
-69.3	44.8	-92.2	33.6	-12.6	96.2				
-99.6	61.9	-54.9	49.6	-52.4	91.0				
-67.9	78.3	-48.1	37.6	-56.0	74.0				
-64.7	64.6	-51.9	49.7	2.6	106.0				
-76.7	69.1			-35.6	101.8				
-49.3	84.5								
-44.2	71.3								
-64.3	83.7								

Subject 07
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-6.2	-1.2	-10.5	-15.5	-59.5	-2.3	-69.2	-10.5	-78.0	6.2
-8.4	-1.5	-108.7	19.1	-84.2	-11.6	-127.4	18.1	-126.2	20.5
-52.3	-8.3	-82.0	-4.6	-59.6	-8.2	-34.8	-11.6	-52.6	-2.0
-2.8	-0.4	-68.5	-34.1	-32.8	-4.6	-69.5	-1.3	-71.1	-0.4
-34.0	-5.1	-138.0	-72.1	-67.2	-9.9	-67.1	-27.0	-84.2	-10.7
-45.3	-7.0	-92.6	-31.4	-49.0	-6.8	-47.9	-11.2	-54.7	2.8
-67.1	-10.4	-148.5	-10.8	-63.6	-2.2	-63.5	20.9	-73.5	33.7
-32.6	-4.4	-82.8	-43.9	-50.2	-3.9	-95.2	-48.5	-143.6	-19.3
-65.1	-7.9	-125.5	-26.0	-62.0	-4.8	-123.2	-56.6	-99.2	-59.0
-33.3	-3.9	-131.0	-66.1	-75.3	-6.5	-148.0	-79.8	-128.4	-49.7
-43.7	-4.8	-100.1	-47.9	-92.3	-3.9	-110.2	-8.1	-128.2	-46.2
-75.4	-7.5	-114.9	-21.9	-63.9	-4.6	-105.1	-19.5	-112.9	39.4
-54.8	-6.1	-22.2	17.9	-74.9	-5.4	-130.5	3.6	-102.0	-9.0
-60.9	-7.2	-98.9	33.5	-61.1	-5.3	-77.2	-15.9	-123.6	16.2
-75.2	-8.8	10.5	44.3	-45.4	-4.0	-95.7	-8.8	-82.7	1.3
-51.1	-5.6	-40.2	23.9	-65.7	-6.3	-94.9	-24.4	-92.7	2.7
-70.4	-6.6	7.8	68.4	-55.0	-4.8	-84.5	-15.3	-99.8	-3.3
4.4	0.8	-62.9	87.4	-69.0	-5.2	-93.1	3.8	-83.3	4.1
22.8	4.3	25.5	58.8	-76.7	-11.0	-78.7	37.0	-93.3	22.3
31.9	6.3	-46.4	60.1	-50.0	-7.2	-123.0	61.8	-105.1	-13.5
-9.5	-1.7	-29.8	33.0	-21.1	-3.0	-43.2	33.5	-66.3	46.6
44.4	7.4	9.7	57.6	-59.4	-9.1	-73.1	39.6	-106.9	73.7
-60.4	-10.2	-3.1	93.3	-38.5	-5.5	-71.3	16.7	-47.8	50.6
14.0	2.1	-37.4	12.1	-81.9	-11.7	-54.5	33.5	-63.5	50.7
63.4	9.4	15.3	13.1	-55.4	-7.9	-67.8	62.2	-75.5	38.7
59.7	8.4	-32.2	-16.8	-26.6	-3.8	-30.7	30.0	-49.7	53.4
40.4	5.8	-57.7	29.6	-64.1	-9.8	-69.1	18.6	-64.8	79.9
23.8	3.5	-133.3	52.0	-44.0	-6.3	-103.9	-15.9	-71.7	14.0
4.3	0.6	-106.0	25.8	-67.4	-11.1	-52.6	61.9	-79.4	11.3
48.8	6.9	13.3	27.0	-90.1	-12.3	-95.3	80.9	-52.6	148.8
		-54.0	47.2	-65.6	-9.0	-25.7	54.6	-45.0	64.3
		30.2	15.7	-38.8	-5.4	-53.7	59.1	-85.3	86.7
		-38.9	25.4	-72.4	-10.7	-52.4	38.4	-32.7	64.4
		-22.3	-9.1	-55.1	-7.6	-36.0	54.4	-47.6	64.3
		15.3	13.0			-47.2	80.4	-59.8	52.5
		3.5	44.7			-101.2	25.3	-34.8	66.8
						-139.6	50.4	-48.4	91.3
						-63.3	23.7	-45.3	30.8
						-90.4	30.2	-62.6	16.3
						-88.6	8.4	-26.2	34.9
						-73.8	23.8	-47.8	70.7
						-86.7	51.0	-130.5	-28.3
								-92.3	29.8
								-126.9	58.7
								-68.2	37.0
								-82.8	37.5
								-93.2	26.6
								-69.5	40.0
								-84.4	65.7

