BIODEX SYSTEM 3
SOFTWARE MANUAL

830-000-J800
835-000-J800
This manual covers installation and operation procedures for the following products:

830-000-J800 Software, System 3 QUICK-SET, Rev M, version 3.30
835-000-J800 Software, System 3 PRO, Rev N, version 3.30

⚠️ IMPORTANT NOTE

While this manual is an important source of information on using the Biodex System software, it is by no means the only resource necessary to begin testing and rehabilitation programs for your clients. Just as important as an understanding of your computer is a thorough knowledge of the mechanical, physical and clinical aspects involved. To that end, the user is referred to the Biodex Multi-Joint System Operation Manual, which offers detailed instructions and general guidelines for patient setups and various joint-testing and rehabilitation patterns, plus an explanation of system controls, modes and operation. For a detailed explanation of report parameters, refer to the Biodex System 3 Multi-Joint and Rehabilitation System Clinical Reference Guide.

Should you have any questions about Biodex Advantage Software, please contact the Biodex Customer Service Department at the following address:

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⚠️ REMARQUES IMPORTANTES

Bien que cette notice d’utilisation contienne beaucoup d’informations sur le logiciel BIODEX SYSTEM, elle ne peut être la seule source de renseignement nécessaires pour évaluer et rééduquer des patients. En plus d’une bonne compréhension de votre système informatique, il faut bien connaître les aspects mécaniques, anatomiques et cliniques applicables. À cette fin, nous vous référons à la notice du système multi-articulaire, laquelle fournit des consignes détaillées et des principes généraux pour les montages patient et les différents mouvements utilisés pour l’évaluation et la rééducation en plus d’explications sur les contrôles, les modes et le fonctionnement du matériel.

Pour de plus amples renseignements sur le logiciel BIODEX ADVANTAGE, nous vous demandons de bien vouloir contracter notre responsable local.

Authorized European Community Representative: Prothia, Paris, France
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1. INTRODUCTION

THE BIODEX ADVANTAGE
Biodex Advantage Software is a user-friendly software package developed specifically for isolated muscle testing and rehabilitation. Windows-based, it is comprehensive, fast and flexible. Whether you’re a computer novice, computer genius or somewhere in-between, you’ll find its many features, functions and applications can greatly enhance your ability to test, motivate and rehabilitate patients.

Biodex Advantage Software features "seamless" architecture, pull-down menus and pop-up windows in a Windows environment to provide for quick, intuitive operation. Need help? Simply follow the Wizard as it guides you through the standard procedures. Not sure how to set up for a particular pattern? Click on the action videos for a real demonstration of the desired exercise or testing setup. Want a report? Choose from a variety of formats with easy-to-read, easy to interpret normative data. Just setting up for a quick and easy exercise session? One click of the mouse is all that’s needed to activate the Biofeedback mode and begin.

Biodex Advantage Software makes it easy for clinicians to gather, organize and report on patient testing and rehabilitation. During testing and rehab sessions, the software gathers pertinent patient data for isometric, isokinetic, isotonic, passive and reactive eccentric modes. Curve analysis functions allow for annotation and comparison of results from different tests. Torque curves and bar graphs enhance biofeedback capabilities. Test data can be generated in standard report format or in easy-to-read, narrative letters that are addressed and ready for mailing to referring physicians or third-party payers. Data legends and on screen editing simplify the task of communicating test results to doctors, payors and employers.

Easy to use, intuitively organized, versatile and complete, Biodex Advantage Software will help speed your patients on the road to functional outcomes, help you to increase your referral base and make the day more manageable for you and your staff. That’s the Biodex Advantage.
2. GETTING STARTED

COMPUTER PRELIMINARIES
Before attempting to test and/or rehabilitate patients on any Biodex System, be certain you are familiar with both the mechanical and software aspects involved. It is suggested that clinicians try several patient setups as described in the Biodex System Applications/Operations Manual, using the current software, before beginning to work with actual test or rehabilitation subjects. This will allow the user to become familiar and confident with the software, helping to promote smooth and professional treatment.

Before proceeding any further, please consider the following points and suggestions:

1. Be sure to verify the system’s factory calibration before attempting to work with patients as explained later in this chapter.

   The verification procedure should be performed on a monthly basis or on any day on which the system will be used to gather data that may be used in court or research applications.

2. Because Biodex Advantage Software operates within the Windows environment, it is vital that you use the Windows Shutdown procedure when exiting the software. Always shut down the Windows program before turning OFF your computer.

3. Biodex Advantage Software and the Windows program are extremely versatile and flexible. Functions and procedures can be accessed in various ways. This manual provides the most basic and efficient ways to move about within the Advantage Software program. For more advanced Windows operations/applications, short-cuts or more detailed information, please refer to your Windows Operation Manual.

STARTING THE PROGRAM
(See Figure 2.1.)

On Power-Up:
1. Turn the main power switch on the back of the controller to the ON (1) position.

2. Ensure the dynamometer and computer power switches on the front of the controller are set to the ON position.

3. Press the ON computer switch on the Central Processing Unit (CPU). The Biodex Logo screen should automatically be displayed, followed by the Dynamometer Operation screen. Once the Dynamometer Operation screen is displayed you are ready to begin.

From the Windows Desktop Screen:
1. Use the mouse to click on the Biodex System icon. The Biodex Logo screen should appear, followed by the Dynamometer Operation screen. Once the Dynamometer Operation screen is displayed you are ready to begin.

NOTE: ERROR MESSAGES
Should an error message display on the screen as you try to access the program, contact Biodex Customer Service for instructions on how to proceed.
EXITING THE PROGRAM
Because Biodex Advantage Software operates within the Windows environment, it is vital that you use the Windows Shutdown procedure after exiting Biodex Advantage software. Always shut down the Windows program before turning OFF your computer.

⚠️ **CAUTION:** Turning your computer OFF without properly shutting down both the Biodex Advantage and Windows software programs may result in lost or damaged files.

⚠️ **ATTENTION:** Arrêter l’ordinateur sans suivre les procédures de sortie et de sauvegarde du logiciel BIODEX et de WINDOWS peut compromettre l’intégrité des fichiers.

To Quit Windows and Shut Down Your Computer:

1. Close the Biodex Advantage Software application by clicking on the "X" in the top right corner of the screen.

2. Click the <Start> button at the lower left side of the screen to access the Start menu.

3. Click "Shut Down" to bring up the Shut Down window.

4. Click "Yes" to shut down the computer. A screen message will be displayed when it is safe to turn the computer OFF.
ON-SCREEN BASICS
(See Figure 2.2.)

The Biodex Advantage Software package features four main screens from which all functions are launched. These screens are Dynamometer Operation, Patient Selection, Protocol Definition and Report Generation. From these screens, pull-down menus and pop-up windows are used to select procedures and enter data. Because any of these screens can be accessed from virtually any point within the Biodex Advantage Software application, they are in the order called upon in the standard testing/exercise procedure. The Dynamometer Operation screen, the first screen from which you can work, is selected by default whenever you access the program.

Except where otherwise noted, Biodex Advantage Software follows the same logic as the Windows operating system. Use of the Desktop, Tool Bar, Task Bar, Help function, etc., are identical. Most choices can be made with a click of the mouse or a few simple keystrokes. Thus, for basic operation, refer to your Windows user guide.

The Tool Bar, Task Bar and Pull Down Bar will allow the user to move quickly from screen to screen and task to task. A brief explanation of each bar is provided below. All options on these bars can be accessed by clicking on the icon or prompt.

NOTE: Some screen pages contain mandatory fields. These are highlighted in red and must be completed before advancing to the next screen.

Figure 2.2. The Primary Tool Bar (1), Screen Tool Bar (2), Task Bar (3) and Pull Down Bar (4). Highlighted fields, such as Last Name, Weight, Patient I.D. # and Involved Side are mandatory and must be completed before moving on to the next screen.
The Primary Tool Bar
Located along the left side of the screen, the Primary Tool Bar features icons for primary screens and functions throughout the program. Click on any icon to advance to the screen or function desired. From top to bottom the icons and their usage are defined as follows:

**Patient Selection:** Access the Patient Selection screen to choose a patient or enter a new patient.

**Protocol Definition:** Access the Protocol Definition screen to select a pre-defined or user-defined protocol, or to enter a new protocol.

**Dynamometer Operation:** Access the Dynamometer Operation screen for testing or biofeedback applications.

**Report Generation:** Access the Report Generation screen to select from a variety of report styles.

**Set ROM:** Use this icon to set a new range of motion or adjust a previously stored range of motion at any point throughout the program.

**View Anatomical Setup:** Access the Anatomical Setup screen to view AVIs (Action Video Inserts) or positioning diagrams of standard patient set ups.

**Curve Analysis:** This function allows the user to view test data on screen in various formats including individual curves, windowed curves, filtered curves, and a curve log.

**Biodex Wizard:** Access the Biodex Wizard feature to guide the user step-by-step through selected sample procedures such as performing an isokinetic evaluation.

**Screen Tool Bars**
Screen Tool Bars are located at the top of selected screens. As opposed to the Primary Tool Bar, which is always available, Screen Tool Bars are specific to the active screen. Icons for each screen are defined as each screen is presented throughout this manual.

**The Task Bar**
Located at the bottom of the screen, the Task Bar shows the Start button, Desktop access, Application Name, and the date.

**The Pull Down Bar**
Located at the top of the screen directly beneath the System 3 header, the Pull Down Bar allows access to the File Menu. From the File Menu you can access Set Up, Database Manager, Compact Database, Verify Calibration, and Exit functions, each of which are described in detail later in this manual.

The view option allows the status bar to be hidden or displayed while the windows option allows selection of cascade or tile window formats. The Biodex Wizard, explained in detail in the next section, can be used to guide the user through selected functions and procedures.

**NOTE:** To obtain basic software information including release date and software version, or to view a video introduction to Biodex Medical Systems, Inc., click on <Help> in the windows tool bar at the top of the screen. Click on “About Biodex” to view the software information.
The Biodex Wizard is designed to guide the user through selected functions and procedures such as testing a subject. This feature also follows the basic Windows format. The Wizard appears in the tool bar for system wide use. It also appears on selected screens for screen-specific use.

To Use the Biodex Wizard:

1. Click on the Wizard Icon in the Tool Bar to access the system-wide Wizard.

2. Click on the desired operation to advance with the Wizard step-by-step through the sample procedures provided.

3. When you have finished with the Wizard, click on <Close> to return to the current operation or function.

**NOTE:** For an example of the Biodex Wizard, click <Wizard> at the bottom left of the Dynamometer Operation screen. This will allow the Wizard to guide you through a clinical study and familiarize you with the basic Biodex setup and testing procedures.

![Image of the Biodex Wizard interface](image-url)

Figure 2.3. The Biodex Wizard will guide you through testing and exercising procedures.
**SETUP OPTIONS**
*(See Figure 2.4.)*

The Setup Options screen allows the user to set default values for selected system prompts and preferences. It also provides access to the Orient Fixtures screen.

To Access the Setup Options screen:

1. Click on `<File>` in the pull-down bar and select setup from the pull-down File menu. The Setup Options screen should now be displayed.

2. Use the mouse or keyboard to choose or enter the appropriate value or preference for each of the fields provided.

3. Once you are satisfied with all of the selections, click on `<Okay>` to record the new settings and return to the Dynamometer Operation screen. When prompted, select "Yes" to restart the application and save the new settings.

![Setup Options Screenshot](image)

*Figure 2.4. The Setup Options screen. This screen is accessed through “File” in the pull Down Bar.*
The following options and fields are addressed from the Setup Options screen.

_Dynamometer Interface:_ Values for this field are factory pre-set and should not be changed.

_AVI Folder:_ Enter here the desired path for storage of the system AVI (Action Video Inserts). The system default is to the CD-ROM drive (consult Biodex Customer Service before making changes. AVIs run faster off the hard disk, but they take up a lot of disk space.

_Facility Name:_ Enter the facility name here. To do this use the mouse to activate the cursor. Hit < ENTER> once you are finished.

_Biofeedback Preferences:_
Using the mouse to activate the cursor and the keyboard to make changes to the following parameters:

_(NOTE: These will be the default values for the patient when using the Biofeedback Mode of the software for exercises.)_

- Rest Period: default value set for the length of rest period between sets.
- Isometric Contraction: default value set for the length of time a patient must maintain an isometric contraction.
- Isometric Relaxation: default value for length of time between repetitions.

_General Preferences:_
- Side Change Reminder Notice: Toggles side change notice ON and OFF. If ON, a notice will appear after completion of all sets for first side.
- Repetition Event Sounds: Toggles audible start and stop signals for exercise and test sessions ON and OFF. If ON, signals are provided at the beginning and end of each set, and during each repetition during data collection.
- Video Clips (AVIs) for: Choose from Pro or Quick Set Formats at scroll bar. If ON, action AVIs can be selected from the Protocol Selection screen for any standard patient setup. _NOTE: Do not change this factory preset value._
- Metric Units: When ON, all data is displayed in metric units. When OFF, all data is displayed in English measures.
- Automatic Start Following Rest Periods: Activate this toggle if you would like the system to initiate the countdown for the next set following completion of each previous set, as opposed to having the system await user input to begin the countdown.
- Warning for Front Panel Computer Control: When ON, the system will flash a window indicating that the Computer Control button must be pushed in order to run a computer controlled protocol.

_NOTE: Panel control contraction direction is determined by the panel, not the software._

_NOTE: In panel control, for safety reasons the passive mode initial speed is 10% of set speed. In computer control, initial speed is 100%._
• Require Anatomical Calibration: When ON, requires anatomical calibration of the joint in the anatomical reference angle before testing can begin. It is recommended to perform anatomical calibration prior to the start of any test to correlate curve deficits to joint position.

