Appendix A

Guidelines for using your camcorder

Benefits of Video Analysis

Humans have quite slow vision. The human eye can only separate a maximum of ten / twelve images per second… There are even some suggestions amongst scientists that events lasting less than 0.25 seconds cannot usually be seen clearly. Although coaches are irreplaceable in analysing athlete's techniques, often the coach's eye cannot extract all the necessary details in a live sporting situation.

Video cameras create the illusion of motion by 'tricking' the human eye. Video cameras play 25 flashing still pictures each second. As an eye cannot separate those pictures, we get the feeling of continuous movement. The use of a video camera is a very effective tool to help you improve sporting technique. Quintic video analysis software enables video capture at 25, 50 and 100fps. At 100fps each still image is 10ms, capable of capturing even the fastest of human movement. In addition to just one video camera, Quintic has the capability of capturing two live video images, simultaneously. The benefits of video have just doubled!

More and more athletes, coaches, scientists are using video feedback as a coaching aid. Video can very quickly help athletes to understand the basic fundamentals of a specific movement. Providing athletes with immediate performance feedback via Quintic video software is a very powerful analysis tool… the images are used to assist coaches in their task, as the athlete's performance can be repeated afterwards and slowed down during critical phases.

By comparing performances of previous movements, or even other athletes, the Quintic software enables you to compare video images via the computer screen. Differences between the techniques can be identified (competition vs. training) and this information made available immediately to the athlete. The coach and the athlete can discuss what they see and plan a strategy for improvement, then repeat the process. How the feedback is presented to the athlete when using Quintic is highly dependable upon the skill of the coach or analyst.

> *They say 'Pictures paint a thousand words' and to see the critical angles and positions of your run up and delivery stride helps me make instant changes to my action. Quintic is another dimension for any training programme..."*
>
> *Matthew Hoggard*

Over the recent years the role that information technology has played in sport coaching has dramatically increased in a wide range of areas, including assisting in the delivery of performance feedback. Practice should be a rewarding experience; a video camera helps you make the most out of your time. When you watch yourself perform via the computer screen, the image is there before your eyes, instead of being just in your mind.

"Being able to synchronise different throws, current and best, proved invaluable in preparation for the games in Sydney 2000 & Athens 2004.

I can compare the timing of current training throws with my best 90m efforts from previous years. By synchronising current and best throws at release we could rewind in slow motion and analyse the differences."

Steve Backley

By studying your technique in depth, (frame by frame), you can start to building a picture of what you're trying to achieve. Seeing an improvement can boost your confidence. Normally it's difficult to correct a fault, even if you know what you should be doing. This is because you don't see yourself in action. The slightest alteration to the technique will always feel uncomfortable to begin with. Negative thoughts and doubts can soon eat away at your performance. It is then you start drifting into old habits, simply because that's what comes naturally. You have aged bad habits and before long you are back to square one. When the video or computer images are there in front of you, it's much easier to set yourself back on the right lines. You can learn a great deal from studying your own technique on video. The benefits of video apply to all levels of performance - from the beginner to the Elite athlete, all you need is a video camera and Quintic software...

Remember the camera never lies...

"With the assistance of Quintic analysis software I've transformed my putting stroke. Visually it looks quite different but the changes have been quite easy to make. What you think you are doing, compared to what you are actually doing can be two totally different things."

David Howell

More Detailed Video Instructions:

Whilst any camera is better than no camera and any video image is better than none, some simple tips will enhance the value of your images... There are four basic operations, which can significantly influence the use of cameras and the quality of images. These are zoom, focus, shutter speed and iris.

During set-up of your camera, it is important to be at right angles, or 90 degrees to the action. The zoom function in the camera changes the picture size and allows you to stand much further back from the action. It is important that the athlete is as large as possible in your camera view and the zoom allows you to have all the details of the performance on the camera as you can restrict the view to be just around the athlete. The camera should be set up so that the entire body is contained within each frame. The correct distance between the camera and subject should be recorded, to allow comparisons in the future (Typically 8-10metres). Set the camera to automatic focus. Data collected using Quintic Biomechanics must have a repeatable and consistent set-up protocol. This will ensure the numeric & graphical representation of variables such as speed, distance, acceleration are accurate. Quintic also accounts for any Parallax error values during the calibration of any particular video.

However, if using a panning or moving camera often a manual focus will ensure correct images are recorded. Auto focus constantly checks and focuses based on what is at the centre of the picture. This, though, is not always practical when videotaping athletes. By learning to use manual focus, you can avoid this problem. Manual focus is set for a certain distance (you do not need to know the distance) and anything that distance away from the camera is in focus. This is another reason for you to stay far away from the athlete (and use the zoom function).

A good hint for manual focusing from a long distance is that you zoom in as close as possible, focus your camera using something like the text on an athlete's clothing and then zoom out to a desired level so that the whole athlete can be seen in the picture. The image stays focused, as zoom and focus are independent of each other.

The iris is the function in your camera, which allows the light come to the camera through the lens. Many cameras have this only as an auto function and so you may not be able to change it. In any case, auto iris is not such a bad thing as the lighting conditions could change during the session, as happens when clouds go in the front of the sun. If you have a camera with a manual iris option, then you can test out its influence on the picture quality. Obviously, more light (smaller iris number) makes your picture brighter (but can also make it too bright), while closing the iris makes the picture darker.

Shutter speed options are essential for good quality video taping of athletics performance, particularly when the speeds are fast... In a normal situation, the picture is taken over 0.04 seconds (25 pictures in a second). During even that short time,

however, an athlete can move a great deal and thus you see a blurred image in your slow motion tape (like TV slow motion repetitions of a tennis ball in a close line call - often you do not really see the ball at all, just a trace of blurred ball images). Shutter speed allows you to reduce the time over which the individual picture is taken. The majority of camcorders today have automatic settings for various filming projects (refer to manufacture's guidelines). However, the sports setting - typically a picture of a golfer or runner will provide you with the highest shutter speed setting.

Note: That does not allow you to take any more pictures: there are still only 25 / 50 or 100 fps frames per second (as this is pre-determined by the camera and computer software), but each picture is taken in a shorter period of time. A shutter speed of 1/500s means that each picture is taken over a 0.002s. The down side of increasing the shutter speed is that you need much more light. This is not usually a problem outdoors, and it is recommended to use at least 1/1000s shutter speed for athletics movement if possible, shutter speeds of 1/10,000 can be used for particular sharp and clear images.. However, sometimes when filming indoors you need to compromise and use a lower shutter speed. Additional lighting may well be required.

Quintic would recommend you to make a verbal report to the camera after each shot, throw, jump… for example; commenting on the flight, distance, result... Without this information, the subsequent viewing of the tape will not give the best possible information.

Finally, remember that the videotapes always rewind slightly at the end of the recording, so be careful not to cut away the end of the performance when you stop the recording. Videotape a few seconds prior to and after the actual performance. This also makes it much easier to look at the tapes, as there are clear, distinct sequences on the tape.