Subject 07
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-142.3	85.7	-114.5	60.3	-72.6	99.7	-101.0	69.0	-102.9	48.1
-65.7	102.7	-89.9	76.8	-46.5	100.4	-90.0	67.7	-87.9	47.9
-57.5	110.6	-104.5	85.5	-33.5	85.1	-75.0	53.9	-72.5	33.7
-51.1	98.7	-89.2	69.3	-15.8	104.5	-46.8	74.1	-41.4	54.4
0.9	92.7	-21.4	64.1	-21.4	107.2	-41.6	67.0	-54.7	47.4
-23.7	102.5	-98.3	74.9	-50.3	100.2	-35.7	65.2	-44.4	46.5
-89.4	90.9	-30.7	48.1	-25.3	100.2	-14.4	49.5	-22.9	30.4
-38.7	97.2	-30.5	68.4	-4.1	83.5	8.6	71.6	8.6	53.3
-32.9	106.0	-47.6	78.3	9.3	104.4	-70.3	27.8	-75.0	17.2
-17.6	92.2	-27.6	59.9	37.2	92.3	-55.9	39.4	-104.1	25.6
27.2	86.3	26.2	54.7	93.9	96.5	-128.5	55.8	-94.9	30.3
25.2	95.0	79.3	54.1	-96.1	69.6	-92.2	46.4	-137.7	-17.6
20.7	122.8	-92.9	19.6	-96.3	90.4	-92.1	53.0	-116.3	28.0
108.2	82.5	-70.4	-13.2	-100.8	83.6	-119.6	7.8	-100.1	37.6
-104.8	-6.5	-103.0	28.7	-95.1	77.7	-111.9	52.0	-100.0	29.1
-150.2	48.5	-101.9	20.6	-78.2	86.5	-87.6	59.4	-65.0	20.2
-175.2	37.6	-92.6	29.1	-142.7	57.6	-89.4	52.7	-115.7	29.3
-160.5	50.9	-95.4	13.5	-113.6	87.0	-50.5	40.5	-87.9	28.2
-142.1	37.4	-80.9	40.5	-88.9	93.9	-112.4	55.8	-59.5	11.5
-128.5	77.3	-63.2	16.1	-79.8	90.0	-81.3	47.2	-81.1	32.1
-56.5	46.2	-108.6	64.5	-12.3	103.1	-47.9	31.9	-114.4	-8.0
-111.6	95.6	-60.5	32.1	-65.0	75.4	-82.5	53.3	-100.1	30.3
-88.5	71.5	-85.7	50.8	-62.7	92.8	-104.3	13.4	-85.0	38.6
-77.5	81.2	-85.8	17.1	-67.5	87.2	-100.9	52.5	-82.8	31.2
-109.5	57.8	-86.8	42.8	-60.7	82.3	-78.1	58.9	-49.4	6.0
-95.0	75.0	-78.0	50.8	-51.8	89.3	-78.6	52.8	-71.0	10.8
-83.2	82.9	-78.9	41.1	-100.9	66.4	-35.2	27.7	-65.0	16.7
-75.1	74.0	-92.0	46.9	-81.9	90.3	-96.4	37.5	-97.4	-32.6
-24.8	125.3	-75.3	23.3	-60.2	95.7	-64.1	30.2	-85.8	14.8
-113.2	89.1	-125.1	75.1	-52.3	92.3	-22.3	8.1	-68.5	22.9
-50.8	58.6	-80.0	44.8	-55.8	50.5	-67.5	39.1	-63.9	12.2
-96.6	105.8	-98.5	58.4	-52.8	71.4	-86.8	-9.4	-23.7	26.3
-76.9	84.1	-103.2	28.8	-59.1	64.7	-87.6	38.8	-47.3	36.6
-69.0	90.9	-98.6	49.7	-49.2	56.3	-62.4	44.7	-37.3	34.7
-95.6	72.3	-90.8	58.3	-40.2	71.1	-61.0	36.0	7.5	18.6
-85.2	85.2	-92.8	49.5	-102.7	34.3	13.1	78.1	-34.7	38.5
-74.1	92.6	-79.8	34.2	-78.6	71.3	-16.0	47.8	-56.2	-1.5
-67.1	84.2	-61.6	8.8	-50.8	78.5	-59.7	63.6	-54.3	36.7
-123.3	67.6	-108.5	55.2	-40.6	74.2	-34.9	55.2	-36.3	45.1
-41.5	35.4	-58.3	20.2	47.0	107.8	7.1	41.8	-27.4	38.0
-102.9	88.4	-84.8	43.7	-32.9	78.5	-41.5	60.4		
-75.3	60.6	-84.7	5.8	-28.3	96.6	-51.0	24.5		
-65.5	74.4	-85.8	36.1	-34.1	90.8	-60.1	59.8		
-100.0	43.9	-76.8	43.7	-24.8	85.7	-36.1	65.8		
-85.7	67.2	-77.8	33.1	-21.8	93.0	-31.9	60.4		
-72.0	76.2	38.9	46.8	-67.2	69.1	-36.7	29.6		
-62.8	66.5	40.2	55.2	-52.8	93.9				
27.9	77.2	-29.4	39.8	-29.7	99.6				

Subject 07

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
72.3	83.9	-13.4	19.7	-21.4	96.1				
-47.9	73.0	-27.3	53.4	-30.5	86.9				
0.6	47.6	11.9	28.2	-84.1	85.6				
-27.8	85.8	-26.1	46.5	-45.4	97.4				
-11.6	66.6	-11.1	19.2	-30.6	92.0				
-13.5	76.6	-31.0	41.2						
-28.4	56.2	-20.3	46.3						
-29.8	72.2	-17.9	38.2						
-18.1	78.1	-80.5	25.1						
-12.9	70.9	-53.7	-10.7						
-115.4	59.7	-88.6	36.3						
-14.9	24.1	-89.2	26.5						
-87.1	87.3	-77.0	36.9						
-49.8	50.8	-77.9	19.8						
-44.2	71.3	-97.9	11.3						
-82.4	27.5	-68.3	-31.8						
-70.1	62.1	-113.6	20.7						
-52.4	73.4	-110.4	11.2						
-41.4	61.7	-99.5	21.7						
-64.1	0.5	-107.4	47.3						
-104.3	54.4								
-131.3	43.8								
-114.2	56.8								
-98.4	43.6								