• Use Color-Coded Columns in Reports: Color is used in graphs and curves to indicate uninvolved (blue) and involved (red) sides.

• Scoring Window: This is drawn on the Dynamometer Operation screen as a horizontal pair of violet-colored lines. The scoring window allows the clinician to set a biofeedback goal for the patient. The top line is 100%. The lower line is a percentage of (default = 70% of max peak torque). To change the lower line default value, simply enter a new value in the scoring window parameter box. This setting also determines the isokinetic window when printing reports which contain windowed data.

Linked Protocol Preferences:

NOTE: All Linked Protocol Preferences described below are default settings.

• During acquisition, mark tests as complete: After completing a linked exercise protocol, an on screen prompt indicates completion of the protocol. On screen results are then automatically marked as completed to confirm for the clinician that the patient did complete the entire routine. Default =ON

• During acquisition, save exercise data: Selecting this option allows collected exercise data to be saved. Storage of this information required additional disk space. If you choose to save exercise data, the system will “time out” after 10 minutes of data collection due to limited database size. Therefore, exercise sessions must be limited to less than 10 minutes if data collection is desired. Default =OFF

• Restrict selections to unilateral protocols: When linking protocols, selecting this option allows only unilateral treatment protocols to be selected. Default =ON

• Restrict selections to same joint/pattern: When linking protocols, restricts selections to protocols for same joint/pattern. Default =ON

• Restrict selections to exercise only: When selected, this option restricts selection to exercise protocols only. Default =ON

Orient Fixtures:
The <Orient Fixtures> button at the bottom of the Setup Options screen is used during system installation to provide the system with information for correcting limb weight readings. You should not need to access this function unless you receive a new set of dynamometer attachments. If you do receive a new set of attachments, you may need to confirm that these settings are correct.

NOTE: If you receive new, updated or attachments other than those originally supplied for your system by Biodex, contact Biodex Customer Service for information on the Orient Fixtures procedure.
DATABASE MANAGER

NOTE: This section is explained fully in Chapter 8.

COMPACT DATABASE

This utility is used to remove any empty spaces that may occur in your database. This utility will occur on its own as the computer detects wasted database space.

CALIBRATION VERIFICATION

(See Figure 2.5.)

Your Biodex System 3 Isokinetic Dynamometer comes factory calibrated. The only maintenance required to assure that your Biodex System 3 remains calibrated is to once a month perform a Calibration Verification Procedure, as described below.

1. Click on <File> in the pull-down bar and select Verify Calibration from the pull-down menu. The Calibration Verification screen should now be displayed.

2. Enter your name in the red field. This is required to perform the verification.

3. Follow steps 1-10, as displayed on the computer screen, and then click <Verify Calibration>.

4. If a message is displayed indicating an Invalid Calibration, repeat the process by performing steps 1-10 again. If you receive the message three times, please call Biodex Customer Service at 1-800-224-6339 or in the State of New York 631-924-9000 for assistance.

5. Click <Report> to generate a printed report, which can be filed for later reference.

6. If desired, click on <History> to generate a listing of all Calibration Verifications performed on the machine.

7. Click on <Exit> to advance to the Dynamometer Operation screen.

NOTE: For research applications, you may want to perform Calibration Verification after a specific number of patients in case questions regarding the validity of your data arise at a later time.
Figure 2.5. The Calibration Verification Screen
THE DYNAMOMETER OPERATION SCREEN

(See Figure 3.1.)

The Dynamometer Operation screen is automatically displayed when the system is turned ON. This screen is active during Biofeedback, Testing and Exercise applications. It is, in effect, the Main Screen for the Advantage Software, serving package as it serves as the launching point for all operations and procedures.

The Dynamometer Operation screen is divided into four main areas: The Graph at the top of the screen and then, from left to right, Biofeedback Parameters, Test/Exercise parameters, and the System Status area. A detailed account of each area follows.

Figure 3.1. The Dynamometer Operation screen with scoring window displayed.

BIOFEEDBACK MODE

(See Figure 3.2.)

Because Biofeedback exercise does not require patient specific parameters to be entered on the computer, it is fast and simple to use. In fact, you could call this the “instant ON” mode, for the Biofeedback feature allows clinicians to set up and begin patient exercise without entering any patient-specific data. When Biofeedback is selected, all computer settings default to match the last biofeedback session and the current settings on the System 3 controller.

NOTE: When Biofeedback mode is selected patient exercise data is displayed on the graph in real-time but it cannot be printed or saved.

NOTE: Panel control contraction direction is determined by the panel, not the software.
NOTE: For safety reasons, Passive mode initial speed is 10% of set speed if panel control is selected. In computer control, initial speed is 100% of the set speed.

NOTE: If you turn the system OFF while it is Biofeedback mode, it will automatically select Biofeedback mode again when turned back ON.

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Figure 3.2. The Biofeedback Graph (with grid selected).

To Access Biofeedback Exercise Via The Computer:

1. At the Dynamometer Operation screen (the main screen displayed on power-up,) click on <Biofeedback> directly beneath the Biofeedback graph. Biofeedback options will display in boldface on the screen. All other options will fade to gray.

2. If desired, click the scroll buttons or use the keyboard to change the biofeedback parameter value for End By (repetitions, elapsed time or work,) # of Sets, number of repetitions or Ft-lb, Away and Toward (work). The Biofeedback parameters are located at the bottom left of the screen.

   NOTE: If you change the default values, the new values entered become the default for future biofeedback sessions.

3. Click <Go> to begin the Biofeedback exercise session. All patient data will be displayed in real-time on the Biofeedback graph. Set number and reps are listed at the bottom right of the screen under the <Go> and <Stop> buttons.

   NOTE: You must set patient ROM in order to start biofeedback exercise and for the curves to accurately reflect the patient limb position during exercise.
THE BIOFEEDBACK GRAPH

(see Figure 3-2.)

During exercise biofeedback sessions, patients (and therapists) can see how well they are doing by looking at the Biofeedback Graph on the Dynamometer Operation screen. This graph allows patient data to be displayed, real-time, in a variety of formats. Data collected during biofeedback sessions is not saved to the database.

Upon opening the program, the Biofeedback Graph Y-Axis (vertical) shows torque in ft-lb (Nm). Velocity and position curves may be displayed as well. The X-Axis (horizontal) displays time in minutes and seconds or position. The presentation of graphs can be altered in several ways as explained in the following section.

The Biofeedback Area

The Biofeedback area of the Dynamometer Operation screen shows selected or default values for the current biofeedback session. The Biofeedback Parameters are accessible when the system is in Biofeedback mode. When active, the Biofeedback parameters appear in boldface. When inactive, they shade to gray.

Use the scroll bars to adjust any Biofeedback parameter.

Available parameters are:

**Mode:** This is automatically displayed based on the mode selected from the Dynamometer Control Pane.

**Contract:** This is the contraction type selected for testing. The contraction type is selected from the front control panel and is automatically displayed by the computer system. This field is not active during exercise.

**End By Rep, Time, Work:** The clinician can choose to end a rehab session based on the number of repetitions, elapsed time (seconds) or total work (ft-lb). The default value is Repetitions. Use the scroll arrows to access your choices.

**End by Reps:** Select "Reps" and enter the number of sets and repetitions required to complete the current session.

**End by Time:** Select "Time" and enter the time required to complete the biofeedback session, and the time for each set.

**End by Work:** Select "Work," then enter the amount of work in Joules.
The Test/Exercise Area
The Test/Exercise area of the Dynamometer Operation screen shows selected values and real-time statistics for the current test or exercise session. This area of the screen also allows the user to set anatomical reference values for patient limb position and measure limb weight. The currently selected test or exercise type is displayed at the top of this area.

The Test/Exercise parameters are accessible when the system is in Test/Exercise mode. This mode is selected when a text/exercise protocol is selected. When active, the Rehabilitation/Test parameters appear in boldface. When inactive, they shade to gray. Use the scroll bars and keyboard to adjust any test or exercise parameter or value.

Available parameters are:

*Test/Exercise*: This is automatically set from the protocol selected and reflects the test/exercise format selected.

*Anatomical Reference*: This parameter sets the system to be goniometrically correct (the exact procedure is explained later in this manual). Use the scroll bar or keyboard to enter the desired setting. Reference values are joint specific.

*Side*: The side to be tested or exercised. Use the pull down arrow to select the desired setting (the uninvolved side is the default value for the start of a test. If there is no involved side, the dominant side is tested first).

*Position*: This is a real-time indication of limb position at any point throughout the test or exercise session. Place the body part at the anatomical reference angle (i.e., 90° Knee flexion,) press <Hold> and click on the position icon to set anatomical reference.

*Limb Weight*: To correct the full influence of gravity effect torque on the data gathered, the patient’s limb is weighed. Test results are then automatically corrected in the software for gravity effect torque.

**NOTE:** Gravity correction applies to the following patterns: Knee Ex/Flex, Elbow Ex/Flex, Shoulder Ab/Ad, Shoulder Er/Ir (90°/90°), Shoulder Ex/Flex. Gravity correction is not used with the Biodex Back Attachment, Lift, Closed Chain Attachment, or Ankle Attachment.

To Weigh The Patient’s Limb:

1. Place the patient’s limb at the angle of maximum gravity effect torque for the selected pattern. The limb should be positioned so that muscle tightness does not provide any resistance on the attachment.

2. Instruct the patient to relax the limb to be weighed. Click on the Weigh Limb icon. The limb weight to be used for data correction will be displayed.
The Statistics Area

Statistics displayed include:

**Peak Torque:** Displays the maximum torque produced for the current set of testing or exercise.

**Total Work (Force x Distance):** The cumulative amount of work produced by the patient during the current set of testing or exercise.

**% CV: Coefficient of Variation:** This is the amount of variation between repetitions. This measure is useful for immediately determining the consistency of a test set or exercise. Less than 15% is within normal limits (WNL) for large muscle groups. Less than 20% is WNL for small muscle groups.

**NOTE:** Pain, apprehension, patient effort and learning effect can all affect the CV value.

The System Status Area

The System Status Area holds several key functions and indicators of current system status.

These include:

**Chair Settings:** Click on this button if you need to record settings for the dynamometer, chair and attachment length. You can then enter each setting in the appropriate field. Click on <OK> to record the settings and return to the Dynamometer Operation screen, or <Cancel> to return to the Dynamometer Operation screen without recording the settings.

**Display Options:** Click on this button to access the display options and modify the biofeedback graph. Click on <Display Options> again to return to the Dynamometer Operation screen. This option is described in detail later in this chapter.

**Away and Toward:** These windows display the selected speed setting from the controller in isokinetic mode, and the torque setting when performing con/ecc, ecc/con, or ecc/ecc movements in the isokinetic, eccentric or passive mode. They are also used to adjust the torque setting in isokinetic concentric/eccentric or eccentric/concentric movements when in computer control mode.

**Go:** Click on this button to begin the test or exercise session.

**Stop:** Click on this button to immediately stop gathering data from the exercise or test session in progress.

**Set:** Click on this button to advance through the protocol for each set as listed in the Set Bar at the bottom right of the screen. Use the blue triangles to advance through completed sets (i.e., to select a set to re-test.)

**%:** This value, active during testing and exercise, shows the percentage of the current set that is complete (i.e., a set of four, three complete = 75%).
MODIFYING THE BIOFEEDBACK GRAPH

Display Options
Click on <Display Options> in the System Status Area of the Dynamometer Operation screen. The Display Options window should now be open. Options in this area allow the user to modify the appearance of the biofeedback graph. The following options are available:

Scaling Torque Values
Auto and Manual Scaling options allow the clinician to scale the data curve y-axis prior to acquisition so that the curves will appear in proportion to the viewing screen. "Auto" appears as the default value. Using this feature the system will scale data curves based on max peak torque.

- To activate the Auto Scale feature, click on the <AUTO> button to the right of then Torque Scale. To return to manual scaling, click on the <AUTO> button again.

Manual scaling allows the clinician to manually scale the Y-axis during exercise.

- For Manual Scaling, click on the <AUTO> button to turn off Auto Scaling and then drag the pointer to an estimate of max peak torque. Maximum Peak Torque value is 3000 ft-lb.

NOTE: Contraction torque display will appear as directed by the patient protocol. For example, if the protocol calls for concentric/eccentric contraction the display will only plot torque when it sees it in this manner. If the patient does not produce torque in the proper direction, the system will not record the torque produced.

Time Values
The Time Value scale is used to increase or decrease the frequency of the data reported. In other words, a lesser time value stretches out the graph for a better look at individual curves. A greater time value compresses the graph to allow viewing of more curves.

To change the Time Value:
- Click on the Time Value Scale bar (to the right of the graph) and drag it to the appropriate point in the scale. The x-axis on the graph will immediately reflect the new time value setting.

History
Click on <History> to view the last test set from beginning to end. This function is similar to set review except the user can choose scales. It is active during testing and exercise only.

Clear
The <Clear> button is used to clear the History data from the selected test or exercise session.
Y-Axis Options (See Figure 3.3.)
The y-axis of the Biofeedback Graph can be set to display position or velocity based on the test or exercise being performed. Both position and velocity can be displayed in standard or bipolar formats.

- To select position for the y-axis, click on the <Position> button in the Y-Axis area.
- To select velocity for the y-axis, click on the <Velocity> button in the Y-Axis area.
- To select a bipolar format for either position or velocity in the y-axis, click on the <Bipolar> button at the bottom of the Y-Axis area.

X-Axis Options (See Figure 3.4.)
The x-axis of the Biofeedback Graph can be set to display time or position based on the exercise being performed. Time is displayed as the default. If you select position, the screen redraws with two graphs to show away and toward position in degrees.

- To select time for the x-axis, click on the <Time> button in the X-Axis area.
- To select position for the x-axis, click on the <Position> button in the X-Axis area.