Appendix B

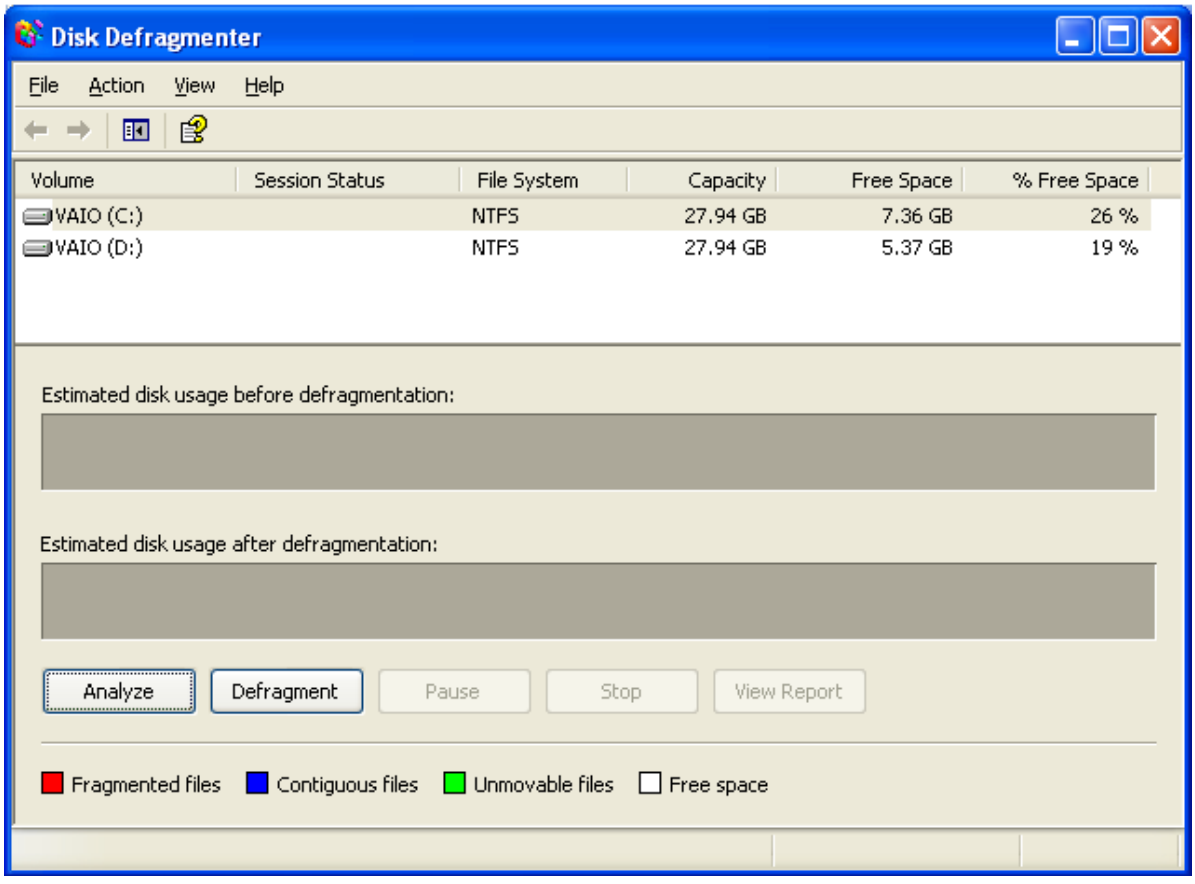
Trouble Shooting

Missing or dropped frames

When capturing video, a hidden file called sample.avi is generated. When you trim in and trim out it is this file that is edited. When you next capture, this sample.avi file gets overwritten with the new footage.

When first using the camera capture feature within Quintic you may find that frames are dropped during the capture process. To overcome this, it worthwhile defragmenting your hard drive.

When you use the same file over and over again, writing, rewriting, saving, and deleting parts of it on the same disk, the file becomes fragmented. That means that although you can't tell, your operating system is storing all the data from that file as separate packages of information, distributed on different parts of the disk. Although fragmentation does not lose the information contained in the file, it does eventually slow down access to the file itself, because Windows must search the whole disk to create the sum of the file's parts. Defragmentation collects all those parts into one stream of data again, speeding up your system.



To defrag your hard drive for better capture performance do the following:

1) Capture 30 s worth of video using the camera capture software within Quintic (do not worry if frames are dropped during this process).

2) Close down Quintic and all other applications.

3) Click Start, point to All Programs, point to Accessories, point to System Tools, and then click Disk Defragmenter.

4) Select C: drive and click on defragment. Note: depending on the size of drive and number of files this process can take a long time (allow for at least an hour).

5) Recapture.

After defragmenting, if you still experience dropped or missing frames then it is likely that your computer is not powerful enough. Please email your computer specification to Quintic for clarification.

Crosshairs

During calibration or digitisation, the cursor should be a crosshair as shown below:

Crosshair cursor

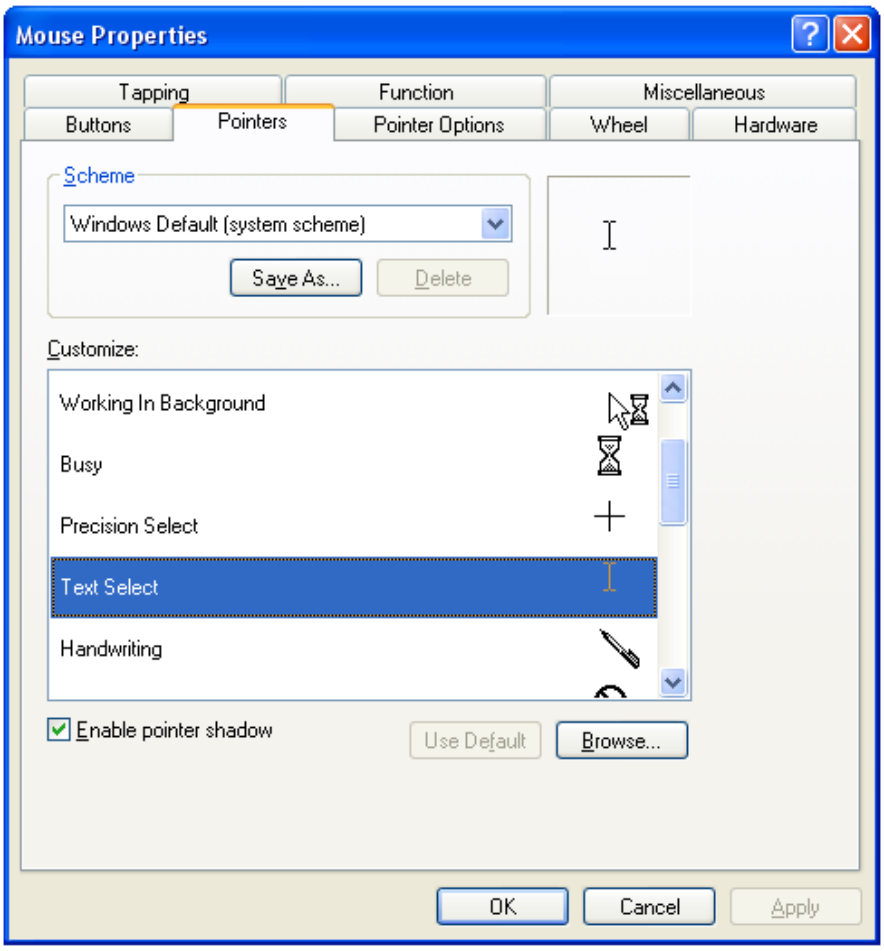
However on some make of laptops e.g. DELL, this defaults to a text select icon as shown below:

Text select cursor

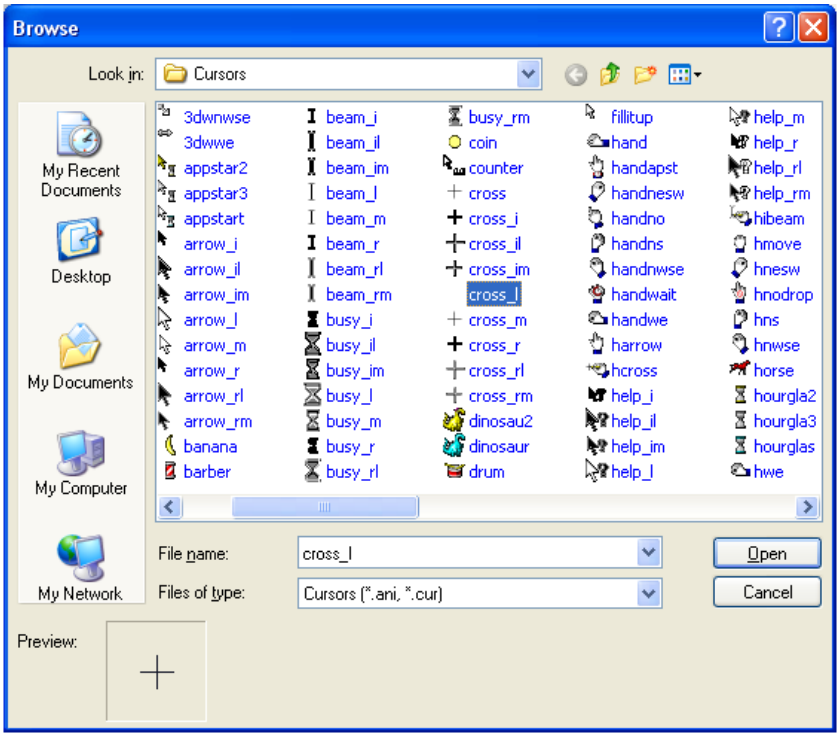
If you have experienced this problem, could please contact Quintic (info@quintic.com with your contact details, version of Quintic and the type and model of laptop/computer. Many thanks.

Quintic are striving to correct this problem and recommend users in the meantime to change the default cursor within the windows control panel.

1. Go to control panel, mouse, pointers.



2. Highlight text select, click on browse, and select cross_l, click OK.



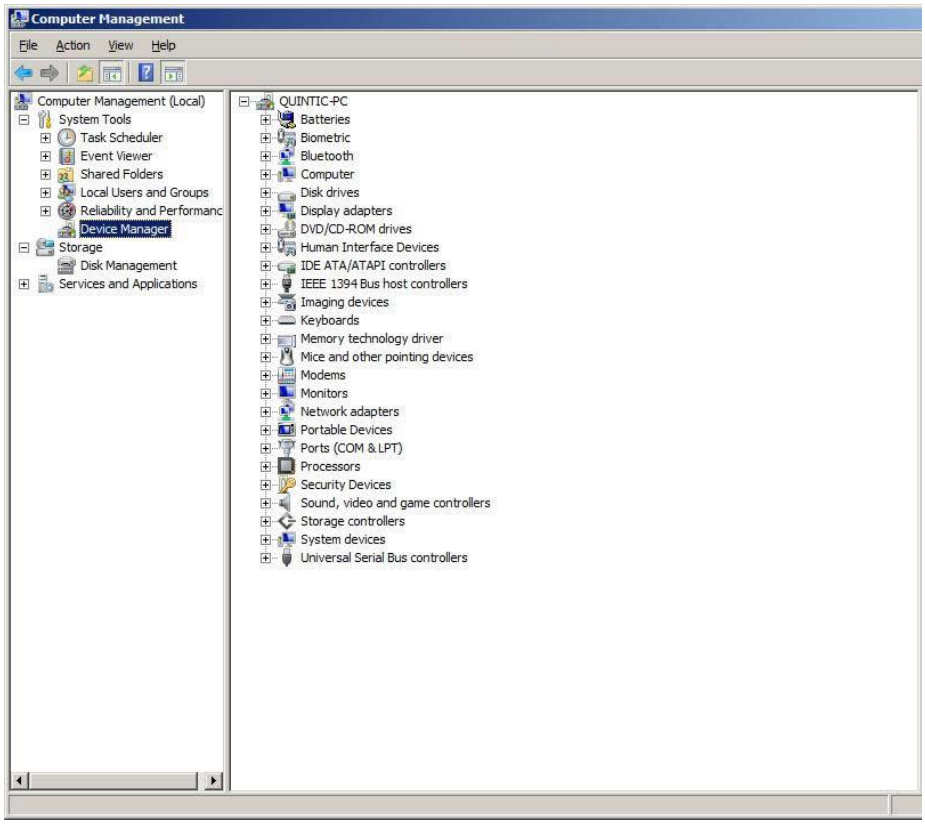
Disabling a Web Camera

When using Quintic Capture, an inbuilt web cam can be recognised as a default camera, to disable the web cam to allow capture from upto four video camcorders please follow the instructions below.

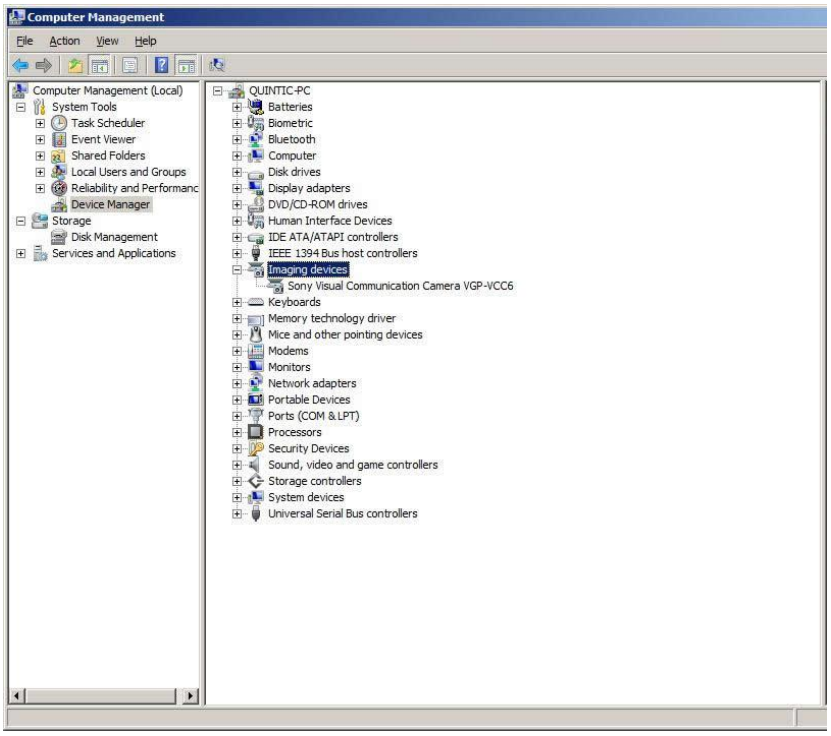
Before following the instructions below please disconnect any other cameras that are connected to your computer.