Subject 08
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-84.7	-14.1	-35.6	61.1	-50.4	-9.3	-26.8	78.1	-24.5	181.3
-55.8	-9.7	-116.7	-29.9	-55.8	-10.4	-68.3	76.8	3.6	224.9
-47.6	-8.8	-73.5	15.1	-85.9	-16.1	-68.4	47.9	-78.0	147.1
-47.8	-7.9	-90.8	-9.5			-69.1	52.9	-120.8	125.4
-57.2	-9.8	-97.5	-27.5			-105.3	53.2	-47.5	170.6
-59.2	-10.1	-120.2	-12.9			-123.3	31.1	-117.4	127.7
						-119.9	36.7	-166.6	104.1
						-94.0	45.2	-45.9	103.6
						-123.5	32.8	-45.9	113.3
						-150.6	37.8	-88.5	117.1
						-174.0	3.8	-31.2	129.7
						-113.2	-23.6	-24.5	181.3
						-147.9	-18.8	-32.7	133.9
								14.2	148.9
								-7.1	137.8
								-64.6	135.9
								70.2	192.8
								-24.5	181.3
								-5.3	209.7
								-6.8	161.8
								3.6	224.9
								-11.6	163.0
								45.4	185.0
								23.1	174.1
								-49.3	162.2
								3.6	224.9
								-79.2	96.6
								-78.0	147.1
								-75.4	103.9
								-33.4	116.0
								-58.3	102.8
								-104.1	108.2
								8.3	152.7
								-78.0	147.1
								-75.3	167.9
								-118.2	80.6
								-120.8	125.4
								-110.7	88.6
								-76.9	97.8
								-102.1	85.3
								-134.3	93.8
								-53.0	126.1
								-120.8	125.4
								-130.4	138.9
								-150.5	30.7
								-179.9	43.8
								-173.2	-39.4
								-201.6	-16.1

Subject 08
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-28.1	72.4	-33.0	46.0	-40.9	94.1	-63.8	91.0	-116.5	62.6
-41.2	71.0	-57.9	41.0	-51.7	104.0	-56.2	77.8	-7.2	40.1
-39.3	107.2	-55.5	84.0	-44.3	116.5	-19.8	69.4	-29.6	42.6
-58.6	89.9	-59.7	66.3	-55.9	102.9	-27.4	71.4	-70.7	61.4
-30.8	73.9	-25.4	50.6	-27.6	93.6	-49.2	77.7	-32.4	52.5
-44.9	94.7	-47.1	70.6	-26.9	97.0	-47.8	89.3	4.1	48.7
-54.2	90.7	-66.4	64.5	-37.0	104.6	-38.5	79.0	-149.6	80.7
-48.2	119.0	-61.5	95.2	-36.0	115.0	-10.5	72.5	-151.6	60.3
-67.7	104.7	-66.0	81.6	-44.2	103.0	-41.3	58.9	-116.5	62.6
-39.9	88.0	-33.8	65.6	-20.4	95.2	-54.1	60.3	-138.6	72.3
-46.7	157.0	-30.6	89.1	-44.5	141.6	-95.1	52.7	-96.9	51.1
-34.1	76.6	-15.3	54.9	14.5	84.9	-76.2	66.4	-152.4	52.9
6.3	65.3	-35.6	42.3	-40.9	94.1	-124.7	61.1	-116.5	62.6
-28.1	72.4	-33.0	46.0	-53.3	101.7	-63.4	98.9	-112.4	44.2
-53.9	64.8	-72.8	72.8	-53.3	90.1	-73.0	104.4	-100.1	60.1
-50.0	95.0	-63.9	55.6	-62.3	81.8	-58.6	86.9	-57.1	38.3
-61.8	81.7	-74.0	51.9	-40.9	94.1	-63.8	91.0	-117.2	37.5
-48.9	76.9	-33.0	46.0	-1.3	95.0	-79.8	86.9	-33.9	56.5
-28.1	72.4	-59.3	37.8	-51.7	104.0	-99.4	98.4	-49.5	39.6
-24.0	56.9	-57.9	41.0	-63.5	111.6	-78.5	97.7	-7.2	40.1
-44.8	63.1	-118.3	32.5	-60.9	97.7	-63.9	83.6	-42.9	53.7
2.8	77.4	-96.7	65.3	-71.2	93.0	-86.6	84.9	-12.9	35.6
-11.3	64.4	-81.4	50.8	-51.7	104.0	-63.8	91.0	-59.4	34.7
-41.2	71.0	-96.5	46.6	-43.7	123.5	-63.4	83.5	-7.2	40.1
-72.7	69.8	-57.9	41.0	-34.7	127.3	-53.4	82.7		
-66.7	65.1	-56.1	90.8	-15.2	109.3	-67.0	91.2		
-61.1	90.2	-42.6	100.1	-44.3	116.5	-49.9	73.3		
-68.5	79.6	-56.8	80.9	-53.4	113.7	-56.2	77.8		
-59.8	75.0	-55.5	84.0	-58.5	122.0	-74.7	65.4		
-41.2	71.0	-83.0	103.3	-50.3	121.6	-101.1	82.4		
-43.3	58.4	-87.5	90.1	-51.9	111.1	-74.6	85.8		
-39.3	113.3	-77.8	102.9	-56.0	110.8	-57.5	71.9		
-11.3	120.0	-72.5	85.5	-44.3	116.5	-84.3	70.3		
-19.3	101.0	-79.1	90.0	-41.9	110.6	-56.2	77.8		
-39.3	107.2	-55.5	84.0	-60.4	107.3	-53.7	64.0		
-53.7	121.1	-59.2	85.5	-48.2	113.2	-5.4	69.2		
-53.5	111.7	-63.0	68.2	-20.0	95.2	-21.0	78.1		
-50.8	123.6	-45.9	81.4	-55.9	102.9	-15.3	65.7		
-59.7	109.7	-60.8	63.1	-72.5	94.4	-19.8	69.4		
-51.1	112.3	-59.7	66.3	-77.7	106.1	-22.0	54.8		
-39.3	107.2	-100.8	79.1	-64.1	108.5	-49.1	70.9		
-39.1	108.2	-101.1	68.5	-62.2	98.5	-36.1	76.6		
-66.9	92.3	-87.5	87.1	-70.0	95.6	-27.6	66.4		
-31.8	101.7	-78.3	70.4	-55.9	102.9	-46.0	63.7		
-34.3	83.6	-88.3	72.3	-56.0	92.3	-19.8	69.4		
-58.6	89.9	-59.7	66.3	-22.7	93.1	-9.5	54.9		
-88.1	100.2	-66.5	62.2	-13.3	98.6				
-81.7	91.4	-18.7	46.1	3.8	86.5				