Figure 3.3. Y-Axis Options: The y-axis of the Biofeedback Graph can be set to display position or velocity based on the test or exercise being performed. Both position and velocity can be displayed in standard or bipolar formats.
Figure 3-4. The x-axis of the Biofeedback Graph can be set to display time or position based on the exercise being performed. The screen above shows torque vs. position.

Style Options
The Biofeedback Graph can be set to display line graphs or bar graphs. Graphs can be presented with or without grid lines, with or without a scoring window, and with or without a pie chart.

- To select line curves for the Biofeedback Graph, click on the <Line Curve> button in the Style Options area.
- To select bar graphs for the Biofeedback Graph, click on the <Bar Graph> button in the Style Options area.
- To add grid lines to Biofeedback Graph, click on <Grid Lines> at the bottom of the Style Options area.
- To select a pie chart to accompany the Biofeedback Graph, click on <Pie Chart> in the Style Options area. The pie chart will be displayed near the center of the screen. Using the mouse, you can click and drag the pie chart to any position on the screen.

NOTE: The pie chart does not distinguish between directions.

- To add a scoring window to the Biofeedback Graph, simply click on the graph where you would like the goal lines to appear. Goals lines are established based upon the scoring window value entered on the Setup Options screen (select Setup Options from File menu in the Pull-Down Bar.)
SETTING RANGE OF MOTION
(See Figure 3.5.)

The Biodex System allows clinicians to set patient ROM manually and to use an automated ROM feature to recall ROM settings from a previous test or for testing the opposite limb. Auto ROM saves the operator time in setting the range of motion, ensures that the ROM is set equally for both sides, and provides a way to repeat range of motion values from previous tests.

**NOTE:** ROM can also be set manually using the controller (see System 3 Applications/Operation manual for this procedure).

### Setting Patient ROM Via Computer Control

1. Place the patient in the anatomical reference angle specific to the joint to be tested or exercised and press the <Hold> button to lock the dynamometer arm in place.

2. Click on the <Position> icon to set the anatomical reference angle. A prompt will display asking "Do you want to set Range of Motion Limits now?" If you wish to use the computer control mode at this time to set ROM click <Yes>. If you wish to use the panel control to set ROM click <No>.

3. After clicking <Yes> the Set Dynamometer Range of Motion screen will display.

4. With new patients, ensure you clear the existing ROM by clicking on the <Clear Limits> button.

5. Set the Away and Toward values by moving the input adapter to the desired limit for each direction. Click on the appropriate <Set> button at the limit for each direction. The patient ROM should now be displayed in red on the screen diagram.

6. Once you have set your ROMs click the <Continue> button to advance to the Dynamometer Operations Screen.

7. Once all sets for the current side are completed, the Auto Set ROM prompt appears. Click <Yes> to use the Auto Set ROM feature or click <No> to manually reset patient ROM as described above.

8. If you have selected Auto Set ROM, a prompt will appear asking if you want to mirror the ROM for the opposite side. Click <OK>. The Auto Set ROM screen should now be displayed.

9. Click on <Auto Set ROM>. You will be prompted to remove the dynamometer fixture (not necessary if using the ankle attachment). Remove the fixture and click <OK> to continue. The system now prepares for verification of ROM on the new side. “Verify ROM” is displayed on the screen.

10. With the Auto Set ROM screen displayed, set up the patient, and verify the ROM by moving the limb to be tested or exercise through the entire ROM. Once the limb has moved through the ROM, the system displays “ROM OK” and the Dynamometer Operation screen is again displayed. You can now continue with the test or exercise.
Auto Set ROM

To Auto-Set ROM when repeating a test or exercise:

1. Select patient from Patient Screen.

2. Select test or exercise to be repeated, highlight then click <Repeat> at the bottom of the screen to advance to the Set Dynamometer Range of Motion screen.

3. Under the section labeled "Use Previous ROM", click the <Auto Set ROM> icon.

4. Follow the prompts to set and use the previous ROM.

5. To make adjustments, simply move the patient to the new position in the ROM by clicking on <Reset> and moving the patient to the new position. Click on <Reset> again to set the new position.

6. To commence the test, place the patient in the anatomical reference using the <Hold> button to keep the limb in position. Click <Position> to set the anatomical reference.

7. Follow steps 7-10, on page 3-9, to test the opposite side.

Figure 3.5. Clicking the <Patient ROM> icon in the Primary Tool Bar displays the Auto-Set ROM screen. From this screen, clinicians set the patient ROM for the side to be tested, allow the Auto-Set ROM feature to provide ROM settings based on previous tests, or have the Auto-Set ROM feature "mirror" the current ROM for the opposite side.
The Curve Analysis function allows the user to view test data on screen in various formats including individual curves, windowed-curves, filtered curves, and a curve log. It also allows printing of curves for individual reps or complete sets.

To Access Curve Analysis:
At the Dynamometer Operation screen, click on the Curve Analysis icon. The Curve Analysis screen should replace the Biofeedback Graph with the most recent test displayed. Data Set, Protocol, Joint and Pattern for the test are displayed across the top of the screen.

To Select A Different Patient: If you desire a different patient from the one currently displayed, click on <Select Patient>. You can then select a different patient and test from the patient list.

To Select A Different Data Set: Use the Data Set scroll down button to view the other data sets from that test/exercise for the currently selected patient. Click on the desired data set to view and the screen will refresh with the new data set displayed.

To Select A Different Test: If you desire to view a different test for the selected patient, click on <Select Patient>. You can then select a different patient and test from the patient list.

Curve Analysis Options
The lower portion of the Curve Analysis screen is divided into the following sections which allow the user to choose from various viewing options: Y-Scale, Cursors, Overlay, Display and Menu. Each section is explained in detail below.

Y-Scale:
Enables the clinician to adjust a minimum and maximum scaling value for torque in ft-lb. When observing graph, the ft-lb setting runs vertically on the left side of the screen. The auto setting allows for automatic rescaling of the torque in ft-lb to compensate for the peak torque curve.

Cursors:
Enable Cursors: Checking the enable cursors icon gives the clinician the ability to use and view data between the cursors labeled "A" and "B".

Move:
This is a pull down menu for cursor movement that allows the following functions:

- Both cursors allows cursor "A" and "B" to be moved at the same time.
- Cursor "A" allows only the "A" cursor to be active.
- Cursor "B" allows only the "B" cursor to be active.

Cursors can also be moved by clicking and dragging, or with the single, half rep or full rep buttons described below.

- Single: allows the cursor(s) to be moved along one data point at a time
- Half Rep: Will place the cursor(s) at the start and end of a half rep
- Full Rep: Will place the cursors at the start and end of a full rep
**Zoom In/Zoom Out:**
Clicking on Zoom in/Zoom out magnifies the area of the curve between the cursors. This allows closer evaluation of the curve quality.

**Select Rep:**
An individual repetition can be viewed using the Select Rep feature. When viewing the graph with the cursors enabled, selecting rep will automatically place the cursors at the start and end of the corresponding repetition.

**Overlay:**
Allows the clinician to select sets of the same parameters to overlay curves for comparison of torque. Up to 4 sets can be selected at one time.

To Overlay Curves:
1. Click on the Curve Analysis icon in the Primary Tool Bar if not already on the Curve Analysis screen.
2. Display the first curve/set on the graph. The current patient is automatically displayed. Select another patient if desired by clicking on <Select Patient>.
3. Click on <Save> to save the displayed curve/set.
4. Click on <OK>. The first curve/set is now displayed.
5. Retrieve the next curve/set.
6. Click <Save>.
7. Click <OK>. Both sets/curves are now displayed, overlayed.

**Legends:**
When checked, lists each set overlayed in order (in the upper left hand corner of the curve analysis screen) in the following corresponding color code:

- Violet = first set selected
- Blue = second set selected
- Black = third set selected
- Green = fourth set selected

If you wish to have legends displayed for overlayed tests, click on <Legends> after saving curves/sets to overlay in steps 3 and 6, above.

**Save:**
Drops the selected set onto the curve analysis screen in the order chosen.

**Clear:**
Clears all overlaid data and graphs and returns graph to single set curve analysis.
Display:
- Bipolar: Displays the graph on a positive/negative axis and is useful for analyzing concentric/eccentric and eccentric/concentric data.
- Window Data: Click here if you want to see only data generated at or above the default percentage of selected isokinetic test speed. Any data acquired at less than 70% of the pre-set isokinetic speed will be eliminated from the display. This feature is used to eliminate torque spikes generated at end ROM stops. The default value of 70% can be changed in the set-up screen previously mentioned.
- Filtered: Click on the <Filter> button to “smooth” the curves displayed. This feature does not alter data. It simply serves as a visual aid by rounding the curves to reduce spikes and noise.
- Metric: When selected, display units in metric values.
- Position: Indicates range of motion for the displayed reps. A purple horizontal line is used to indicate start (towards) direction. (See Figure 3-6.)
- Velocity: The green line indicates the speed at which reps were produced.

Rep. Info: Click on <Rep Info> to display:
- Beginning and end of each repetition
- Peak torque repetition, both toward and away
- Peak work repetition

Curve Info: Click on <Curve Info> to display toward and away values for:
- Peak torque rep
- Peak torque ft-lb
- Max work ft-lb
- Max work rep
- Average power (watts)
- Seconds to peak torque (sec)

Menu:
Print: Click on <Print> to access print options. You can then edit the title and key in comments to be added to the printout. When ready, click on <Continue> to print.

Log To File: For a numeric log of the currently displayed curve, click on <Log To File>. Choosing this feature displays every data point for the set displayed for: time (milliseconds), torque (ft-lb), dynamometer position (degrees), anatomical position (degrees), and velocity (deg/sec) See Figure 3-8.

Close: Click on <Close> to close the Curve Analysis screen and return to the Dynamometer Operation screen.
Figure 3.6. The Curve Analysis function allows clinicians to view test curves on a set by set basis.

Figure 3.7. Click on <Show Log> to view individual data points for the currently selected set.
Figure 3.8. The Curve Analysis Log To File option can be used to provide a numeric log of the currently displayed curve.
THE PATIENT SELECTION SCREEN
(See Figure 4.1 and 4.2.)

The Patient Selection Screen is used to:
- Open and View existing Patient Records
- Add a New Patient to the Patient List
- Add a New Test or exercise to a Patient Record
- Update or Edit Patient Records

To access the Patient Selection screen, click on the Patient Selection icon in the primary tool bar. The Patient Selection screen is now displayed with the last patient saved noted as the current patient.

Figure 4.1. The Patient Selection Screen. Mandatory fields are highlighted.

Figure 4.2. Click on any patient for a full listing of all test/exercise sessions.
PATIENT SELECTION OPTIONS
(See Figure 4.1 and 4.2.)

Located at the top of the Patient Selection screen, the Patient Selection Tool Bar displays icons used to access the patient selection options. To select any option from the Patient Selection screen tool bar click on the appropriate icon. From left to right, the icons and their usage are defined as follows:

Open: Select and open an existing patient record to view, edit, update or add a new test/exercise.

Add Patient: Add a new patient to the patient database.

Edit: Edit or update and existing patient record.

Save: Save a new or edited patient record.

Cancel: Cancel the currently selected function.

Delete Test: Delete the current test/exercise from the patient record.

Delete Patient: Delete the currently selected patient and all associated tests from the patient file.

Sync (NT Systems only): This network option allows synchronization of data between Biodex Systems. Call Biodex Customer Service for details about this option.

Close: Closes the Patient Selection screen.

Open
The Open option is used to open an existing patient record, allowing the clinician to view, edit or update the selected patient record, print reports, repeat a test/exercise, or add a new test/exercise to the patient record.

To Open a Patient Record:
1. Click on the <Open> icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients.
2. Click on any patient to expand the patient list to show all tests and exercise sessions for each patient. Use the scroll buttons to advance through the alphabetical listing as needed.
3. Select the desired test/exercise. The Patient Selection screen should now display the desired patient and the test/exercise selected.

To Add a New Test/Exercise to the Patient Record:
1. Click on the <Open> icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients.
2. Highlight the desired patient from the patient list.
3. Click on <New> to add a new test or exercise to the patient record. The Protocol Definition screen should now be displayed.
4. Complete the Protocol Definition screen (see Chapter 5) and click on the <Save> icon in the screen tool bar to save the new test or exercise protocol. The Patient Selection screen should now be displayed with the currently selected patient.
To Repeat a Test/Exercise Session:
1. Click on the <Open> icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients.
2. Click on any patient to expand the patient list to show all tests and exercise sessions for each patient. Use the scroll buttons to advance through the alphabetical listing as needed.
3. Click on the desired test/exercise to repeat.
4. Click on <Repeat>.
5. Set patient ROM as instructed, then click <OK>.
6. The Dynamometer Operation screen should now be displayed with the currently selected patient and appropriate protocol.

To View Reports for This Test/Exercise:
1. Click on the <Open> icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients.
2. Click on any patient to expand the patient list to show all tests and exercise sessions for each patient. Use the scroll buttons to advance through the alphabetical listing as needed.
3. Click on the desired test/exercise for the report.
4. Select the desired report parameters, then click on <Report>.

NOTE: For more detailed instructions on selecting reports, along with an explanation report types and parameters, see Chapter 7, The Report Generation Screen.

To Edit a Patient Record:
1. Click on the <Open> icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients.
2. Highlight the desired patient from the patient list.
3. Click on <Edit>. The Patient Selection screen should now be displayed with the selected patient.
4. Click on <Edit> in the <Open> screen tool bar. All fields on the screen that can be edited should turn from gray to white, indicating that you may now edit this record.
5. Edit the desired fields. Click on <Save> in the Patient Selection screen tool bar to save your changes.