Right click on the My Computer icon found on the computers desktop or on the start menu and select ‘Manage’

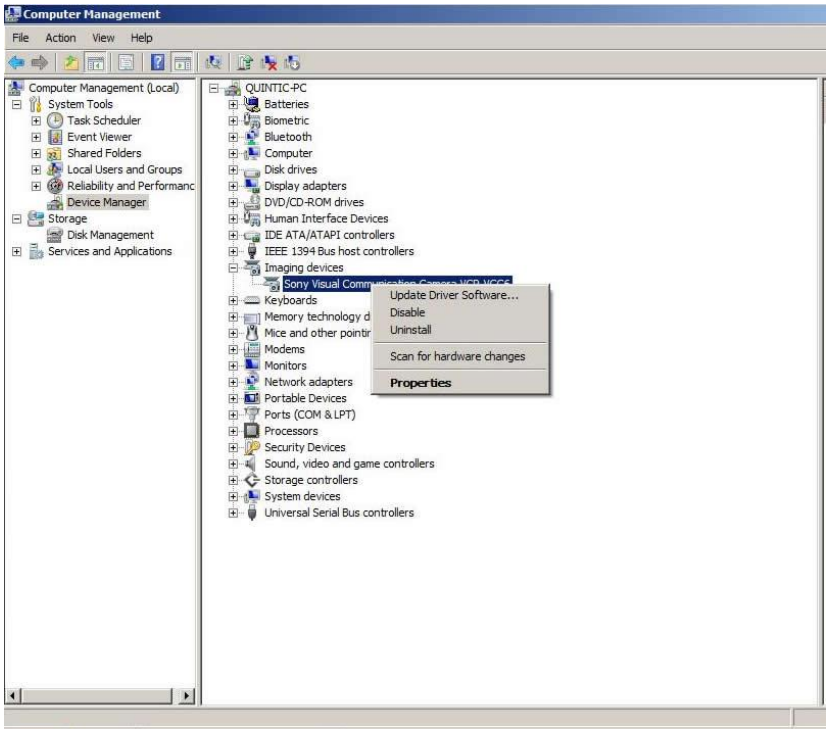
This will open the Computer Management window shown below



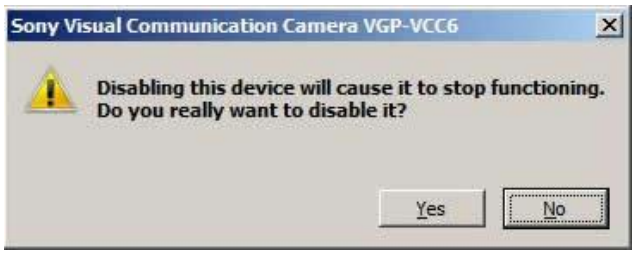
Click on the Imaging Devices option on the right hand menu, this will expand a drop down menu identifying all of the Imaging devices currently enabled on your computer.



Right click on the web camera option and a menu will appear , to disable the camera click on the disable option.

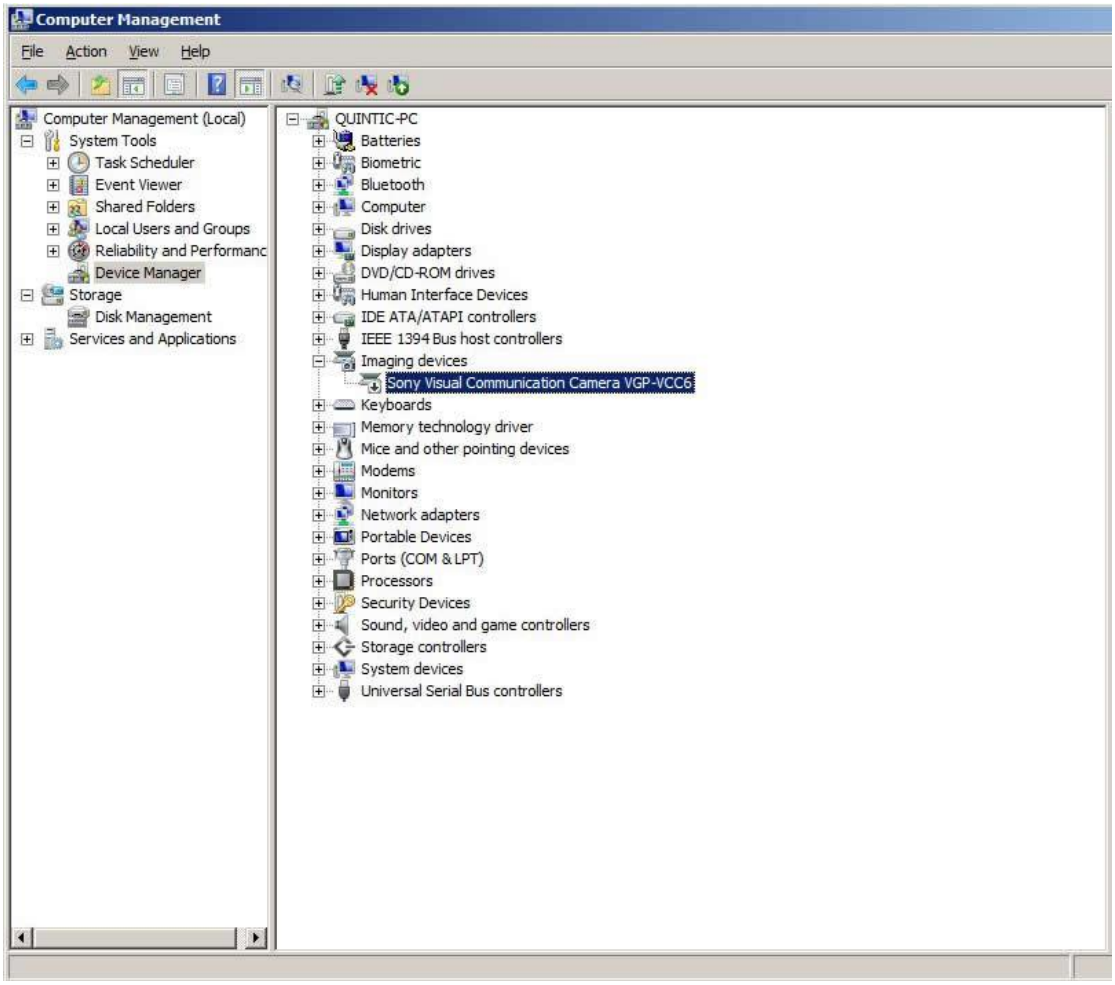


An confirmation message will now appear asking if you wish to disable the device, click on Yes to continue the process.