Subject 08

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-75.4	107.8	-7.2	56.7	-27.6	93.6				
-78.9	94.5	-27.2	48.6	-33.5	82.5				
-74.2	94.9	-25.4	50.6	-40.3	93.7				
-58.6	89.9	-38.5	50.4	-33.7	98.1				
-64.8	86.9	-50.3	49.1	-37.9	91.8				
-29.9	69.9	-44.6	66.2	-40.2	87.3				
-2.1	76.6	-45.0	57.3	-27.6	93.6				
-10.9	68.3	-47.0	55.4	-21.9	81.5				
-30.8	73.9	-25.4	50.6						
-44.0	74.7	-22.3	42.3						
-44.3	71.5	-55.6	65.2						
-41.9	87.1								
-51.5	81.1								
-42.3	77.3								
-30.8	73.9								
-29.9	66.8								
-98.4	94.8								
-151.6	70.7								
-65.8	89.1								

Subject 09
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-52.4	-2.7	-87.1	27.0	-80.2	-3.4	-91.3	28.8	-91.6	68.8
-46.6	-2.0	-64.1	35.9	-92.2	-1.7	-96.2	37.9	-89.2	82.6
-60.0	-3.0	-58.8	32.1	-68.5	-0.2	-75.2	35.9	-72.9	77.9
-53.3	-2.2	-69.2	16.7	1.2	0.1	-10.4	9.9	-75.9	66.4
-50.4	-2.3	-62.8	13.9	-31.6	-0.7	-41.5	23.6	-20.9	24.7
-78.2	-4.1	-118.4	14.2	-17.0	-0.1	-26.8	22.5	-46.7	55.6
-0.6	0.0	-57.7	35.7	-25.6	-1.2	-10.4	7.7	-33.2	52.2
-55.0	-2.2	-30.9	36.5	27.5	1.1	-43.1	21.5	-43.2	86.8
-17.0	-0.7	-51.7	18.6	-46.7	-2.1	22.5	29.1	-10.7	20.9
-44.4	-1.6	-86.5	27.3	-44.7	-1.8	-11.9	37.2	-54.3	52.6
-69.9	-3.1	-8.1	33.5	-31.1	-1.5	-30.9	39.7	16.1	64.2
0.0	0.0	-36.6	68.1	-46.4	-1.9	-1.6	53.4	-50.4	122.1
-46.7	-1.1	-36.5	40.8	-43.3	-0.5	-48.7	59.9	-47.6	100.7
-48.0	-1.5	-39.8	42.5	-51.5	-1.1	-28.3	39.1	0.3	79.2
-14.6	-0.5	-14.1	57.1	-14.6	-0.2	-57.9	49.4	-19.1	83.9
-50.4	-1.2	-63.2	64.0	-99.5	0.6	-39.7	51.5	1.1	102.9
-34.8	-0.7	-20.9	42.4	-60.1	-0.4	-44.7	24.0	-44.2	114.2
		-68.9	51.9	-67.1	-1.4	-62.8	31.8	-24.7	83.4
		-47.6	54.0	-42.1	-0.5	-18.2	35.9	-57.4	100.8
		-46.5	15.3	-67.0	-1.0	-81.0	63.9	-38.6	102.4
		-79.4	24.1	-55.0	-1.3	-80.1	54.0	-43.1	56.5
		-6.6	28.9	-67.6	-1.2	-44.2	43.0	-65.4	71.4
		-31.9	59.3	-59.5	-0.8	-52.5	43.7	-19.6	76.9
		-68.4	45.4	-25.5	0.1	-32.8	53.0	-98.1	97.5
		-32.3	35.2	-34.1	-0.2	-64.3	58.7	-60.6	116.4
		-35.8	37.6	-1.6	0.0	-50.1	43.1	-62.3	103.3
		-11.7	49.4	-67.3	1.4	-71.5	51.3	-30.6	87.6
		-56.6	56.7	-60.0	1.7	-59.1	52.5	-38.9	89.4
		-18.4	37.5	-38.4	0.3	-28.2	22.6	-24.3	101.9
		-62.2	46.1	-47.5	-0.3	-45.9	30.0	-54.0	111.4
		-42.6	47.7	-24.4	0.1	-6.4	32.9	-42.4	89.1
				-46.3	0.0	-62.5	42.2	-64.4	102.2
				-37.4	-0.3	-58.6	57.2	-51.4	102.9
				-47.4	-0.1	-54.4	47.5	-29.0	52.6
				-39.6	0.1	-27.9	39.0	-51.0	67.2
						-37.6	40.6	-9.6	71.4
						-19.4	48.3	-69.5	85.4
						-48.2	54.1	-46.1	107.7
						-35.7	40.2	-44.9	93.8
						-54.4	47.6	-19.0	80.9
						-42.9	48.3	-28.2	84.0
						-33.4	70.2	-14.6	95.1
						-4.4	42.0	-42.7	105.1
								-31.5	83.9
								-51.8	96.5
								-39.6	96.6
								-90.5	204.5
								20.9	90.9

Subject 09

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
								47.9	117.9
								-21.1	128.6
								11.3	89.8
								-35.7	111.4
								-8.5	115.1
								-42.6	127.1