To Delete a Patient/Test:
1. Click on the Patient Selection icon in the Patient Selection screen tool bar. The Patient Name screen should now be displayed with a listing of all previously entered patients. To delete a patient, click on any patient and proceed to step 4. To delete a test, proceed to step 2.
2. Click on any patient to expand the patient list to show all tests and exercise sessions for each patient. Use the scroll buttons to advance through the alphabetical listing as needed.
3. Click on the desired test to delete.
4. Click on <Delete Patient/Test>. If you delete the patient, all associated records will be deleted. If you delete a test, only the information for the test selected will be deleted.
5. Click on <Yes> to delete the patient/test or <Cancel> to return to the Patient Selection screen without deleting the patient or test.

Add Patient
The Add Patient option is used to enter a new patient on the patient list, creating a patient record. When you select this option, a blank Patient Selection screen is displayed. The new screen must be filled out to create the new patient record.

The following fields on the screen appear in red. These are mandatory fields that must be completed to save this screen as a new patient record:

Last Name:
Weight:
Patient ID:
Involved Side:
NOTE: If the first name of the patient is not filled out, you can not edit this field later. It will remain blank.

Data entry for the remaining fields is optional. Should you forget to fill in one of the mandatory fields and try to save the new patient, a prompt will appear to inform you that all mandatory fields must be completed before saving.

NOTE: The patient ID number is a permanent number used to identify the patient in your files. Once entered and saved as part of the Patient Record, it cannot be changed.

To Add a New Patient to the Patient Files:
1. Click on the Patient Selection icon in the primary tool bar. The Patient Selection screen should now be displayed.
2. Click on <Add Patient> in the Patient Selection screen tool bar. All fields on the Patient Selection screen should clear, indicating that you can now enter the new patient data.
3. Enter the information required for each line on the Patient Selection screen. Be sure to complete all mandatory (red) fields.
4. Click on <Save> in the Patient Selection screen tool bar to add the new patient record to the patient list. The new patient is now the currently selected patient and the patient record is ready to accept study data.

Edit
The Edit option allows the clinician to edit an existing patient/test.

To Edit an Existing Patient Record:
1. Click on the Patient Selection icon in the primary tool bar. The Patient Selection screen should now be displayed. The last patient saved is displayed as the current patient.
2. If you want to edit a patient record other than the one displayed, click on the <Open> icon in the Patient Selection screen tool bar. A listing of patient files should be displayed. Select the desired patient.
3. With the desired patient record selected, click on <Edit>. All fields on the screen that can be edited should turn from gray to white, indicating that you may now edit this record.
4. Edit the desired fields. Click on the <Save> icon in the Patient Selection screen tool bar to save your changes.

Save
The Save option allows the clinician to save any changes made to the currently selected patient record.

To Save an Edited, Updated or New Patient Record:
1. Click on the <Save> icon in the screen tool bar. All changes will be saved to the patient record. After it has been saved, the patient record remains selected.

Cancel
The Cancel option allows the user to exit any operation on the Patient Selection screen without saving or making changes to the currently selected patient record. In some instances, you will need to cancel before closing a record if you do not wish to save.

To Cancel An Operation:
1. Click on <Cancel> in the Patient Selection screen tool bar. Any changes made since the last time the currently selected patient record was saved will be erased and the previous values will be restored. The currently selected patient file is still open.
Delete Test\Exercise
The Delete Test\Exercise option allows any study to be permanently deleted from the currently selected patient record.

To Delete a Specific Test\Exercise from the Patient Record:
1. Click on the <Open Record> icon in the Patient Selection screen tool bar.
2. Highlight the patient and specific test to be deleted.
3. Click on <Delete> at the bottom of the screen.
4. Respond "YES" to the "Delete Test\Exercise?" prompt. The selected test\exercise will be permanently deleted from the patient record.

Delete Patient
The Delete Patient option allows for removal of a selected patient and associated records from the patient file.

To Delete a Patient Record from the Patient File:
1. Open the file for the patient to delete.
2. Click on <Delete>.
3. Respond "Y" to the "Delete Patient?" prompt.
4. The currently selected patient will be deleted from the patient file.

NOTE: If you delete a patient, the entire patient record is permanently deleted from the patient file. This information cannot be restored unless it has been backed up on floppy diskette.

Close
The Close option allows the clinician to close any screen or patient record currently displayed. The user is given an option to save or discard any changes made since the current patient record was last saved.

NOTE: If you have performed any operation on the screen or patient record, you must first <Save> or <Cancel> before closing.

To Close a Patient Record or Screen:
1. After saving the patient record, or canceling any function, click <Close> on the screen tool bar. The system will close the currently displayed screen and display the logical next or previous screen.
The Protocol Definition screen allows the clinician to clearly define individual test and exercise parameters.

To access the Protocol Definition screen, click on the Protocol Definition icon in the primary tool bar. The last protocol selected should be displayed on the screen.

**PROTOCOL DEFINITION OPTIONS**
*(See Figures 5.1 and 5.2.)*

The Protocol Definition screen displays the basic parameters for an individual test or exercise session.

Located at the top of the Protocol Definition screen, the Protocol Definition Tool Bar displays a set of icons used to access the Protocol Definition options. To select any option from the screen tool bar, click on the appropriate icon. From left to right, the icons and their usage are defined as follows:

- **Protocol:** Select an existing protocol.
- **Add:** Create and add a new protocol to the protocols list.
- **Edit:** Edit or update an existing protocol.
- **Save:** Save a new, updated or edited protocol.
- **Cancel:** Cancel the currently selected function.
- **Delete:** Delete an existing protocol from the protocols list.
- **Close:** Close any Protocol Definition screen.

**NOTE:** The joint, pattern and study type selected on the Protocol Definition screen will be displayed on the Dynamometer Operation screen for testing and exercise sessions.

**Protocol**
The <Protocol> icon is used to recall an existing protocol to select, edit or update.

To Select A Desired Protocol:

1. Click on the <Protocol> icon in the Protocol Definition screen tool bar. A listing of existing protocols will be displayed in the Select Protocol window. Protocols on this list are grouped by mode, joint and pattern.

2. Click on <+> to view the parameters for the desired protocol format to select, (i.e., Isokinetic/Bilateral, Isokinetic/Unilateral, Isometric/Bilateral, Isometric/Unilateral).

3. Highlight the desired protocol and then click <Select>. The selected protocol should now be displayed on the Protocol Definition screen.
Figure 5.1. Click on <+> or <-> proceeding each listing to expand or limit the presentation of Protocols in the Protocol List, or click on <Expand All> at the bottom of the Protocol List for a full view of all protocol levels.

Figure 5.2. The Protocol Definition screen.
Add
The <Add> icon is used to add a newly created protocol to the protocols list.

To Add A New Protocol:
1. Click on the <Protocol Definition> icon in the primary tool bar. The Protocol Definition screen should now be displayed.
2. Click on <Add> in the Protocol Definition screen tool bar.
3. Enter the information required for each line on the Protocol Definition screen.
   
   NOTE: To increase or decrease the number of sets (speeds,) enter the appropriate number in the "number of sets" field.
4. Click on <Save> in the Protocol Definition screen tool bar to add the new protocol to the protocols list. The newly added protocol is now the currently selected protocol.

Edit
Use the <Edit> icon to edit or update any currently selected protocol.

NOTE: If you edit an existing protocol, it will be permanently changed for all patients that have used this protocol. If you try to repeat a test completed previous to the change, you will need to re-define the protocol for that test.

To Edit An Existing Protocol:
1. Select the desired protocol.
2. Click the <Edit> icon. All fields on the screen should turn from gray to white, indicating that you may now edit this protocol.
3. Edit the desired fields. Click on the <Save> icon in the Protocol Definition screen tool bar to save your changes.

Save
The Save option allows the clinician to save any changes made to the currently selected protocol.

To Save an Edited, Updated or New Protocol:
1. Click on the <Save> icon in the screen tool bar. All changes will be saved to the selected protocol. After it has been saved, the protocol remains selected.

Cancel
The Cancel option allows the user to exit any operation performed on the protocol without saving or making changes. In some instances, you will need to cancel before closing a protocol if you do not wish to save.

To Cancel An Operation:
1. Click on <Cancel> in the Protocol Definition screen tool bar. Any changes made since the last time the currently selected protocol was saved will be erased and the previous values will be restored. The currently selected protocol remains open.
Delete
The Delete option allows for removal of a selected protocol from the protocols list.

To Delete a Protocol from the Protocols List:
1. Select the protocol to delete.
2. Click on <Delete> in the Protocol Definition screen tool bar.
3. Respond "Y" to the "Delete Protocol?" prompt.
4. The currently selected protocol will be deleted from the protocol list.

Link Protocol
See Linking Protocols, later in this chapter.

Close
The Close option allows the clinician to close any screen or protocol currently displayed. The user is given an option to save or discard any changes made since the selected protocol was last saved.

NOTE: If you have performed any operation on the screen or selected protocol, you must first <Save> or <Cancel> before closing.

To Close a Selected Protocol or Screen:
1. After saving a protocol or canceling any function, click <Close> on the screen tool bar.
   The system will close the currently displayed screen.

LINKING PROTOCOLS
(See Figure 5.3)

Once created, protocols can be "linked" or connected to an individual test or rehabilitation session. This saves the clinician several steps when rehab sessions are to be conducted using different protocols. It also provides more time for the patient to spend exercising since less time is spent on software set up.

Linked protocols allow the clinician to set up patients to be guided through multiple phases of the rehabilitation program with only one software set up. A patient could, for example, be set up for ten minutes of passive motion, followed in succession by bouts of isometric and isokinetic exercise. In so doing, the need to return to the computer at the end of each bout to set up the next phase is eliminated and the continuity of the exercise session is maintained. Once linked protocols are established and the patient is appropriately set up, the rehabilitation session can proceed from beginning to end with no need to reset the ROM stops or anatomical positioning for each new protocol.

NOTE: Ensure that exercise data is not being saved in Setup Options under “Linked Protocol Preferences” or the software will close due to applicational memory error.
To Link a Protocol to an Exercise Session:
1. Click on the <Protocol> icon in the primary tool bar. The Protocol Definition screen should now be displayed.

2. If they do not already exist, define (add or edit) any protocol(s) you would like to use to build the linked protocol.

3. Click on the <Linked Protocol> icon in the Protocol Definition screen tool bar.

4. Click on <Create Linked Protocol>.

5. Enter a name for the new linked protocol.

6. Click on the <+> next to each mode to expand the list of individual protocols.

7. Highlight the desired single protocol to link, then click on <Insert> at the top of the screen. The single protocol should now be displayed in the linked protocol sequence window.

8. Continue to highlight and add protocols as desired.

9. When all the single protocols have been linked, click <Save> to save the linked protocol.

**NOTE:** To remove a single protocol from the linked protocol sequence, highlight it in the linked protocol sequence window and click <Remove>. The single protocol will be deleted from the linked protocol sequence.

---

**Figure 5.3. The Linked Protocol Setup screen.**
PROTOCOL PARAMETER FIELDS DEFINED

**Mode:** Choose from Isokinetic, Passive, Isometric, Isotonic or Reactive Eccentric. This field will automatically match the touch panel setting in computer control mode.

**Joint:** The joint to be tested or exercised. Choose from Knee, Ankle, Hip, etc. The description selected on this screen carries over to the Dynamometer Operation screen as well.

**Pattern:** The test or exercise pattern selected, i.e., Extension/Flexion, Pronation/Supination, etc. The description selected on this screen carries over to the Dynamometer Operation screen as well.

**Contraction/Direction:** The test or exercise contraction type, i.e., concentric/concentric, etc.

**Description:** This is the test type, i.e., Two-Speed Bilateral, Velocity Spectrum, etc. The description entered on this screen carries over to the Dynamometer Operation screen as well.

**Bilateral:** For Isokinetic testing and exercise, the user can set speeds away and toward, # of sets, number of reps for each limb to be tested. For Isometric testing, the user can set angles, away and toward.

**NOTE:** Number of sets refers to the number of speeds or angles for both bilateral and unilateral tests, (i.e., 2 for 2-speed tests, 3 for 3-speed tests).

**Unilateral:** For Unilateral testing and exercise the user can set speeds away and toward, # of sets, number of reps for the limb to be tested. The system defaults to the involved side when unilateral tests are selected.

**Trial Reps:** This field is used to toggle the Trial Reps function ON and OFF. Trial reps allows the patient to get used to the test speed before the test begins.

**Anatomical Reference:** The position of the limb immediately prior to testing or exercise. This figure carries over to the Dynamometer Operation screen. Each joint has a specific default value which can be changed as needed.

**Attachment Sensitivity:** This value controls acceleration based on attachment selection. It is a factory preset value based on the attachment used.

**Cushion:** This setting mirrors the End Stop Cushion setting on the Controller. As a general rule, "hard" cushions are used for testing while "soft" cushion are used to improve comfort during exercise and rehabilitation.

**NOTE:** If pain prohibits the use of hard cushion, or if a protocol calls for use of a soft cushion, there will be some decrease in time spent at isokinetic speed.

**Rest Time in Seconds:** This is the rest period between sets, in seconds.

**End By:** This is the parameter selected to end the exercise or test set. Available options are Rep, Time and Total Work.
Whereas the Biodex Biofeedback option allows the clinician to set up an exercise session without entering any patient data, Biodex exercise and testing requires patient-specific data entry. The standard procedure is the same for both testing and exercise, but there are some differences in report generation. A proprioceptive testing procedure is also provided later in this chapter.

**NOTE:** For a quick sample tour through the basic Rehabilitation and Testing procedure, click on the Biodex Wizard and continue as directed on the screen.

![Figure 6.1](image1)

Figure 6.1.

![Figure 6.2](image2)

Figure 6.2.