Once this process has been completed you will be returned to the Device Management Screen. The web cam will still be shown on the Imaging Devices menu however now it a disabled icon is located next to it.

N.B. Disabling the device does not remove it from the computer if you wish to use this device in the future it can be enabled again by using this process and selecting 'Enable' rather than 'Disable'



Video Codec information

A **video codec** is a device or software that enables video compression and/or decompression of digital video. They are used with Quintic Software to reduce the size of the video file to benefit storage and transmission.

The many types of video codec have differing performance as there is a complex balance between the video quality, the quantity of the data needed to represent it (also known as the bit rate), the complexity of the encoding and decoding algorithms, robustness to data losses and errors, ease of editing, random access, the state of the art of compression algorithm design, end-to-end delay, and other factors.

If a video file has been compressed with a particular codec then that codec has to be available for decompression to enable its use.

Commonly Used Standards and Codecs

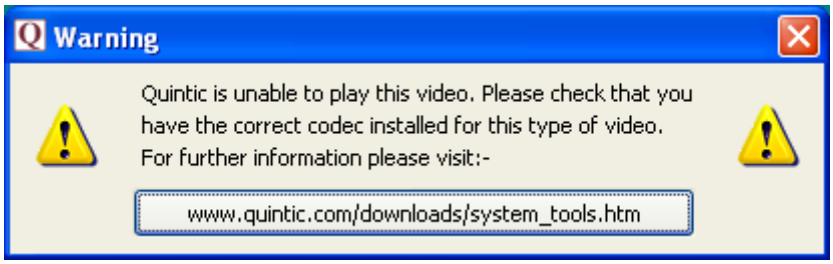
A variety of codecs can be implemented with relative ease on PCs and in consumer electronics equipment. It is therefore possible for multiple codecs to be available in the same product, avoiding the need to choose a single dominant codec for compatibility reasons. In the end it seems unlikely that one codec will replace them all. Some of the video codecs that Quintic currently uses are **MPEG-4 Part 2, DivX**, **Xvid**, **FFmpeg MPEG-4** and **3ivx.**

MPEG-4 Part 2: An MPEG standard that can be used for internet, broadcast, and on storage media. It offers improved quality relative to MPEG-2 and the first version of H.263. Its major technical features beyond prior codec standards consisted of *object-oriented* coding features and a variety of other such features not necessarily intended for improvement of ordinary video coding compression capability. It also included some enhancements of compression capability, both by embracing capabilities developed in H.263 and by adding new ones such as quarter-pel motion compensation. Like MPEG-2, it supports both progressive scan and interlaced video.

DivX, **Xvid**, **FFmpeg MPEG-4** and **3ivx** are different implementations of MPEG-4 Part 2.

Missing Codecs and Video-File Issues

A common problem when a user wants to watch a video stream encoded with a specific codec is that, if the exact codec is not present and properly installed on the user's machine, the video won't play (or won't play optimally). If a video codec has not been installed when a video is loaded into Quintic's main or best screen an information box will pop up directing you to our website where a range of codecs can be downloaded.



Help - My Video Will Not Play in Quintic

If your video won't load within the main Quintic software it is most likely due to a codec error:

Please follow the instructions below to rectify this problem.

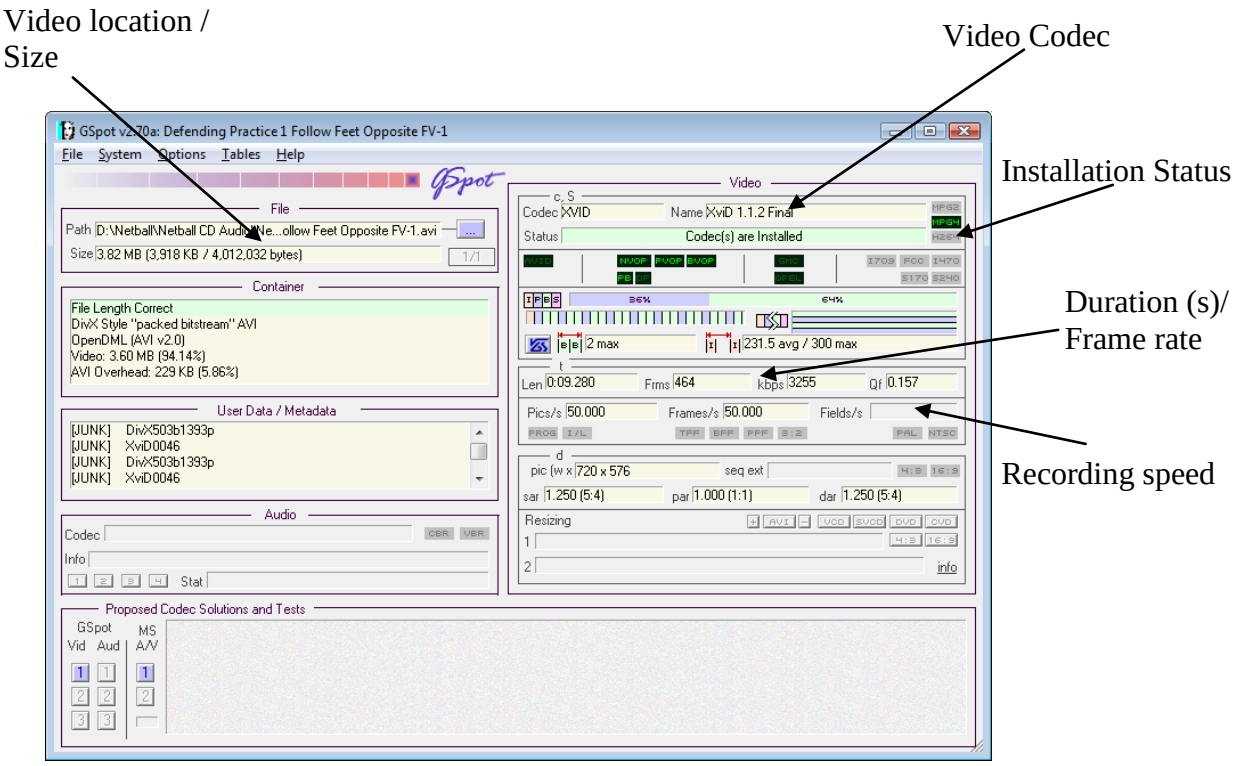
- Reinstall the Quintic codecs, navigate to C:\Drive\Program Files\Quintic
- Open the Biomechanics, Coaching or Sports folder and open the codecs folder, install the codecs one at a time by double clicking on the setup icon.
- If you are using the Casio Exilim FH20 or F1 please go to http://www.quintic.com/downloads/system_tools.htm and download the required codecs.