Subject 09
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-178.5	79.2	-203.8	50.6	-191.3	91.1	-41.2	36.6	-25.2	-1.7
-99.5	92.7	-94.5	67.9	-55.6	67.2	-57.1	65.8	-59.1	37.3
-121.1	122.3	-126.7	98.8	-57.0	93.4	-10.2	15.3	-22.6	-32.7
34.1	21.8	-25.4	-60.1	-4.3	49.8	-29.4	29.9	-58.1	-2.1
7.9	-32.1	3.4	17.8	-7.2	58.6	-49.3	33.1	-61.8	-4.8
6.9	46.8	-20.3	35.6	-45.1	64.3	-230.9	73.1	-90.5	31.7
-2.7	61.0	-24.3	33.3	-208.3	94.8	-97.1	59.1	-105.2	52.1
-23.8	60.8	17.1	-34.6	-213.9	103.0	-107.5	79.2	-35.8	42.6
26.5	-2.8	-147.2	51.9	-103.4	85.2	-50.8	65.3	-25.1	21.5
-145.3	79.1	-141.0	58.9	-106.1	105.8	100.6	-12.9	-48.8	44.4
-141.2	85.3	-76.0	71.8	-65.8	88.7	-158.3	60.5	53.1	32.1
-82.4	97.1	-98.2	91.0	73.6	36.4	-27.1	44.4	31.5	26.5
-98.3	118.8	-13.9	86.5	38.1	49.4	-41.1	68.1	-7.9	56.4
-26.2	113.3	28.4	-8.8	-146.3	89.9	67.5	47.2	-76.0	-73.6
19.8	30.1	-10.1	5.5	-28.2	67.7	-17.8	0.4	-126.8	-46.3
13.7	36.4	-151.8	62.2	-28.8	92.3	-68.2	18.7	58.5	49.5
-18.7	42.4	-65.5	76.4	-24.6	44.2	-59.5	-12.2	-113.3	-47.1
-145.4	88.5	-93.8	101.9	-38.3	51.9	-144.7	-41.5	-158.7	-21.5
-66.6	101.9	-4.5	2.5	-72.1	58.7	-55.0	12.4	-154.7	-23.0
-86.4	132.2	-38.4	15.3	-54.2	37.3	-81.3	24.1	-14.7	-34.9
-7.8	3.0	-38.5	16.8	-88.1	69.7	-89.9	27.1	-25.3	5.7
-32.1	-50.2	-94.1	-1.8	-103.0	19.0	-84.0	-26.6	-77.4	-17.3
-12.2	36.6	-96.8	25.0	-54.8	51.3	-97.4	8.5	-85.3	-53.1
-32.5	46.7	-114.3	-33.3	-70.9	59.6	-143.8	49.3	-24.9	-18.9
-47.1	48.9	-56.7	12.3	-88.0	63.5	-167.8	-10.3	-41.9	-0.9
-10.5	-19.8	-92.6	26.9	-76.7	27.3	-80.0	21.0	-44.7	-2.1
-80.7	36.0	-85.0	25.2	-84.3	50.1	-107.4	34.1	-30.7	-47.5
-84.4	57.1	-83.8	-19.0	-120.9	82.1	-112.2	35.4	-6.2	39.5
-111.3	25.8	-101.5	14.8	-159.0	67.2	-116.8	-3.1	-40.5	-5.2
-118.6	18.7	-104.5	39.4	-159.6	65.5	12.2	28.1	-51.9	34.1
-93.6	7.7	-146.0	14.2	-127.2	37.0	-14.4	11.1	-101.0	22.1
-57.0	44.0	-154.7	4.2	-75.2	57.2	-24.2	37.9	-115.7	13.7
-82.3	56.0	-117.9	-10.8	-93.8	67.1	-52.6	20.6	-104.4	-16.8
-85.2	55.7	-66.9	19.7	-106.4	69.6	-57.8	16.4	-43.4	0.6
-78.6	21.0	-98.5	35.1	-102.9	41.8	-59.3	-1.6	-60.0	19.1
-107.3	64.0	-91.6	32.3	-13.3	55.1	-24.7	23.2	-62.0	17.2
-89.6	46.7	-93.2	-0.6	-15.7	43.9	-35.8	32.9	-55.0	-15.7
-94.6	67.2	-48.5	29.8	-24.4	65.7	-45.6	35.1	68.8	-37.9
-116.3	46.1	-35.7	54.3	-37.5	49.9	-30.1	3.0	68.9	12.6
-121.7	39.2	-62.6	33.3	-41.7	49.4	-9.3	64.5	-8.9	-64.6
-100.8	23.2	-74.5	23.9	-47.9	32.5	-26.1	29.6	27.5	-16.2
-66.0	49.4	-66.7	5.8	-27.4	54.8	-37.8	60.6	13.0	4.2
-89.5	62.1	-34.6	31.4	-33.2	61.2	-67.4	48.7	7.0	2.7
-91.3	61.1	-55.6	47.4	-50.2	65.2	-72.6	45.2	50.5	-54.2
-87.8	33.5	-54.2	44.1	-32.9	37.3	-70.6	19.0	-72.5	-40.9
2.6	80.3	-44.8	14.8	-12.5	90.3	-33.4	35.7	-116.3	-11.8
-45.2	57.6	-68.7	46.8	-16.6	59.5	-45.4	47.8	-115.3	-13.9
-34.6	79.3	-61.0	76.2	-25.2	86.6	-54.5	48.6	24.6	-13.5

Subject 09

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-47.7	59.1	-90.5	59.3	-38.4	74.2	-41.3	21.6	-12.9	18.1
-58.6	51.7	-101.0	48.8	-42.7	72.9	54.8	4.0	22.8	-1.1
-57.3	34.1	-85.8	22.2	-49.4	48.8	64.7	38.1	-2.0	33.2
-36.7	58.9	-48.8	41.5	-28.9	65.8	1.0	-16.8	-10.1	28.2
-51.7	72.3	-72.4	60.6	-34.6	74.7	16.8	23.4		
-58.2	70.9	-69.4	55.6	-52.0	77.5	12.1	33.8		
-45.9	44.2	-63.8	30.7	-34.1	52.5	-5.2	36.6		
-56.5	72.5	15.1	27.5	46.7	36.1	33.2	-7.2		
-48.7	101.1	61.4	63.2	61.1	63.0	-39.1	-9.4		
-64.1	83.2	-13.0	-5.8	7.2	16.9	-44.0	17.1		
-74.3	73.3	4.8	33.7	9.0	54.3	-70.3	31.2		
-68.7	47.9	-10.3	52.1	11.4	60.5	-81.6	33.5		
-44.8	68.4	-15.1	48.2	-16.0	65.6	-68.5	-26.9		
-61.9	85.1	14.7	8.2	22.1	26.5	-22.0	4.9		
-67.6	81.9	-106.3	2.8	-16.4	34.2	-77.4	25.4		
-56.6	57.8	-129.9	-38.1	-77.9	6.7	-1.3	29.8		
10.0	55.4	-57.9	17.2	-34.0	53.4	-17.7	50.9		
57.3	87.8	-101.8	35.9	-46.7	63.0	-41.0	50.7		
25.6	38.7	-91.5	32.4	-71.3	67.1	1.5	33.8		
-7.1	21.7	-91.5	-19.2	-46.8	20.5	-13.2	56.0		
-1.8	60.8	-10.1	39.5	-28.3	41.8	-36.9	55.1		
-10.2	76.3	-28.7	8.4	-87.2	57.8				
-24.8	74.3	-75.3	26.8	-19.9	60.6				
5.9	37.3	-12.6	34.4	-30.2	76.1				
-75.8	36.9	-49.9	66.1	-65.7	78.2				
-92.4	-2.9	-48.2	55.9	-15.9	62.1				
-49.5	47.5	-2.1	44.8	-24.5	78.8				
-79.9	62.8	-35.0	84.1	-62.4	80.4				
-84.1	61.2	-37.0	69.3						
-72.7	16.5	-37.9	169.9						
-20.0	65.4	-19.3	73.9						
-34.1	38.3								
-79.2	54.8								
-85.7	54.2								
-28.1	60.6								
-59.7	87.9								
-70.5	80.1								
-18.4	69.8								
-46.7	105.7								
-62.1	92.7								
-85.5	190.6								
-22.7	99.1								