Figure 6.1. and 6.2. The testing and rehabilitation procedure assumes that all controller settings have already been selected and that the patient is properly positioned and ready for the test. Clinicians can choose between Torque vs. Time and Torque vs. Position display screens.
STANDARD REHABILITATION AND TESTING PROCEDURE
(See Figures 6.3 – 6.10.)

1. Position and set up the patient as required by patient protocol. (Refer to the Biodex System 3 Operation/Applications Manual or click on the AVI icon in the primary tool bar to view a setup and positioning photo or video clip for the desired pattern.)

2. At the Dynamometer Operation screen, click on the <Patient> icon in the Primary Tool Bar. The Patient Selection screen should now be displayed. Click on <Open> to view a listing of patients previously entered patients or add a new patient <Add Patient> if necessary.

3. Select the patient to be tested by clicking on the desired name in the patient list. Any tests/exercises previously performed by the patient selected will now be displayed.

4. To perform a new test, click <New> at the bottom of the screen and proceed to step 5. To repeat a previous test, highlight the desired test under the patient name and click on <Repeat>. Proceed to step 8.

5. The Protocol Definition screen should now be displayed. Click on the <Protocol> icon to view a list of available protocols. Click on the "+" next to each protocol mode grouping to further expand the protocol.

6. Highlight the desired protocol and click to select. You may now review the currently selected protocol parameters or simply click on the Dynamometer Operation icon to proceed with the test.

   NOTE: If the desired protocol is not listed, close the protocol list screen and select the <Protocol> icon from the Dynamometer Operation screen. Follow the procedure for adding a protocol as outlined previously in this manual. Do not edit protocols as this will change the preset protocol selected for ALL patients that have used that protocol.

7. To record or verify the chair settings, click on the <Chair Settings> button. The Chair Settings window will be displayed. Record the chair settings appropriately, then click on <OK> to return to the Dynamometer Operation screen.

8. Click on <Display Options> to open the Display Options window. Click on the desired parameters to modify the appearance of the Biofeedback Graph as desired.
Figure 6.3. The Protocol Definition screen allows the clinician to view a selected protocol or define a new protocol.

Figure 6.4. The Display Options window (see arrow) allows the clinician to modify the appearance of the biofeedback graph.
9. Calibrate the patient’s anatomical position by placing the joint to be tested in the anatomical reference angle specific to the default value. Press the <HOLD> button to lock the Dynamometer into place.

**NOTE:** If you want to use a different anatomical position than the default, use the scroll keys or keyboard to enter the new value (i.e.; 45 degrees) in the Anatomical Reference box. Be sure to measure this value with a goniometer.

**NOTE:** You must calibrate the patient’s anatomical position if you will be using the Auto-Set ROM feature.

10. Click on the <Position> icon to set the anatomical reference angle. The position reading under the icon should now match the patient’s anatomical reference position.

11. A prompt will now display asking “Do you want to set Range of Motion Limits now?” If you wish to use the computer control mode at this time to set ROM click <Yes>. If you wish to use the panel control to set ROM click <No>.

12. After clicking <Yes> the Set Dynamometer Range of Motion screen will display.

13. With new patients, ensure you clear the existing ROM by clicking on the <Clear Limits> button.

14. Set the Away and Toward values by moving the patient and the attachment to the desired limit for each direction. Click on the appropriate <Set> button at the limit for each direction. The patient ROM should now be displayed in red on the screen diagram.

15. Once you have set your ROMs click the <Continue> button to advance to the Dynamometer Operations Screen.

---

*Figure 6.5. Setting Range of Motion.*
16. Calibrate the subject’s limb weight (optional).
   • With the limb positioned at an angle greater than 40 degrees from vertical, press<br>   <Hold> on the controller or dynamometer.
   • Instruct the patient to relax the limb, then click on the <Correct Torque > icon to record<br>   limb weight. The limb weight value displayed in the Limb Weight box will be used to<br>   negate gravity effect torque on collected data. Press <Hold> on the controller or<br>   dynamometer to release the limb once the gravity effect torque value is displayed.<br>   
   **NOTE:** Passive mode does not support gravity correction for any testing or exercise pattern.<br>   It is also unavailable for use with the back, lift and closed chain attachments.<br>   
17. Position the patient to start the test. Click <GO> and follow the countdown prompts to<br>   begin the trial reps. Once the trial reps are completed, instruct the patient to hold the limb in<br>   the start position before beginning the test. For unilateral tests, proceed to step 25. For<br>   bilateral tests, proceed to step 18.<br>   
   **NOTE:** Data is collected in the away direction first.<br>   
18. Once all sets for the current side are completed, the Auto Set ROM prompt appears. Click<br>   <Yes> to use the Auto Set ROM feature or click <No> to manually reset patient ROM.<br>   
19. If you have selected Auto Set ROM, a prompt will appear asking if you wish to auto-set the<br>   ROM for the opposite side. Click <Yes> to auto-set, <No> to abort the operation. The Auto<br>   Set ROM screen should now be displayed.<br>   

![Image of Auto-Set ROM screen]

**Figure 6.6.** If you respond “Yes” to the Auto-Set ROM prompt, the system will next request if you would<br>like to mirror the subject’s ROM. If yes, the system will guide you through the verify ROM process.
20. Click <Auto Set ROM>. You will be prompted to remove the dynamometer attachment (not necessary if using the ankle attachment). Remove the fixture and click <OK> to continue. The system now "mirrors" the ROM for testing of the new side and prepares for verification of ROM on the new side. "Verify ROM" is displayed on the screen.

21. With the Auto Set ROM screen displayed, place the attachment for the opposite side on the dynamometer. Set up the patient and verify the ROM by moving the limb to be tested or exercised through the entire ROM. Once the limb has moved through the ROM, the system displays "ROM OK" and the Dynamometer Operation screen is again displayed.

22. Set the Anatomical Reference as previously explained.

23. Weigh the patient limb for the new side as previously explained. Be sure to place the limb at the same point in the ROM as used for the first side.

24. Click <Go> and proceed with the test or exercise.

25. Once all sets have been completed the system prompts: "Click to Finish Test" or "No to Repeat a Set". Click "Yes" to complete the test or exercise and return to the Dynamometer Operation screen. Click "No" to go back and select a set to repeat.

**NOTE:** To repeat a set, use the blue arrow buttons to scroll through the protocol to the desired set.

Figures 6.7, 6.8, 6.9 and 6.10. Based on patient protocol and clinician preferences, the Dynamometer Operation screen during data acquisition can present patient data in curve or bar graph format, with or without a grid, and with or without the patient goal bar.
Figures 6.8. Data acquisition in bar graph format.

Figures 6.9. Data acquisition in bar format with grid selected.
Figures 6.10. Data acquisition in bar format with patient goal bar displayed.

PROPRIOCEPTIVE TESTING AND EXERCISE PROCEDURE
(See Figure 6.11.)

1. After selecting/entering a patient and the desired proprioceptive protocol, click on the <Dynamometer Operation> icon. The Dynamometer screen should now be displayed with directions for proprioceptive testing.

2. Ensure the patient is properly positioned and that range of motion has been set.

3. Set the anatomical reference position and click <GO>.

4. Give the <Hold/Resume> button to the patient and explain how it is used to hold and free the limb.

5. Allow the patient (or the system) to move the limb to the starting position and press the <Hold/Resume> button. The system will hold the limb in place. Click on <OK>.

6. Instruct the patient to move the limb to the target angle. The system will automatically hold the limb in place once the target angle is reached. The system provides a countdown allowing the patient to become familiar with the limb position. After the countdown, the system releases the limb.
7. Return the limb to the start angle and press <Hold/Resume> to hold the limb. Click <OK>.

8. Instruct the patient to move the limb to the target angle and press <Hold/Resume>. The system will record the limb position after <Hold/Resume> has been pressed. The system will then release the limb to return to the starting angle.

9. Repeat steps five through eight for each.

10. Once all sets have been completed, click on <Yes> to record the test as completed, or <No> to repeat a set.

**NOTE:** If include trial reps is selected on the patient’s proprioceptive protocol, the system will prompt you to perform an additional (trial) repetition for each test rep. (i.e., one trial rep, show target angle, perform one test repetition to target angle.)

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![Image of the Proprioceptive Testing Screen.](image-url)
Biodex Advantage Software is extremely flexible when generating printed reports. In addition to four standard report formats displaying bar graphs, pie charts and statistical data, you can print cover letters for referrals and payors. Progress reports are available in Graphical Evaluation and General Evaluation formats.

**NOTE:** For a detailed explanation of report parameters, refer to the Biodex System 3 Multi-Joint and Rehabilitation System Clinical Reference Guide.

**REPORT FORMATS**

The Biodex Reports can be grouped into the following categories:

- Graphical Evaluation
- General Evaluation (not available for passive, isotonic and reactive eccentric)
- Comprehensive Evaluation
- Progress Reports (compare two similar protocols of different test sessions)
- Narrative Cover Letter
- Isomap (available only for three speed, bilateral concentric/concentric, concentric/eccentric, eccentric/concentric or eccentric/eccentric tests, minimum three reps per speed).

![Figure 7.1. The Report Generation Screen.](image-url)
GENERATING REPORTS

NOTE: The following procedure is used to generate Graphical Evaluations, General Evaluations, Comprehensive Evaluations, Progress Reports and Narrative Cover Letters. To generate Isomap Reports, see “Generating Isomap Reports,” later in this chapter.

To Generate A Report:

NOTE: The following procedure details report generation for a saved patient. Reports can also be generated immediately following any test by clicking on the <Report> icon.

1. Click on the <Patient Selection> icon in the primary tool bar. The Patient Selection screen should now be displayed. The last patient saved is the current patient.

2. Click on the <Open> icon in the Patient Selection tool bar. The patient list should now be displayed.

3. Highlight the desired patient from the Patient List.

4. Highlight the test for which you desire a report.

5. Click <Report> at the bottom of the Open Record screen. The Report Generation screen should now be displayed. A summary of test information for the selected test appears on the right side of the screen. For progress reports, proceed to step 6. For other report formats, proceed to step 8.

6. Check “Progress” if a Progress Report is desired. The system will determine which sides are available for progress reporting (left or right). If both sides are available, select the desired side.

NOTE: Progress Reports can only be printed for tests that are similar. Both tests must be of the same protocol type (bilateral or unilateral,) mode (isokinetic or isometric,) and speed (or position).

NOTE: Incomplete bilateral tests can be used for progress reporting. If the subject undergoes a complete bilateral evaluation and, at a later date, is tested for follow-up on the involved side only, the program will generate a report for the involved side. Be aware that the two tests must be identical in protocol. In other words, the follow-up test on the involved side must be a bilateral protocol even though it is considered “incomplete” as a bilateral procedure. The Print as Unilateral report option (see step 8) can be used to print reports for an incomplete bilateral test.

7. Using the drop-down list on the Report Generation screen (immediately beneath “progress,”) select a test date for comparison. The system will automatically order the test dates so that the most recent test date is compared to the previous test date.

8. Under “Choose Option,” highlight the desired report options. As options are selected, the list of available report formats displayed in the Choose Report window is narrowed to reflect only those report formats available based on the options selected.

NOTE: For a description of each report option, click on the Report Wizard at the bottom of the screen or see the section “Report Options” later in this chapter.
9. If you wish to enter any comments on the report, key them into the Comments box at the bottom right of the screen. You can now enter up to eight lines of comments. These will appear at the bottom of the report.

10. Highlight the report format desired in the "Choose Report." For Narrative Cover Letters, proceed to step 11. For other report formats, click <Print Preview> to see the report on the screen and proceed to step 12.

11. If you have selected a Narrative Cover Letter, complete the Recipient Name and Address Screen. Click <OK> to advance to the Print Preview screen.

12. At the Print Preview screen, ensure that the correct report is displayed with accurate information. If desired, click <Zoom> at the top of the screen to enlarge the report display for better viewing.

13. Click <Print> to print out a hard copy of the report, or click <Close> to exit without printing a report.

14. Once the report has been printed, click <Close> to return to the Dynamometer Operation screen.

REPORT OPTIONS
Window Isokinetic Data: Applies to isokinetic protocols only. This option filters out points inside the isokinetic data curve which fall below a predetermined percentage of the specified dynamometer speed.

Torque vs. Position Graph: All graphs in reports are normally plotted as Torque vs. Time. This option allows Position (in degrees) to appear on the x-axis of graphs in reports.

Use Metric Units: This option allows the data to be reported in metric units.

Print as Unilateral: Applies to bilateral tests only. This option allows the operator to print unilateral style reports for a bilateral test. This option is useful for printing results on partially completed tests.

Monochrome: Applies to Isomap tests only. This option causes Isomap images to be printed using a black and white (monochromatic) scale instead of color.

NOTES ABOUT WINDOWING, CUSHION FILTERING AND CURVE FILTERING
When operating at high speeds and torques, it is possible to generate torque spikes as the subject decelerates into the end stop. Sometimes, this end stop spike is erroneously reported as the peak torque. To address this problem, Biodex software imposes cushion filtering and windowing. These are separate, selectable parameters that are set to default values in the software.

Windowing:
During report selection, if windowed data is enabled, only data above 70% of isokinetic speed value is reported. The numeric data will also be windowed. The report will indicate whether data is windowed or non-windowed. The default value for isokinetic speed is to report all torque above 70% of isokinetic speed. This can be changed in the set-up options (under File in the main tool bar.)
Cushion Filtering:
This is an additional method used in conjunction with isokinetic windowing to eliminate erroneous torque end spikes caused by deceleration into the end stop. This is not selectable in the report selection menu. The amount of filtering is calculated from the speed of the dynamometer and the level of the deceleration. If one assumes a cushion setting of 1 (default) for testing, this corresponds to a deceleration of 6 degrees per second per degree traveled. At 180 degrees per second, deceleration will begin 7.25 degrees from the stop. The “cushion” filter will remove torque values that occur within 7.25-degree deceleration zone. The cushion filter values can also be changed. These are INI file parameters. The default is ON. The default degree setting is 6 (degrees per second per degree).