If this does not solve the problem and your videos still fail to play follow the instructions below:

i) Download the GSpot video codec diagnostic program from http://gspot.headbands.com/ ;

ii) Open the program, select the video file and open it;

iii) The following information will then be shown:



iv) Check the codec name and the installation status. What is the codec name? Is it present and installed on your computer? Also take a screen shot of this window (Ctrl+Alt+PrtSc and paste into a Word Doc and save it) as Quintic may ask for this information if assistance is required.

v) Double check the codec installation by using windows media player, this method produces a list of all the video and audio codecs installed on the computer, to view this list follow the instructions below:-

1. Open Windows Media Player
2. Press the ALT key to access the menus dropdown.
3. Follow "Help"->"About Windows Media Player"
4. Click on the "Technical Support Information" link in the About Window
5. This will open a new window with a complete list of video applications including all the installed video codecs. Can you see the codec named in the GSpot program on the list? Take a screen shot of this page as Quintic may ask for this information if assistance is required.

Try loading the video in Windows Media Player, does it run? If “yes” then try installing the codecs located in C:Drive\Program Files\Quintic.

If “no”, Windows Media Player will automatically try and find a suitable codec to download; follow the onscreen instructions; once a recommended codec has been located and installed, try running the video in Quintic again.

If you are still having problems send the following information to info@quintic.com

- Copy of the video is possible
- Screenshot of the GSpot diagnostic program
- Screenshot of the Windows Media Player codec list
- Model and make of the camera that was used to take the video originally
- Model and make of the computer you are using and specifications (processor, Ram etc)
- Windows Operating System
- User account, are you using an administrator account or a restricted access user account with standard or specific restrictions?

Installing The Software: Administrator & Non-Administrator Accounts

Quintic has been designed so that the software can be used in both administrator and user account modes.

Instructions and information:

i) Installation: To install Quintic van Administrator Account must be used, i.e. only an Administrator Account can install the system effectively.

ii) Trial Mode: The software always loads in Trial Mode. This mode is accessed via the "Register Later" option and allows the use of an effective but limited version of the software for 21 days. It then stops working unless a valid Quintic Licence has been registered.

iii) Quintic Licence Registration – Full Program:

a) Fully registering a valid Quintic Licence via the "Register Online" option will access full permanent program. Again this must be done in an Administrator Account.

b) Due to default restriction settings on Microsoft Operating Systems, the full permanent program may require certain video codecs to be re-installed to allow video playback. If an indicative message appears during usage, please refer to the codec advice section within the Troubleshooting chapter of the Quintic Tutorials for guidance.

iv) Access by any User Account: When the software (in Trial or Permanent mode) has been installed via an Administrator Account, the software can be accessed and used by double clicking on the Quintic shortcut icon on the desktop of any User Account.

v) Uninstalling (Unregistering) the Quintic Licence: Quintic Licences may be uninstalled only by an Administrator Account. Open the Quintic program and proceed via the Help Menu tab. Select 'Help' and then select 'Uninstall Quintic Software'. Follow the onscreen instructions or for more assistance please refer to the Uninstall Section within the Quintic Tutorials.

Reasons for Uninstalling (Unregistering) the Quintic Licence:

a) to make fundamental changes to the PC (e.g. re-formtting hard drive) which otherwise could cause the Program to be locked out.

b) to move the Licence to a different PC: The automated system allows this twice in any 12 month period

Appendix C

Quintic System Requirements

Quintic System Requirements

To use the Quintic Video Analysis Software you will need a personal computer, either desktop or laptop. Quintic software is fully supported by Microsoft Windows Eight, Seven, Vista & XP as well as Mac PC's using Parallel Desktop or Boot Camp (Please Note: Quintic does not recommend Windows 8 tablet computers).

Quintic software requires full administrator rights to load and run the software on the first occasion. Once the software has been 'unlocked' using Quintic security, then specific user accounts (if required) can be set-up on your computer.

A high specification graphics capability is recommended for the use of Quintic Software - in particular Multi HS LIVE Camera Capture.

Quintic Video Analysis Software: Minimum System Requirements

- Windows XP, Vista, Seven or Eight Operating System and Mac. (Please Note: Quintic does not recommend Windows 8 tablet computers)
- Intel i3 Processor 32/64 bit
- 2.0 GHz Processor with 2036 Mb RAM
- 50 GB free hard disk space (10GB for System Program - 40GB to store video files)
- Monitor resolution of 1280 x 1024 pixels (2560 x 1440 pixels for 4+ camera capture)

Required Connectivity Ports for Quintic HS Camera Capture

- USB2 port for Quintic HS Single USB2 Camera Capture
- USB3 port(s) for Quintic HS Single/Multi USB3 1MP Camera Capture
- Ethernet port(s) for Quintic HS Single/Multi GigE Camera Capture

Quintic Player: Minimum System Requirements

- Windows XP, Vista, Seven & Eight Operating Systems and Mac (Please Note: Quintic does not recommend Windows 8 tablet computers).
- Intel i3 Processor 32/64 bit.
- CPU of 500 MHz or higher.
- Windows Media Player (free download from Microsoft.com).

Recommended PC Specifications

Desktop PC – for use with up to 6 GigE cameras

- i7 processor (ivy bridge or newer)
- Windows 7
- SSD write speed above 325mb/s
- Quad port Ethernet card
- Dual port Ethernet card (only required for 5 and 6 camera systems)

Standard Laptop - for use with either 1-2 x GigE cameras or 1 x USB3 1MP camera

- i7 processor (ivy bridge or newer)
- Windows 7
- USB3 port (single or dual Ethernet adapter for GigE camera capture)

High Spec Laptop - for use with either 3-4 x GigE cameras or 2 x USB3 1MP cameras

- i7 processor (ivy bridge or newer)
- Windows 7
- SSD write speed above 325mb/s (usually small storage so an additional 500GB/1TB hard drive is needed)
- 2 x USB3 port (with dual Ethernet adapter for GigE camera capture)

Appendix D

Glossary of Terms

Glossary of Technical Terms associated with Quintic Products

Active window: The window that you are currently using or that is currently selected. Only one window can be Active at a time, unless the synchronisation function is being used. The Active window has a dark blue border along the top of the screen. The current file name and directory is displayed in the title bar at the top of the window.

AVI: Audio Video Interleave : the format of the video files needed to run within the Quintic **software**.

Compression: Video files can be large. Compression reduces their size with negligible loss of quality.

Directory or Folder: Part of a structure for organizing your files on a disk. Directories/Folders are an extremely useful tool, allowing you to group related files together in the same directory/folder for easy access. When you select a particular directory/folder, the files it contains are instantly displayed.

Double click: To twice press and release quickly the left (usually) mouse button.

Drag mouse: Press and hold down the left mouse button while moving the mouse - for drawing lines and angles within Quintic Products.

Draw: To mark on a frame of a video file using options under the Draw Menu - Line drawing / freehand drawing.

Drop down Menu: A menu that opens from a command on another menu. A command that opens a cascading menu has a right arrow next to it: for example Digitisation : Set step size 1, 5 or 10.

FireWire / 1394 / IEEE 1394 / i-Link: All these terms refer to the IEEE 1394 standard defining a high speed mode of transmission which guarantees bandwidth for connections such as between computers and digital video cameras. A FireWire and firewire cable must be used with Quintic Products

Filename: The name given to a file of information on disk.

Frame: One still picture from a video file. Individual frames or a sequence of 6 or 12 frames may be captured within the program and printed out within a word document. This function is ideal for reports.