Subject 10
Pelvic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-53.4	-1.2	-51.6	-1.7	-53.7	0.7	-47.5	5.9	-66.6	9.0
-29.3	-0.5	-91.1	35.9	-28.9	0.9	-78.7	36.8	-8.5	177.7
-115.9	-6.6	-129.9	29.6	-74.8	-2.6	-126.6	31.2	-68.9	168.4
-112.5	-6.1	-128.2	26.8	-108.8	-4.3	-128.2	28.2	-63.5	174.5
-89.0	-4.5	-80.4	28.3	-108.6	-3.6	-71.5	30.1	11.9	179.1
-60.8	-2.4	-87.7	44.2	-70.5	-2.2	-77.3	44.0	-10.9	181.9
-89.1	-4.7	-90.3	45.4	-75.9	-2.7	-78.7	45.0	-4.2	195.4
-84.7	-4.1	-88.2	37.9	-73.9	-2.0	-82.3	38.6	2.3	204.1
-52.2	-2.1	-110.5	32.0	-75.4	-3.0	-97.2	33.6	-42.9	169.8
-61.9	-2.5	-102.3	45.6	-52.7	-1.7	-45.2	41.3	38.6	106.1
-61.4	-2.8	-49.6	41.0	-86.8	-3.2	-92.0	36.0	-76.7	76.0
-63.5	-1.8	-90.9	35.2	-84.8	-2.6	-90.2	33.4	-147.4	86.4
-87.6	-3.5	-86.9	32.8	-47.4	-1.4	-35.3	35.0	-131.6	69.0
-83.7	-3.1	-37.5	34.1	-54.0	-1.8	-45.2	48.1	-135.6	63.2
-56.4	-1.5	-48.9	48.4	-49.0	-1.2	-42.4	49.2	-68.9	64.3
-64.4	-1.9	-46.0	49.5	-54.5	-2.0	-40.9	43.3	-72.9	87.2
-60.3	-1.3	-41.6	42.9	-52.5	-0.7	-64.2	38.3	-76.1	88.2
-51.5	-1.0	-69.5	37.5	-88.9	1.4	-103.5	39.9	-85.0	78.2
-63.9	-2.1	-97.2	40.3	-79.5	-1.3	-45.2	38.2	-105.9	72.2
-72.9	-0.3	-52.7	36.8	-77.5	-0.8	-80.9	43.4	-10.8	107.9
-35.8	-0.3	-92.6	41.7	-48.4	-0.4	-82.8	34.9	-160.0	88.1
-40.2	-0.9	-88.6	32.7	-53.5	-0.7	-80.7	32.7	-37.7	83.7
-65.8	-2.3	-85.0	30.3	-49.7	-0.2	-37.6	32.9	-81.0	95.2
-61.4	-1.9	-42.6	30.6	-45.3	0.1	-45.1	43.8	-89.5	77.5
-33.3	-0.7	-51.8	43.4	-53.9	-0.9	-42.9	44.1	-88.4	72.5
-41.3	-1.0	-49.7	43.8	-49.8	2.5	-42.0	39.2	-25.5	73.2
-34.9	-0.5	-46.3	37.9	-64.6	2.9	-60.5	36.2	-36.9	93.9
-26.6	-0.4	-69.8	34.2	-34.1	1.4	-69.3	34.1	-35.4	95.2
-41.9	-1.1	-75.8	31.7	-33.4	0.2	-75.9	40.5	-36.9	86.4
		-84.1	38.1	-55.0	1.9	-65.6	55.8	-66.4	80.2
		-69.3	57.6	-56.5	0.2	-67.1	62.4	-141.5	27.3
		-36.0	51.7	-53.6	0.5	-31.3	49.6	-122.9	80.3
		-62.8	60.0	-29.3	0.3	-52.3	56.9	-37.5	78.2
		-69.1	47.3	-34.3	0.2	-61.2	47.8	-69.5	85.5
		-65.0	45.8	-29.6	0.5	-58.3	46.6	-79.7	74.4
		-26.9	46.9	-24.9	0.5	-24.7	45.9	-78.1	70.0
		-36.0	56.8	-35.2	0.1	-31.5	53.8	-28.2	69.2
		-32.5	58.2			-28.6	54.6	-36.6	87.0
		-29.0	53.7			-26.8	51.5	-35.5	87.2
		-51.5	49.1			-43.8	48.2	-36.9	79.4
		-58.4	31.5			13.2	75.8	-60.9	76.2
						-54.0	65.6	-82.0	66.6
						9.4	83.5	-80.1	78.4
						-16.2	69.3	-79.1	103.9
						9.3	41.5	-57.9	109.9
						-53.0	33.6	-28.2	94.4
						-45.4	29.5	-46.8	104.1
						29.2	32.9	-60.2	92.9