NOTE: See appendix C for more information concerning Cushion Filtering.

Curve Smooth Filter:
A different type of filtering called Curve Smooth Filter is also used for reports. The curve smooth filter is used to provide a more graphically appealing curve. The exact method is explained in Appendix B, System 3 Dynamometer Structures, Formulas and Calculations.

GRAPHICAL EVALUATION REPORTS
(See Figure 7.2.)

Graphical Evaluation Reports provide graphical data of a bilateral comparison of peak torque values. The line graph documents the maximum repetition of peak torque of involved to uninvolved muscle groups. The pie chart shows the percent of peak torque deficit between the involved and the uninvolved muscle groups. The bar graph compares the peak torque to body weight ratio of involved and uninvolved muscle groups to a population goal.

Figure 7.2. The Graphical Evaluation Report.
GENERAL EVALUATION REPORTS
(See Figure 7.3.)

This report generates numeric values including peak torque, peak torque to body weight ratio, maximum repetition of total work, coefficient of variance, average power, acceleration time, deceleration time, ROM, and agonist to antagonist ratio. Charts include a pie chart of peak torque deficits and a bar graph with peak torque to body weight ratios compared to a population goal. For this report, deficits are displayed in red.

This report presents numeric data for 20 parameters, plus a line graph showing the maximum peak torque repetition. The numeric values include peak torque, peak torque to body weight ratio, time to peak torque, angle of peak torque, peak torque at X degrees of ROM, peak torque at X time, coefficient of variance, maximum reputation of total work, maximum work repetition number, work to body weight ratio, total work, work first third and work last third, work fatigue, average power, acceleration time, deceleration time, ROM, average peak torque, agonist to antagonist ratio.

Figure 7.4. The Comprehensive Evaluation Report.
NARRATIVE COVER LETTER
(See Figures 7.5 and 7.6.)

This is a form letter that allows the user to input certain parameters regarding an individual patient’s test data. This letter provides the reader with a simple, clear and concise interpretation of the patient’s performance.

NOTE: The software does not automatically update the letter to match patient’s test data. The user must update the text.

Figure 7.5. A Biodex Narrative Cover Letter.
Figure 7.6 The Recipient Name and Address screen allows the clinician to select appropriate descriptions for a variety of parameter fields.
This report uses information from two different test/exercise sessions to compare patient performance for the same side (i.e., involved knee initial test vs. current test). Progress Reports can be generated in graphic, general and comprehensive formats.

NOTE: The protocol parameters must be the same for each test session.

Figure 7.7. A General Progress Evaluation Report.
Figure 7.8. A Comprehensive Progress Evaluation.
GENERATING (OPTIONAL) ISOMAP REPORTS
(See Figures 7.9, 7.10A and 7.10B.)

NOTE: Isomap Reports require the optional Isomap program.

Isomap reports provide data from a three speed, bilateral, concentric/concentric, concentric/eccentric, eccentric/concentric or eccentric/eccentric test. The report illustrates exactly where the patient is having difficulty in relation to ROM, speed and contraction type. The report allows the clinician to input definitive information on the patient’s status, consistency of effort, correlation of impairment to physical deficit, rehabilitation potential and treatment plan. The clinician is able to utilize both subjective and objective information to create a home program and estimate the total treatment duration. The clinician is also provided with the option to fill out a numeric analog scale for pain and function, which can then be updated on a visit basis. Isomap reports allow comparisons between involved and uninvolved sides while facilitating examination of regional strength impairments in terms that can translate into design of effective rehabilitation programs specific to the impairment.

To Generate an Isomap Report
1. Click on the <Patient Selection> icon in the primary tool bar. The Patient Selection screen should now be displayed. The last patient saved is the current patient.

2. Click on the <Open> icon in the Patient Selection tool bar. The patient list should be now be displayed.

3. Highlight the desired patient from the Patient List.

4. Highlight the three speed bilateral test for which you desire a report.

5. Click <Report> at the bottom of the Open Record screen. The Report Generation screen should now be displayed. A summary of test information for the selected test appears on the right side of the screen.


7. Click <Print Preview>. The Isomap report Set-Up screen should now be displayed.

8. If desired, use the Scale Adjust settings at the left of the screen to adjust the Isomap Torque Scale to enhance image quality. Click on the desired map setting description (i.e., involved deficit) then adjust the scale itself (below the map setting descriptions). Red indicates levels of highest torque while dark blue indicates levels of lowest torque.

9. If desired, use the mouse to adjust the Deficit Map by clicking on the high/low scale bar.

10. Once satisfied with the Torque and Difference Scale settings, complete the Isomap parameter fields (at the right of the screen) based on the Isomap Report Set Up maps displayed.

11. Once all fields are completed, click <Preview> to view the completed Isomap report.

   NOTE: To re-access and edit the Isomap parameter fields, click <Close> to return to the Report Generation screen and proceed from step four above.

12. Click <Print> to print the Isomap Report.
Figure 7.9. The isomap Report Set Up screen allows the user to select subjective and objective data to be displayed on the report.
**Isomap Evaluation**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Joe Smith</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:</td>
<td>1234</td>
</tr>
<tr>
<td>Birth Date:</td>
<td>1988-01-01 (yyyy-mm-dd)</td>
</tr>
<tr>
<td>HT:</td>
<td>71</td>
</tr>
<tr>
<td>WT:</td>
<td>165.8</td>
</tr>
<tr>
<td>Gender:</td>
<td>Male</td>
</tr>
</tbody>
</table>

**Functional Limitation:**

**Pain**
- Constant/Sever: [ ]
- [ ] indicates change from previous test
- [ ] indicates no pain

**ADL**
- Unable to function: [ ]
- [ ] indicates no problem

### CONCENTRIC - QUADRICEPS
- Uninvolved |
- Involved |
- Deficit (%) |
- Clinically Significant |
- Peak Torque: 124.7 |
- Peak Torq / Body Wt (%): 67.0 |
- Angle of Peak Torq: 72.0 |
- Total Work: 1033.0 |

### CONCENTRIC - HAMSTRINGS
- Uninvolved |
- Involved |
- Deficit (%) |
- Clinically Significant |
- Peak Torque: 63.6 |
- Peak Torq / Body Wt (%): 51.6 |
- Angle of Peak Torq: 21.0 |
- Total Work: 541.6 |

**Consistency:**

**Physical Impairment:**
- The deficit map indicates that there is strength impairment.
- Contraction: CON/CON
- ROM: [ ]
- Speeds: [ ]

**Correlation of Impairment to Deficit:**
- The strength impairment with the functional deficit.

**Rehabilitation Potential:**

**Treatment Plan, Clinic:**

**Estimated Treatment Duration:**

**Home Program:**

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Figure 7.10A. An Isomap Evaluation Report.
Figure 7.10B. Isomap Evaluation Reprint, continued.
Isomap Report Parameter Fields
(See Figure 7.8.)

Pain: Select an indication of pain severity ranging from Constant/Severe (10) to No Pain (1).

ADL: Select an indication of the patient’s ability to function ranging from Unable to Function (10) to No Problem (1).

Apply Scale Settings: Click this button to apply the Pain and ADL scales to the next report to note the difference in improvement or deficit.

Functional Limitation: Enter here a description of the patient’s condition.

Consistency: Select the validity of the test, valid or invalid.

Physical Impairment: Select the appropriate description of patient impairment, minor, significant or none.

Correlation of Impairment: Choose from Is Consistent or Is Not Consistent.

Contraction: Select the appropriate contraction type.

ROM: Choose from End, Middle or Beginning.

Speed: Choose from Fast, Medium or Slow.

Rehabilitation Potential: Choose from Excellent, Good, Fair, Poor or Not Applicable.

Treatment Plan, Clinic: Enter Facility Name or Treatment Plan name here.

Estimated Visits to Clinic: Enter here the estimated number of patient visits required.

Home Plan: Enter here any assigned home therapy plan or directions.
The Biodex Database Manager is used for the following operations:

1. Copying, deleting, moving, or archiving patient files
2. Copying, deleting, or moving protocols
3. Patient loads can be managed based on clinician or classification of patients. Separate databases can be created for each group of patients, clinician, or researcher at your facility, then the selected database can be made active for the current session.

Database files can be maintained on the primary hard drive, but for backup purposes, it is strongly recommended removable media be used. This Database Manager supports media such as CD-RW, ZIP disks, or floppy disks (floppies are very limited in size however). Removable media are preferred as they can be stored away from the computer and used to back up the existing database should you ever experience computer problems.

It is recommended that you back up your patient files on a regular basis and have a copy of the database stored in a safe place.

Information can be easily transferred between databases. This is done by single clicking on the data you wish to transfer, or by single clicking in the check box found in front of each patient or protocol file.

**ACCESSING THE DATABASE MANAGER**

(See Figure 8.1.)

To access the Database Manager screen, click on <File> in the Pull Down Menu (found at the top left portion of the screen). Click on <Database Manager>. Once the screen is open follow the directions below to develop databases to manage your patient load.

**NOTE:** The Database Manager will also be automatically invoked when the application first starts, if the application detects an error in the database file it is attempting to read. If this occurs, you can set an alternate database active, or create a new database and make it active.

**NOTE:** Database Manager files are in Microsoft Access ‘97 format and can be analyzed using this program.
NAVIGATING THE DATABASE MANAGER MAIN SCREEN

Data Management
This is a blue box found on the top center portion of the screen and is used to select the database content you wish to view.

Patient/Studies
Will open up the currently selected patient database. Once you have selected this option you will be taken to the Patient Data Screen. From this screen you are able to move, copy, delete, or archive patient records. You will also be able to create and open other databases. These operations will be described further in the section titled: Patient Data Screen.

Protocols
Will open current list of protocols available in the database. Once you reach the list of protocols you will be able to sort them by using a filter to look at specific exercise protocols and, even further, by joint pattern. The operations specific to this icon are described in the section titled: Protocol Screen.

Active Database
This is the blue box located at the bottom of the Database Manager screen. It provides information regarding which database is actively in use by the application. This box will allow you to select the active “in use” database by browsing your computer and external drives for additional databases that have been created. It also maintains a list of the most recent active databases for quickly switching from one to another.

![Figure 8.1. The Database Manager Main Screen.](image)
Pull Down Menus
The Pull Down Menus found at the top of the Database Manager Screen are useful for a variety of operations, although many of their functions are available on the Main Database Manager Screen.

From the <File> pull down menu you can access the following:

- Patient/Studies: This will list the patients in the database selected. Further navigation of this screen can be found in the section titled: Patient Data Screen.
- Protocols: This will take you directly to protocols that are available in the database. Further navigation of this screen can be found in the section titled: Protocol Screen.
- Browse for a Database: Will allow you to search for databases saved on your computer or on any of the external drives.
- Exit: This will close the application.

From the <Options> pull down you can access the following:

- Change Path to Application: Used to change the location of the installed System 3 application. This should only be used when the Database Manager is installed in a different folder than the application. This is not a typical installation, and it is not recommended to use this command.

From the <Help> pull down menu you can access the following:

- Contents: Not presently supported.
- Search For Help On: This option in not currently supported.
- About: Displays the program version, company information, and access to System Info, which provides detailed information on the configuration of your computer.
THE PATIENT DATA SCREEN
(See Figure 8.2.)

This screen displays the patient listed in the current database and allows you to Move, Copy, Delete and Archive patients to a back-up database on an external drive; or Create new databases which can be category specific. Information regarding the total number of patients, total number of studies and total number of protocols can be found at the bottom of each database list.

This screen can be repositioned by clicking on the title bar of the screen, holding the mouse button down and dragging the screen to the desired location. The screen can be resized by clicking on a corner, holding the mouse button down, and dragging the screen corner to the desired size.

Columns can be sorted by clicking on the column header by which you wish to sort the record data. Clicking again will change the sort order from ascending to descending, or descending to ascending.

Columns can be resized by dragging the column header dividing lines left or right.

Figure 8.2. The Patient/Studies Data Screen.
Controls On the Screen
Below is a list of the action controls present on the screen and how they are used:

Browse: This icon will allow you to browse and open databases you may have stored on your hard drive or an external drive. To open databases from here, click on the database and it will then open on the side you clicked.

New: This icon is used to create a new destination database in which to save data. The destination location can be either in an area of the hard drive or an external, removable media drive.

Move: This icon will completely move selected patients (single click on the patient or click the check box in front of it) to the destination database. There will be no record remaining of this data in the source database. Do this only when you wish to completely remove a patient and all their data records from the original database.

Copy: This icon will copy the selected patients and their data to the destination database while leaving a copy in the original source database.

Delete: This will delete the selected patients and their data completely from the source database – USE WITH CAUTION.

Archive: This icon, when clicked, will take you to a dialogue box that will prompt you for a Move "Patient Data Prior To" date. This will then move all patient data prior to that date to the archive database.

Find Patient: You can find any patient by simply typing their last name into the text box.

Close: This will allow you to exit from the current screen.

Column Specific Navigation
This applies to both the Patient Data Screen and the Protocols Screen. A right mouse click on the heading or content of each column will provide a quick method for navigating through patient records. By right mouse clicking on the column headings or on the list you will get the following options on the pull down menu:

Find: When clicked a dialogue box will pop up. Type in the name, or number you are looking for and the item will be highlighted. This can be done for each column.

Select All: When clicked this will select all records of the list displayed in which you are working in.

Clear All: This will clear or turn off all the selections which have been previously made.

Select By Check Box: This will allow you to select file by using a check mark placed in a box next to the file you wish to select.
Select By: Standard: This selection highlights the row blue that you select. You can select multiple rows by holding the Ctrl key down while clicking on a row. To do a contiguous group of rows, click the top row of the group, move the cursor downward to the bottom row, then hold the Shift key down while clicking on the bottom row of the group.