Hard Disk / Drive Capacity: This is the amount of storage space on your computer

Inactive window: A window that is not currently being used. The next movement by the mouse action or keyboard will not affect its contents. An inactive window can be activated by clicking on it.

Markers: 10 markers are available to the user. This enables 10 frame numbers to be chosen by clicking on the marker icon. The video clip that contains a frame number chosen by selecting markers can be saved. Any previously saved markers will default on when opening the relevant video clip. By marking a video frame, you can easily return to that frame by clicking on the marker tag. It is possible to reset all 10 markers, or each marker can be reset individually by placing the cursor over the marker tag and pressing the CTRL key.

Play: To initiate the play of a video file, either through its entire sequence of frames or frames specified using Main file menu. There is a shortcut key to play a video clip on the toolbar.

Scroll Bar: To move through a video clip frame by frame using the scroll bar.

Screen Resolution: Settings of the monitor, the Quintic system best runs on a screen setting of 1024 x 768 pixels.

Title Bar: The blue horizontal bar at the top of the monitor screen that contains the number of the open window, the title of the system and the name of the current file.

Toolbar: A menu of quick selections (icons) across the top of the monitor screen and below the menu bar. The items in the toolbar are the most commonly used features in the Quintic System and are available by clicking the mouse on the desired icon.

Trace: Marking the position of a point or object frame by frame through a video file - creating a point trajectory.

Video file: A video clip that has been given a name and is stored on the disk. This file can be accessed by selecting Open Video under the File Menu. Quintic Products use only *.avi files.

Window: A framed area on the computer screen within which you may place a file for manipulation. Quintic allows you to open one or two windows, but only one window may be active at a time unless you are using the synchronisation mode.

Glossary of Biomechanical Terms

KINEMATICS

Mass: The quantity of matter in an object. The mass of an object will, remain constant regardless of location or gravitational conditions (e.g., earth or moon gravity). The importance of mass in mechanics is that it represents, in linear terms, the resistance to a change of state (a speeding up or slowing down). The unit of mass is the kilogram (kg).

Centre Of Mass: The point at which the mass of the body acts (the point representing the mean position of the matter in a body).

Kinematics: Description of motion of a body.

Linear Motion: motion in which all parts of the body travel along parallel paths.

Angular Motion: motion in which a body travels along a circular path; all parts of the body travel though the same angle, in the same direction, at the same time.

Scalar: A quantity that only has magnitude, for example, mass, and length, are both scalar quantities.

Vector: a quantity that has both direction and magnitude. A force, for example, is always described by its size and by the direction in which it is acting. Velocity is also a vector quantity because it expresses the rate of change of position in a given direction.

Displacement: the change in the position of a body.

Velocity: the rate of change of displacement.

Angular Velocity: the rate of movement in rotation.

Acceleration: the rate of change of velocity with respect to time.

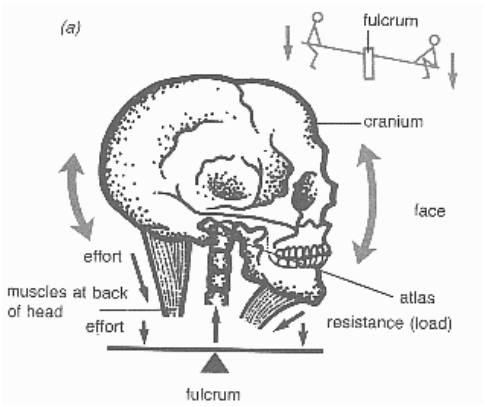
Angular Acceleration: angular acceleration refers to the rate at which the angular velocity of a body changes with respect to time.

FORCES

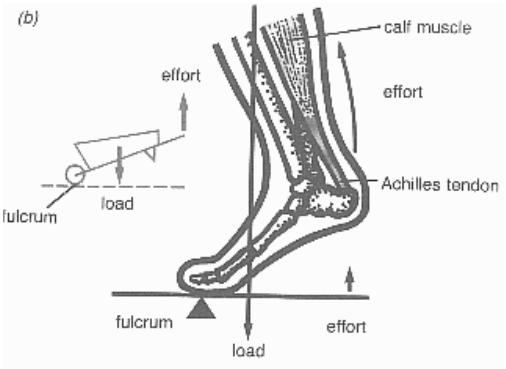
Force: A vector quantity that describes the action of one body on another.

Moment Arm: the perpendicular distance from the point of application of a force to the axis of rotation.

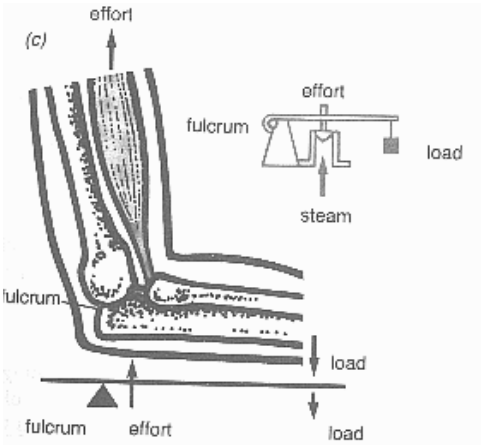
Lever: a lever is a system that tends to change the mechanical advantage of an applied force. Basically, it consists of two forces and a fulcrum or hinge. The two forces are called an effort force (such as a muscular force) and a resisting force (such as a weight held in the hand or a ground reaction force). The perpendicular distance of each force from the fulcrum is called the lever arm.



a) First Class Lever: On opposite sides of the fulcrum.

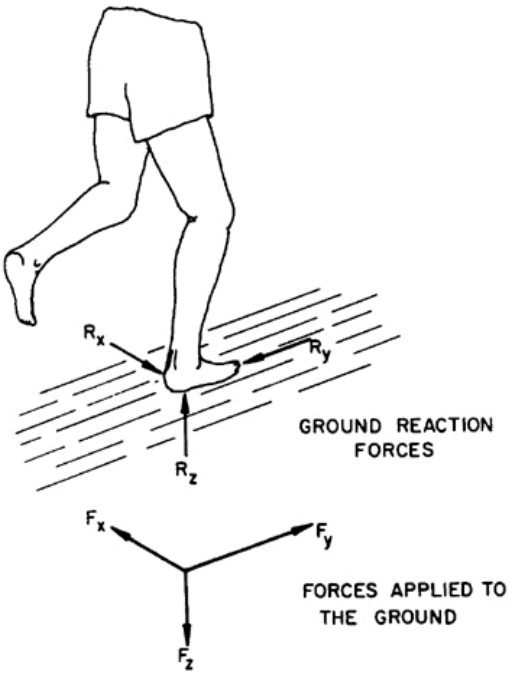


b) Second Class Lever : On the same side of the fulcrum with resistance arm closer to the fulcrum.



c) Third Class Lever: On the same side of the fulcrum with the effort force closer to the fulcrum.

Ground Reaction Force: the forces that act on the body as a result of interaction with the ground.



Gravitational Force: the force exerted on an object as a result of gravitational pull.

g: the symbol used to represent the acceleration because of gravity on earth. Although this quantity actually varies according to location and altitude, the usual value used is 9.81 m/sec^2.