Subject 10

Pelvic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
						6.2	50.4	-57.6	90.6
						18.8	51.7	-20.8	88.5
						-17.7	37.3	-27.8	100.4
								-26.1	101.4
								-26.3	96.9
								-46.3	93.4
								18.4	131.2
								-44.3	122.0
								-35.9	121.5
								43.1	125.1
								13.9	139.7
								23.9	147.2
								35.5	145.8
								-18.0	124.8
								38.2	129.9
								-37.2	117.6
								-25.7	116.3
								72.9	122.2
								30.8	140.2
								45.7	149.3
								-6.1	121.6
								83.7	114.9
								9.8	83.0
								-59.1	72.9
								-52.7	65.0
								35.3	68.2
								6.0	96.8
								15.0	98.3
								25.2	85.5
								-29.7	77.6

Subject 10
Thoracic Centers (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
9.7	75.0	-147.6	125.8	-4.5	67.2	-18.4	25.4	-142.6	81.5
-169.3	153.7	-14.3	20.4	55.3	70.2	-15.3	-54.4	-170.7	109.2
-2.8	56.2	-32.4	-24.5	-12.9	27.2	-17.6	-38.7	-139.6	36.7
47.4	57.4	-13.0	-43.1	-2.5	15.5	-0.3	29.4	-173.3	1.0
25.8	17.3	-14.5	-30.5	-5.2	25.2	-147.9	95.6	-156.4	-37.5
-10.3	22.9	0.2	23.4	6.0	3.9	-120.6	106.8	-153.3	-18.0
-1.9	13.0	-114.7	81.5	-7.2	72.0	-115.5	-1.2	-110.4	40.7
-3.9	21.2	-92.6	88.9	-118.4	118.5	-119.3	-88.1	-164.1	41.9
5.1	3.2	-109.3	94.0	-25.8	76.4	-124.9	-72.0	-164.6	58.6
-4.9	60.2	-116.1	112.7	-111.0	129.0	-102.9	1.8	-202.7	22.4
-94.5	103.0	-112.0	118.2	-106.6	138.2	-98.1	73.2	-185.6	-17.7
-20.6	63.2	-47.9	127.6	-63.4	167.9	-79.4	88.0	-182.1	2.9
-16.1	-7.8	-90.7	0.6	-92.5	40.5	-101.1	59.6	-134.9	64.5
-21.3	4.6	-126.1	-49.8	-121.7	-11.6	-98.6	45.7		
-25.9	70.5	-94.7	-67.3	-90.9	-19.9	-118.8	50.1		
-88.0	110.9	-98.9	-54.5	-98.3	-9.8	-101.7	31.3		
-86.8	119.4	-80.6	2.9	-100.8	45.0	-103.6	41.4		
-99.4	140.4	-49.3	80.8	-123.5	89.0	-114.8	40.7		
-46.2	142.9	-76.1	60.7	-66.7	120.0	-90.5	76.9		
-75.8	34.6	-60.1	72.1	-84.4	98.9	-99.3	64.2		
-63.2	27.9	-77.7	50.3	-73.7	111.3	-128.8	27.8		
-100.3	-7.7	-75.9	39.3	-96.4	91.8	-102.4	3.8		
-75.2	-15.2	-93.0	43.1	-94.4	81.5	-105.7	17.6		
-81.2	-6.7	-80.0	27.6	-99.0	80.0	-125.1	7.3		
-106.6	-37.9	-81.2	35.7	-85.7	66.3	-88.9	69.5		
-82.5	38.4	-89.9	35.9	-88.9	74.1	-102.1	75.3		
-81.3	82.8	-70.0	63.5	-99.0	74.7	-133.3	38.7		
-97.9	78.1	-78.2	53.0	-88.2	103.3	-105.2	12.6		
-50.0	100.8	-54.6	69.0	-68.9	93.0	-108.7	27.3		
-67.8	84.3	-82.6	28.2	-45.4	110.7	-91.3	81.5		
-57.7	94.4	-102.2	24.7	-79.1	75.0	-104.2	84.2		
-76.7	78.8	-81.6	4.9	-87.0	62.5	-134.7	50.2		
-75.1	70.2	-84.0	16.0	-68.3	46.2	-107.4	23.8		
-80.1	69.1	-99.7	8.7	-72.9	56.5	-110.9	38.4		
-69.6	57.2	-69.7	57.1	-84.4	50.3	-93.8	90.6		
-72.0	63.8	-80.9	62.2	-74.0	98.9	-115.0	53.1		
-79.9	64.9	-56.4	85.0	-73.6	101.6	-153.0	6.9		
-70.7	88.1	-106.5	33.6	-49.6	126.2	-118.7	-19.2		
-56.3	79.0	-84.4	11.9	-93.7	69.9	-123.4	-3.3		
-35.7	93.6	-87.0	23.8	-72.7	51.4	-103.7	58.9		
-64.3	64.3	-104.8	19.0	-77.8	62.6				
-57.7	45.0	-72.1	67.1	-92.2	58.1				
-71.8	54.0	-80.5	68.1	-79.3	108.3				
-56.5	39.8	-57.0	92.0	-60.8	109.0				
-60.2	48.5	-85.3	56.4	-26.7	139.8				
-69.8	44.0	-104.6	42.1	-79.6	75.9				
-60.4	84.1	-83.9	20.7	-59.3	55.6				
-60.5	86.5	-86.3	32.3	-64.3	67.7				

Subject 10

Thoracic Centers continued (coordinates in mm)

re: lumbar seg 1		re: lumbar seg 2		re: lumbar seg 3		re: lumbar seg 4		re: lumbar seg 5	
X	Z	X	Z	X	Z	X	Z	X	Z
-39.2	107.3	-102.3	30.9	-74.3	64.2				
-71.8	75.5	-72.0	72.9	-66.3	116.4				
-77.8	60.4	-91.8	44.4	-95.5	80.4				
-60.4	44.3	-123.0	8.1	-123.9	38.3				
-64.6	53.8	-95.8	-13.7	-94.0	22.0				
-76.7	50.8	-99.3	-0.8	-101.2	33.8				
-65.2	92.3	-82.6	48.9	-103.5	87.1				
-49.4	91.9	-81.6	91.8						
-19.6	117.0								
-52.3	83.0								
-65.3	64.7								
-48.8	47.3								
-52.7	57.5								
-60.9	55.1								
-53.7	98.2								
-79.2	68.6								
-66.4	84.6								
-103.5	33.9								
-78.6	19.6								
-84.5	29.6								
-109.6	15.5								
-85.8	74.4								
-59.4	112.6								
-54.7	34.8								
-68.7	125.5								

APPENDIX H

Individual Subject Lumbar Link Lengths

Distances between the upper and lower joints were calculated under test conditions (TC) as described in Section 2.5.17. These distances are listed in the tables below for each subject, relative to each lumbar segment definition. All distances are in millimeters.