Compact Database: Compacts the displayed database. Compacting reduces the file size if there is wasted space in the database file. If you have deleted many patients with studies from a database, compacting the database will save a significant amount of disk space. This is especially important when moving the database to removable media for backup, archive, or transport purposes.

THE PROTOCOLS SCREEN
(See Figure 8.3).

This screen is set up and controlled much like the Patient Data Screen with a few differences as shown below.

Filter By: This area, found at the top of the screen, shows you what restrictions are placed on the displayed protocol lists. The displayed lists of protocols are filtered in regards to type of Protocol(s) and specific Joint Patterns for each protocol type you select. To make changes to these filters use the pull down menu provided and make your selections from there. The database file name displayed in parenthesis to the right of "Filter By" is the database used to determine what Protocols and Joints are available, and listed in the pull down menus. To change this database, mouse click on the displayed file name above the left list or right list.

Browse: This icon will allow you to browse and open databases you may have stored on your hard drive or an external drive. To open databases from here, just click on the database and it will then open on the respective side you clicked the Browse icon on.

New: This icon is used to create a new destination database to save data into. The destination location can be either in an area of the hard drive or an external, removable media drive.

Move: This icon will completely move selected protocols (single click on the protocol or click the check box in front of it) to the destination database. There will be no record remaining of this data in the source database. Do this only when you wish to completely remove protocol records from the original source database.

Copy: This icon will copy selected protocols to the destination database while leaving a copy in the original source database.

Delete: This will delete selected protocols completely from the source database - USE WITH CAUTION.

Close: This will allow you to exit from the current screen.
Figure 8.3. The Protocols Screen.
## A. DEFAULT PROTOCOLS

Default protocols for Advantage Software version 3.2.

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| Mode:                  | Isokinetic     | Unilateral               | # Sets     | 2          |
| Study Type             | Test only      | Set #                    | 1          | 2          |
| Joint                  | Knee           | End By Reps              | 5          | 5          |
| Pattern                | Extension/Flexion | Speed Away            | 60        | 120        |
| Contraction            | con/con        | Speed Toward             | 60        | 120        |
| Description            | Fall protocol knee test | Torque          | 30        | 30        |
| Trial reps             | yes            | Anatomical reference    | 90        | End By Reps |
| Rest Time in secs      | 60             | Attachment sensitivity   | 1-Knee Cushion | 1-hard |

| Mode:                  | Isokinetic     | Unilateral               | # Sets     | 2          |
| Study Type             | Test only      | Set #                    | 1          | 2          |
| Joint                  | Ankle          | End By Reps              | 5          | 5          |
| Pattern                | Plantar/Dorsiflexion | Speed Away         | 60        | 120        |
| Contraction            | con/con        | Speed Toward             | 60        | 120        |
| Description            | Fall protocol ankle test | Torque          | 30        | 30        |
| Trial reps             | yes            | Anatomical reference    | 0         | End By Reps |
| Rest Time in secs      | 60             | Attachment sensitivity   | 3-Ankle Cushion | 1-hard |

<p>| Mode:                  | Isokinetic     | Bilateral                | # Sets     | 2          |
| Study Type             | Test only      | Set #                    | 1          | 2          |
| Joint                  | Knee           | End By Reps              | 5          | 5          |
| Pattern                | Extension/Flexion | Speed Away            | 60        | 60         |
| Contraction            | con/con        | Speed Toward             | 60        | 60         |
| Description            | IPCS Knee evaluation | Torque          | 30        | 30        |
| Trial reps             | yes            | Anatomical reference    | 90        | End By Reps |
| Rest Time in secs      | 25             | Attachment sensitivity   | 1-Knee Cushion | 1-hard |</p>
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| Mode: Isokinetic | Unilateral | # Sets | 10 |
| Study Type: Exercise only | 1 2 3 4 5 6 7 8 9 10 |
| Joint: Knee, Shoulder | 10 10 10 10 10 10 10 10 10 10 |
| Pattern: Knee ex/flex, Shoulder ex/flex, Ab/Ad | Speed Away | 300 330 360 400 450 400 400 360 330 300 |
| Contraction: con / con | Speed Toward | 300 330 360 400 450 400 400 360 330 300 |
| Description: Davies Functional | Velocity Spectrum | Torque | 30 30 30 30 30 30 30 30 30 30 |
| | Anatomical reference | Rest Time in secs | 30 30 30 30 30 30 30 30 30 30 |
| | Attachment sensitivity | per joint | 30 30 30 30 30 30 30 30 30 30 |
| Mode: Reactive | Unilateral | # Sets | 10 |
| Study Type: Exercise only | 1 2 3 4 5 6 7 8 9 10 |
| Joint: Knee, Lumbar | 6 8 10 15 20 20 15 10 8 6 |
| Pattern: Knee ex/flex, Semi-standing ex/flex | Speed Away | 30 60 90 120 150 150 120 90 60 30 |
| Contraction: ecc / ecc | Speed Toward | 30 60 90 120 150 150 120 90 60 30 |
| Description: Davies Incremental | Eccentric velocity spectrum | Torque Away | 30 35 40 45 50 50 45 40 35 30 |
| | Trial reps | no |
| | Anatomical reference | Rest Time in secs | 30 30 30 30 30 30 30 30 30 30 |
| | Attachment sensitivity | per joint | 30 30 30 30 30 30 30 30 30 30 |

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APPENDICES
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APPENDICES — A-6 —
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B. DEFAULT LINKED PROTOCOLS
(ONLY FOR KNEE EX/FLEX, ANKLE P/D, SHOULDER INT/EXT ROTATION)

Linked Protocol Name: Passive, Isok con/con Slow VSR
Linked Protocol Sequence (Only for Knee ex/flex, Ankle P/D, Shoulder Int/ext rotation)
Passive: 30/60 deg sec 10 minute warm-up
Isok: Slow velocity spectrum rehab

Linked Protocol Name: Passive, Isok con/con & con/ecc slow VSR
Linked Protocol Sequence (Only for Knee ex/flex, Ankle P/D, Shoulder Int/ext rotation)
Passive: 30/60 deg sec 10 minute warm-up
Isok: Slow velocity spectrum rehab
Isok: Con/Ecc slow velocity spectrum

Linked Protocol Name: Passive, Isok con/con & ecc/con slow VSR
Linked Protocol Sequence (Only for Knee ex/flex, Ankle P/D, Shoulder Int/ext rotation)
Passive: 30/60 deg sec 10 minute warm-up
Isok: Slow velocity spectrum rehab
Isok: Ecc/Con slow velocity spectrum

Linked Protocol Name: Passive, Reactive, Isok conc/con Intermediate VSR
Linked Protocol Sequence (Only for Knee ex/flex, Ankle P/D, Shoulder Int/ext rotation)
Passive: 30/60 deg sec 10 minute warm-up
Reactive: Davies Incremental Eccentric Velocity Spectrum
Isok: Davies Intermediate Velocity Spectrum

Linked Protocol Name: Knee - early phase rehab
Linked Protocol Sequence Passive: 2/5 deg/sec 10 minute warm-up
Isom: 30/45/60 Agonist/Anatagonist
B. SYSTEM 3 STRUCTURES, FORMULAS AND CALCULATIONS

INTRODUCTION

The purpose of this document is to present technical information regarding the database structure, formulas and calculation methods used in the System 3 Software application.

The application software for the System 3 is written in the Microsoft Visual C++ language with MFC (Microsoft Foundation Classes). The program is structured as a “multiple document interface” (MDI) application. The user is presented with a group of windows or views, each of which encapsulates a group of related functions. The user can navigate between views by clicking on the main toolbar icons or by clicking on the window titles of any view.

DATABASE ENGINE

The application utilizes DAO (data access objects) to interface with Microsoft’s Access database engine. This strategy yields a reliable database platform with the fastest possible access times. There is no password protection and any user can view the contents of the database by opening the “database\biodex.mdb” file using MS-Access ‘97.

Figure B1 illustrates the tables that comprise the System 3 database. Patient information is recorded in the Patient Set table. A unique identifier is assigned to the patient. This identifier (key) is subsequently used to link study information (StudySet) and raw data (DataSet) with the patient’s record. The application also maintains tables to store protocol information and values for normative data.

Figure B1. System 3 Database Tables.
A key point concerning the database is that “results” are not saved. In other words, the numerical results computed from study parameters and datasets are dynamically evaluated and sent to reports (in either PRINT or PRINT PREVIEW mode). There is no risk of generating reports using stale parameters. Relevant changes in patient and study information are instantly reflected in any report mode.

A data “export” function is provided so that numerical results from tests can be saved in an ASCII delimited text file. This mechanism provides a standard interface with external applications such as word processors, spreadsheets or customized applications.

**ISOKINETIC REPETITIONS**

Before measurements can be made on isokinetic data, it is imperative to accurately determine the start and end points of all repetitions in a data set. Repetitions must further be resolved into “half” reps. A “half” rep in the away direction and a “half” rep in the towards direction constitutes a whole rep. The System 3 dynamometer velocity signal contains both magnitude and direction information and is the most reliable and reproducible source for determination of half reps.

Figure B2 illustrates a five repetition test showing the torque and velocity signals superimposed upon each other. The graph is in Bipolar mode which allows both positive and negative numbers to be viewed on the axis. Note that the velocity signal has positive and negative components. Once the System 3 dynamometer range of motion limits have been properly set, the sign of velocity will always indicate direction of travel. Positive velocity values occur during the “away” segment of the repetition. Negative velocity values occur during the “toward” segment of the repetition. This holds true for both anatomical sides (right and left).

![Figure B2. A five-repetition test showing the torque and velocity signals superimposed upon each other.](image-url)
The System 3 software scans the velocity signal and establishes the points of “zero” crossing. In other words, by marking points where the velocity signal changes sign, one can accurately determine the start and end points of every repetition in the test. This method of rep detection relies heavily on the accuracy of the velocity signal. If there are spikes or other forms of noise, the software may count more repetitions than really exist. To help eliminate false counting, a velocity threshold (defined in the application’s INI file as “IsokRepVelThresh”) is used to introduce a small amount of hysteresis. At the points where the velocity magnitude rises above or drops below this threshold, a half repetition is established. This method increases noise immunity and insulates the rep detector against noise spikes occurring at the range of motion limits.

Figure B3 illustrates a normal (unipolar) view of a torque curve with velocity superimposed. The small bars identify the starting and ending points of repetitions as calculated by the software. Notice the tight alignment of the endpoints with the velocity signal. Altering the threshold in the INI file will have an impact on the placement of the endpoints and can subtly change calculations of times to peak torque and work integrations. However, these differences are small relative to the accuracy of the dynamometer. The threshold percentage delineates the tradeoff between accuracy and sensitivity to noise.

Figure B3. A unipolar (normal) view of a torque curve with velocity superimposed.
ISOKINETIC WINDOWING

In a perfect Newtonian world, there would be no need for isokinetic windowing. All data points collected by the dynamometer would occur at zero speed or at the selected isokinetic speed. However, this is an imperfect world. In terms of a dynamometer, there are discrete phases of acceleration and deceleration when can produce torques that are not “isokinetic” and torques that do not occur at the selected speed. Using torque data from these “non-isokinetic” phases can introduce substantial errors in all measurements associated with torques.

Figure B4. Temporal relationships between torque and velocity in a single repetition at 60° per second.

Figure B4 illustrates the temporal relationships between torque and velocity in a single repetition acquired at 60 degrees per second. The region highlighted in the circle illustrates a torque artifact resulting from deceleration. Note that the torque level increases as the velocity is dropping. At high speeds, this torque artifact can be large and often exceeding the true peak torque of the repetition.

An isokinetic window is a filter that removes torque points that lie outside of a specific temporal envelope. In the System 3 software, two components contribute to the formation of the filter envelope. The first is an INI file parameter called “IsokWindowThresh”. This threshold is expressed as a percentage and determines the velocity below which data are no longer isokinetic. Torque points measured at speeds below this threshold are removed. The second component is controlled by INI file parameters called “CushionFilter” and “CushionDeceleration”. Based on the testing speed, the program calculates the exact beginning of the dynamometer’s deceleration phase. Torque points measured in this phase are also removed.
Figure B5. Application of a 70% isokinetic window threshold (with cushion filter).

Figure B5 illustrates the application of a 70% isokinetic window threshold (with cushion filter) to the curves of Figure B4. Notice that all of the torque points falling outside of the velocity envelopes are set to zero and do not contribute to data measurements.

NINE-POINT WEIGHTED SMOOTH “FILTER”

For presentation of graphical data, it is often visually desirable to “smooth” the rough edges of torque curves. System 3 offers the option to “smooth” curves using a convolution function. In curve analysis, the filter option is applied to the raw data. Using the cursors, the effect of the filter can be observed on a point-by-point basis. In report mode, the filter is applied to the only to the visual graphs. The raw data (and measurements made from this data) are not affected by the filter in Report mode. System 3 software uses this strategy for a simple reason. The application of a smoothing filter can dramatically alter peak torque measurements as it tends to average data points.

Figure B6 illustrates the basic concept of convolving a one-dimensional function using digital numeric methods. For each curve data point in the output domain, eight neighboring data points are included in the calculation. The contributions of the neighboring points are “weighted” and close neighbors have a large effect while distant neighbors have a small effect. To calculate the filtered value of P0 in Figure B6 (inside circle) the following equation is used:
P_{filtered} = 
[(P-4 \cdot k4) + (P-3 \cdot k3) + (P-2 \cdot k2) + (P-1 \cdot k1) + (P0 \cdot k0) + (P1 \cdot k1) + (P2 \cdot k2) + (P3 \cdot k3) + (P4 \cdot k4)]

Where:

\begin{align*}
  k4 &= 1 / 18 \\
  k3 &= 1 / 18 \\
  k2 &= 2 / 18 \\
  k1 &= 3 / 18 \\
  k0 &= 4 / 18
\end{align*}

Figure B6. Convolving a one-dimensional function using digital numeric methods.

The result of these “binary-weighted” coefficients is to produce a high-frequency filter. Rapid changes in curve data are surpressed. Slow changes in data (attributed to the subject’s strength) are not affected. Figure B7 illustrates the curve of Figure B5 with the “filter” option turned on.
GRAVITY CORRECTION

For various joints in the body (such as the knee), the weight of the limb can be a significant factor in measuring the performance of the joint. To deal with this factor, the System 3 software can optionally perform gravity correction on the torque data. There are two steps in the gravity correction process:

- Measure the weight of the limb
- Apply the correction based on direction of shaft rotation

Figure B7. Curves with filter option turned on.

Figure B8. Angle of error from horizontal.
The measurement of limb weight is made with the dynamometer. The subject’s limb is anatomically positioned at the point of maximum gravity effect (horizontal with respect to the ground). The subject is asked to relax and a torque measurement is made. It is not always possible to move the limb to the position of maximum gravity effect so the software corrects for any angular error from the horizontal. Figure B8 depicts the angle of error from the horizontal. This correction is only permitted within 45 degrees of the horizontal. Beyond 45 degrees, the error associated with the measurement is too large. The torque is corrected by the equation:

\[
T(\text{Limb}) = \frac{T(\text{Measured})}{\sin(\text{angle})}
\]

During a test, the limb weight contribution is calculated as:

\[
T(\text{Correction}) = T(\text{Limb}) \times \sin(\text{angle})
\]

Depending upon the direction of travel, the limb weight correction is added or subtracted. For the knee, the away direction is upward (working against gravity) so the gravity correction is added to the subject’s torque. The towards direction is downward (working with gravity) so the gravity correction is subtracted from the subject’s torque. Figure B9 illustrates a knee dataset with no gravity correction (left) and a dataset for the same patient with a limb weight contribution of 20 ft-lb (right). Notice that limb weight corrections are added to the quadricep muscle data (away direction) and subtracted from the hamstring muscle data. Although the curves appear similar in height they are not similar in magnitude. The torque scale for the left graph is 30 ft-lb while the scale for the right graph is 60 ft-lb.

Figure B9. Knee datasheets with gravity correction (left) and without gravity correction (right).
WORK INTEGRATION

The value of “work” is calculated from the basic physics equation:

\[ \text{Work} = \text{Force} \times \text{Distance} \]

In the System 3 environment, rotational force is measured in foot-pounds and distance is measured in degrees. To integrate work over the entire half repetition, numerical methods are used to sum the work contributions from each data point. Thus, the work contribution at time “t” is:

\[ \text{Work(Delta)} = [\text{Torque}@t \times \Omega \{\text{Torque}@t - \text{Torque}@{t-1}\}] \times [\text{Position}@t \times \text{Position}@{t-1}] \]

The total amount of work is the sum of the contributions (deltas). Figure B10 graphically illustrates the work area under the torque curve for a single point. Note that the height of the area “rectangle” is halfway between the current and previous torque points. This is a numerical estimation technique and yields very accurate results when the distance between sample points is small.

Figure B10. Graphic illustration of the work area under the torque curve for a single point.
WORK “FIRST” AND “LAST” THIRD

The amount of work produced in the “first third” of a test is obtained by calculating the total number of sample points in each direction (away and toward) and then integrating the first third of these sample points. Similarly, work produced in the “last third” is obtained by integrating the sample points from the last third of the test:

\[
\text{NumSamplesAway[Third]} = \frac{\text{TotalSamplesAway}}{3} \\
\text{NumSamplesTwd[Third]} = \frac{\text{TotalSamplesTwd}}{3}
\]

\[
\text{WorkAway[First Third]} = \int_{t=0}^{\text{NumSamplesAway[Third]}} \text{WorkDelta}[t] \\
\text{WorkTwd[First Third]} = \int_{t=0}^{\text{NumSamplesTwd[Third]}} \text{WorkDelta}[t]
\]

\[
\text{WorkAway[Last Third]} = \int_{t=(\text{TotalSamplesAway} - \text{NumSamplesAway[Third]})}^{\text{TotalSamplesAway}} \text{WorkDelta}[t] \\
\text{WorkTwd[Last Third]} = \int_{t=(\text{TotalSamplesAway} - \text{NumSamplesAway[Third]})}^{\text{TotalSamplesTwd}} \text{WorkDelta}[t]
\]

AVERAGE POWER

\[
\text{AveragePowerAway (in watts)} = \frac{\text{TotalWorkAway}}{\text{Total Time}} \times 1.3560 \\
\text{AveragePowerToward (in watts)} = \frac{\text{TotalWorkToward}}{\text{Total Time}} \times 1.3560
\]

COEFFICIENT OF VARIATION

The coefficient of variation is defined as the standard deviation of a set of points divided by the set’s mean value. In the System 3, peak torques (away and toward) for each repetition are used to compute the CV. At least three repetitions are required and the CV will not be calculated until the end of the third repetition and after which the CV is recalculated for subsequent complete repetitions.

\[
\text{CV} = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}} \\
\text{CV} = \frac{\sqrt{\sum (x / n)^2}}{n-1}
\]

TIME TO PEAK TORQUE

This is the time interval measured from the beginning of the peak torque repetition to the point where peak torque occurs for that repetition. It is calculated independently for the away and toward components of the repetition.
ACCELERATION / DECELERATION TIMES

The acceleration time is defined as the time interval measured from the beginning of the peak torque repetition to the point where the velocity threshold is reached. The velocity threshold is calculated as:

\[
\text{VelocityThreshold} = \frac{\text{DynamometerSpeed} \times \text{ISOKWINDOWTHRESH}}{100.0}
\]

Where ISOKWINDOWTHRESH is the “isokinetic window threshold” defined in the application’s INI file (see SYSTEM 3 INI FILE PARAMETERS section). For example, if the dynamometer speed was 60 degrees per second and the isokinetic window threshold is 70%, the velocity threshold is \((0.7 \times 60)\) or 42 degrees per second.

Deceleration time is defined as the time interval measured from the velocity threshold to zero velocity at the end of a repetition.

SYSTEM 3 INI FILE PARAMETERS

The System 3 application maintains a private INI file in the application’s working folder. In general, the contents of this INI file should not be changed. Most of the settings are maintained automatically by the software and changing them can disable the application.

There are several settings which can be altered by the user to customize the application’s behavior for a site’s specific requirements. These settings are as follows:

[Dynamometer]
IsokWindowThresh=70 ; velocity threshold for isokinetic windowing (in %)
IsokVelAcqMin=1 ; velocity threshold for motion (deg/sec)
IsokRepVelThresh=15 ; velocity threshold for start of a repetition (in %)
TorqueLimitAwy=100 ; default torque limit away for eccentric motion
TorqueLimitTwd=100 ; default torque limit toward for eccentric motion
TorqueLimitThresh=10 ; default torque limit threshold for eccentric motion
MinPositionThresh=15 ; minimum position (in degrees) to initiate acquisition
DebouncePercentage=10 ; % of total ROM limit used to debounce direction change
IsomTorqThresh=3 ; torque threshold (ft-lb) for start of isometric acquisition
CushionFilter=0 ; flag to enable isokinetic cushion filter component (1=on)
CushionDeceleration=6 ; deceleration value used for cushion filter (deg/sec)
C. RANGE OF MOTION CUSHION IMPLEMENTATION

The firmware of System 3 implements the Range Of Motion cushions. Both the main 68331 processor and the DSP are involved in this implementation. The 68331 processor computes the width of the cushions and then the associated starting position, while the DSP actively implements the deceleration within the cushion range.

CUSHION WIDTHS

The cushion widths are computed based on the front panel settings. The max velocity and cushion setting directly affect the width of the cushions. The 68331 processor computes the cushion widths whenever one of the following commands are received, either from the Front Panel or the computer:
- Set Commanded Velocity
- Set Cushion Value (1 – 9)
- Set Range Of Motion
- Set Range Of Motion Percentage

Once the cushion width is determined, the 68331 computes the resulting start position of the cushions and downloads these positions to the DSP.

The algorithm to calculate the width uses a table to define the velocity delta to apply to the current commanded velocity, in order to slow the attachment down to stop at the end ROM position. The equation is as follows:
\[
\text{cushion width (in degrees)} = \frac{\text{commanded velocity}}{\text{delta velocity}}
\]

There are two special rules applied on the resulting cushion width:
- The cushion width is restricted to 43 degrees maximum (if greater, it’s forced to 43)
- If the two cushion regions overlap, both cushions will be reduced by setting the start of cushion positions to the mid-point of their overlapping regions.

There are 5 separate tables defining delta velocities, 1 table per velocity range, where each table has 9 elements, one per cushion setting. The table definitions are as follows:

<table>
<thead>
<tr>
<th>deg/sec</th>
<th>CUSHION DEPTH</th>
<th>deg/sec</th>
<th>CUSHION DEPTH</th>
<th>deg/sec</th>
<th>CUSHION DEPTH</th>
<th>deg/sec</th>
<th>CUSHION DEPTH</th>
<th>deg/sec</th>
<th>CUSHION DEPTH</th>
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</thead>
<tbody>
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<td>1 cm</td>
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<td>1 cm</td>
<td>24 deg/sec</td>
<td>1 cm</td>
<td>24 deg/sec</td>
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</tr>
<tr>
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<td>17 deg/sec</td>
<td>2 cm</td>
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<td>3 cm</td>
<td>16 deg/sec</td>
<td>3 cm</td>
<td>16 deg/sec</td>
<td>3 cm</td>
<td>18 deg/sec</td>
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<tr>
<td>8 deg/sec</td>
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<td>11 deg/sec</td>
<td>4 cm</td>
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<td>5 cm</td>
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<td>6 cm</td>
<td>7 deg/sec</td>
<td>6 cm</td>
<td>7 deg/sec</td>
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<td>4 deg/sec</td>
<td>9 cm</td>
<td>8 deg/sec</td>
<td>9 cm</td>
</tr>
</tbody>
</table>
Using the equation and the values above, this results in the following example cushion widths being calculated:

<table>
<thead>
<tr>
<th>Max Velocity</th>
<th>Cushion Setting</th>
<th>Cushion Width</th>
</tr>
</thead>
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<tr>
<td>180 deg/sec</td>
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<td>7.5 degrees</td>
</tr>
<tr>
<td>75 deg/sec</td>
<td>5</td>
<td>9.4 degrees</td>
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<td>300 deg/sec</td>
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<td>30 degrees</td>
</tr>
<tr>
<td>45 deg/sec</td>
<td>1</td>
<td>2.3 degrees</td>
</tr>
<tr>
<td>45 deg/sec</td>
<td>6</td>
<td>15 degrees</td>
</tr>
</tbody>
</table>

CUSHION DECELERATION
Once the cushion width is computed on the 68331 processor, it downloads the resulting start of cushion positions to the DSP. The DSP will then perform cushion deceleration dynamically, based on the actual measured velocity when the cushion region is first entered. Once the system enters the cushion region and maintains movement in the direction towards the ROM stop position, the velocity is decreased in real-time (every _ milli-second) until 0 velocity is reached at the ROM stop position, or the direction of movement is reversed. This real-time method will result in a smooth, controlled stop, minimizing impact and any noticeable stepped down speed.

CUSHION FILTERING
This is an additional method used in conjunction with Isokinetic windowing to eliminate erroneous torque end spikes caused by deceleration into the end stop. This is not selectable in the report selection menu. The amount of filtering is calculated from the speed of the dynamometer and the level of the deceleration. The cushion width (in degrees) is defined by the firmware and is based on the lever arm speed and the cushion value selected on the front panel. For example, at 180 deg/sec and a cushion setting of 1, deceleration will begin at 7.25 degrees from the end stop. With the same 180 deg/sec and a cushion setting of 9, deceleration will begin 45 degrees from the end stop. The “cushion” filter will remove torque values that occur within the deceleration range. The cushion filter values can also be changed. These are INI file parameters. The default is ON. The default degree setting is 6 (degrees per second per degree).
D. PATIENT PROGRESS CHART

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Date</th>
<th>Exercise</th>
<th>Client</th>
<th>Service ext. 241</th>
<th>Software Support ext. 120</th>
<th>Clinical Education ext. 114</th>
<th>Biodex Phone: 1-800-224-6339</th>
</tr>
</thead>
</table>

---

**Appendices**
### E. CURRENT RECORDED NORMATIVE GOALS (ENGLISH UNITS)

<table>
<thead>
<tr>
<th>Joint Movement and Position</th>
<th>Speed Degrees/Seconds</th>
<th>Peak Torque/BW Range Male</th>
<th>Flex/Ext Ratio Male</th>
<th>Ext Rot/Init Rot Ratio Male</th>
<th>Abd/Add Ratio Male</th>
<th>Dorsi/Plantar Ratio Male</th>
<th>Ever/Inver Ratio Male</th>
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</tbody>
</table>

* The Biodex normative database is a compilation of published information to be used as unilateral goals. Peak Torque to body weight is expressed in a range which enables these goals to be recommended for various groups (Prepubescent patients do not apply).
## E. CURRENT RECORDED NORMATIvE GOALS- (METRIC UNITS)

<table>
<thead>
<tr>
<th>Joint Movement and Position</th>
<th>Speed Degrees/Seconds</th>
<th>Peak Torque/BW Range Male</th>
<th>Flex/Ext Ratio Male</th>
<th>Ext Rot/Int Rot Ratio Male</th>
<th>Abd/Add Ratio Male</th>
<th>Dorsi/Plantar Ratio Male</th>
<th>Ever/Inver Ratio Male</th>
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