Subject:			01		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	188.0	126.4	186.7	151.3	107.3
TC11	194.3	131.4	193.4	156.0	112.3
TC10	183.6	122.5	181.2	147.6	104.4
TC3	178.9	123.0	180.2	148.3	104.7
TC6	183.9	120.6	178.4	145.1	103.3
TC7	198.9	133.2	193.2	157.3	115.7
TC14					
TC10	197.3	131.9	194.9	156.3	114.9
TC18	192.1	132.0	193.4	156.4	111.3

Subject:			02		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	193.0	124.7	185.4	148.3	108.9
TC11	190.2	121.3	181.1	144.2	105.7
TC10	183.7	119.2	178.4	143.6	101.4
TC3	182.2	122.4	180.9	147.6	104.1
TC6	181.8	116.5	174.0	140.1	99.1
TC7	193.3	124.3	181.6	145.7	107.9
TC14	189.7	120.9	180.8	144.0	105.2
TC10	198.5	137.5	200.3	161.6	117.2
TC18	190.7	124.1	186.1	148.4	107.4

Subject:			03		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	207.2	144.8	205.4	169.6	126.0
TC11	216.1	151.0	212.8	175.5	133.3
TC10	190.3	133.4	190.3	158.9	116.1
TC3	200.7	147.6	203.3	173.2	130.7
TC6	200.7	142.7	200.2	168.1	125.2
TC7	205.0	142.5	201.4	167.2	124.6
TC14	215.4	147.9	209.6	171.9	131.9
TC10	207.4	144.9	207.1	169.5	125.6
TC18	216.2	153.2	214.9	177.8	134.3

Subject:			04		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	221.5	156.2	219.2	180.6	139.1
TC11	216.0	152.9	215.6	177.4	134.0
TC10	221.6	155.9	217.8	180.3	138.6
TC3	214.8	152.7	213.9	177.4	133.5
TC6	217.5	152.5	214.2	177.0	134.7
TC7	228.3	159.1	219.9	182.3	144.4
TC14	225.3	157.9	221.0	182.2	142.9
TC10	223.6	160.4	224.1	184.7	142.3
TC18	215.9	151.1	213.9	175.6	133.4

Subject:			05		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	150.3	95.6	153.7	119.8	73.8
TC11	152.2	93.1	153.6	117.4	71.7
TC10	144.1	86.1	144.0	111.3	67.3
TC3	140.9	91.3	146.0	115.5	71.6
TC6	136.3	80.5	135.7	106.3	65.3
TC7	155.7	90.9	150.9	115.5	72.8
TC14	150.0	90.5	150.8	115.1	69.6
TC10	154.4	95.4	156.5	119.3	73.5
TC18	145.9	91.3	149.9	115.0	68.2

Subject:			06		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	208.7	142.9	203.6	167.1	125.5
TC11	205.9	139.3	200.3	163.4	122.3
TC10	208.9	143.1	202.9	167.1	125.7
TC3	198.8	138.7	196.2	163.8	121.6
TC6	205.1	140.1	198.1	163.9	122.7
TC7	209.3	141.2	200.4	164.1	124.7
TC14	213.2	144.8	205.8	168.3	129.3
TC10	213.0	147.4	209.8	171.8	130.1
TC18	208.3	144.1	206.1	168.7	125.8

Subject:			07		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	174.0	115.5	175.8	139.9	94.3
TC11	173.5	112.2	174.2	136.5	91.9
TC10	161.6	102.5	161.8	127.5	82.7
TC3	161.1	105.5	164.2	129.8	83.9
TC6	170.2	106.4	165.7	131.1	88.4
TC7	174.9	108.9	169.7	133.2	91.4
TC14	172.0	111.2	172.7	135.6	90.7
TC10	173.9	111.3	173.6	135.8	91.9
TC18	168.0	108.6	170.1	132.7	87.0

Subject:			08		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	166.1	102.5	164.4	127.2	83.6
TC11	156.6	95.1	155.7	119.9	75.3
TC10	158.9	95.3	156.2	120.1	76.5
TC3	165.7	103.6	165.4	128.1	83.7
TC6	178.8	109.4	167.4	131.2	93.6
TC7	169.5	101.9	160.4	125.0	84.9
TC14	168.5	102.8	165.0	127.4	85.4
TC10	170.7	107.2	169.9	131.7	88.5
TC18					

Subject:			09		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	180.2	118.4	178.3	143.3	99.6
TC11	175.7	113.5	174.3	138.4	94.3
TC10	180.5	117.5	176.3	142.2	99.6
TC3	188.8	126.0	186.8	150.7	107.1
TC6	171.4	109.4	165.4	134.0	93.2
TC7	185.1	118.2	176.8	141.6	101.0
TC14	182.3	117.7	178.5	142.3	99.6
TC10	170.0	110.3	171.6	134.6	89.1
TC18	180.5	120.1	181.5	144.6	99.5

Subject:			10		
Lumbar:	S1 to T12	LL to T12	S1 to T10	LL to T10	L3 to T10
	1	2	3	4	5
TC12	209.0	145.7	205.3	170.3	127.6
TC11	207.3	143.5	204.6	168.1	125.1
TC10	210.2	146.5	204.0	170.6	129.2
TC3	210.1	147.9	205.7	172.5	130.5
TC6	209.7	146.9	200.3	169.5	130.3
TC7	214.1	148.8	206.4	172.2	131.3
TC14	212.8	146.6	206.5	170.5	129.3
TC10	207.4	141.7	202.9	166.0	124.2
TC18	209.2	143.7	203.9	167.9	126.1

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