KINETICS

Newtons Laws:

1. Newton's first law states that a body will maintain a state of rest or uniform motion unless acted on by a net force.

2. Newton's second law states that the change in momentum of the body under the action of a resultant force will be proportional to the product of the magnitude of the force and the time for which it acts (i.e., the impulse). The second law also states that the change in momentum will be in the direction of the resultant force.

3. Newton's third law states that action and reaction are equal and opposite.

Linear Momentum: the product of the mass of an object and its linear velocity.

Angular Momentum: The rotational equivalent of linear momentum that can be thought of as describing the "amount of motion" that the body possesses during rotation.

Work: work (w) is done when a force moves an object through a distance. Whenever a constant force exists and motion takes place in a straight line, then work equals the magnitude of the force (f) times the distance (d) through which the object moves

(w = f d).

Power: the rate of doing work. Power (p) is equal to the work done divided by the time during which the work is being done: p = w/t.

Energy: the capacity for doing work. In any system, this capacity cannot be destroyed, but energy can be transformed from one form to another.

Kinetic Energy: that component of the mechanical energy of a body resulting from its motion.

Potential Energy: that component of the mechanical energy of a body resulting from its position.

MUSCLE MECHANICS

Contraction: development of tension by a muscle whether or not shortening is underway.

Muscle action: The development of muscle tension (more appropriate than the term "contraction"). It can be applied to any type of tension development regardless of whether a muscle is lengthening, shortening, or maintaining the same length.

Eccentric muscle action: muscle lengthening under tension. This lengthening occurs when the external force acting on the segment to which a muscle is attached causes a net moment that is greater than the moment that is being developed by the muscle and its synergists.

Concentric muscle contraction: muscle shortening under tension. This shortening occurs when the net moment developed by a muscle and its synergists is greater than the moment caused by the external forces acting on the segment to which the muscle is attached.

Isometric Contraction: Muscle action that involves no change in length of the muscle the action of a muscle when no change exists in the distance between its points of attachment—referring to the joint and not to the muscle.

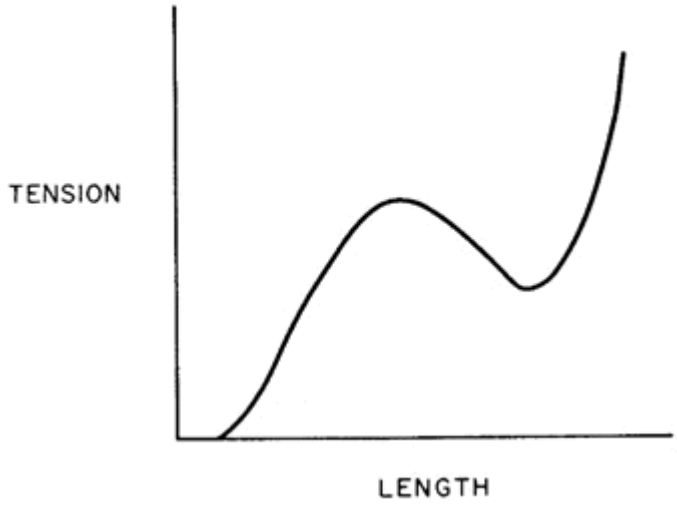
I**sotonic Contraction:** Muscle action that involves the production of a constant force.

Isokinetic contraction: Muscle action in which the rate of shortening or lengthening of the muscle is constant.

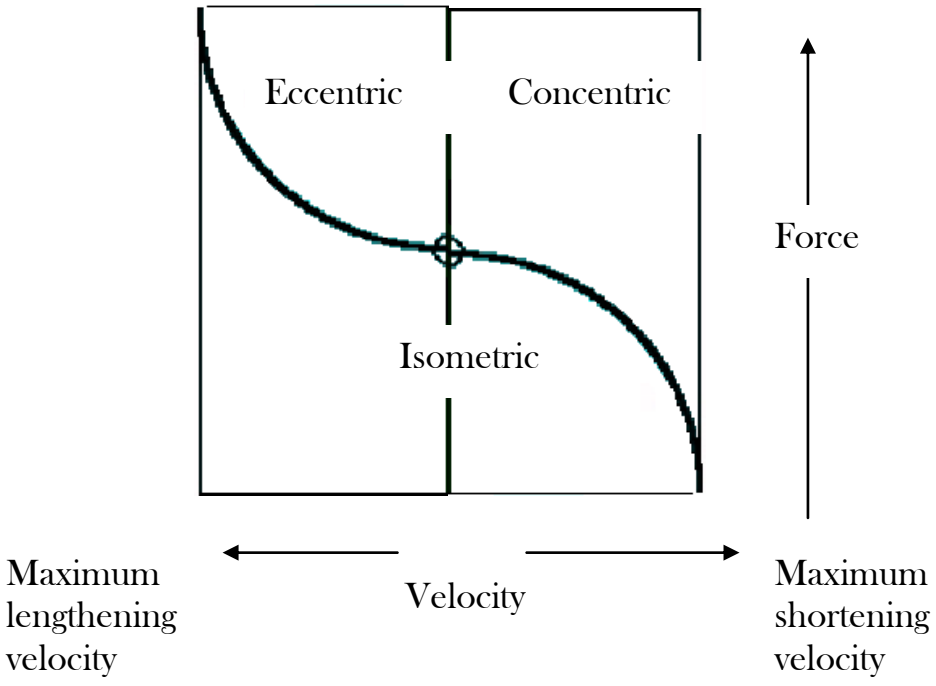
Origin: The source or beginning of a muscle. The term generally refers to the more fixed end or the more proximal end.

Insertion: The more distal attachment of the muscle or the attachment that is more mobile.

Tension- length relationship: The variation in force output of a muscle, with the same neural input, over a range of lengths. The reasons for this variation include a change in the number of possible active sites for cross-bridge formation and the effect of the elastic tissues that are in parallel with the contractile tissue.



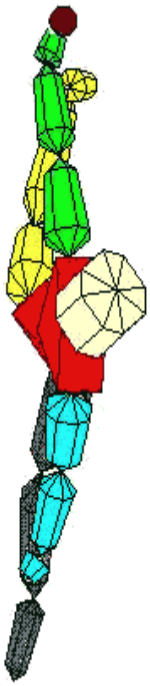
Force – Velocity Relationship: At any given length, the speed of shortening or lengthening of a muscle that is stimulated at a constant level will depend on the force that is applied to the ends of the muscle. The Hill equation, best known of the force-velocity equations, describes mathematically the fact that light loads can be lifted quickly but heavy loads only slowly. Although it is often stated that maximal muscle force is available at zero velocity (isometric action), the highest loads are achieved during eccentric muscle action.



Appendix E

Quintic Sports Science

What is Biomechanics?



The word 'biomechanics' is derived from the Greek bios meaning life and mekhaniki meaning mechanics, so that biomechanics may said to be the study of the mechanics of life forms. The extent of this subject area is evident in research of plants, insects, reptiles, dinosaurs, birds, fish, whales, elephants, kangaroos and humans. In the biomechanics of humans, topics range from the mechanics of bone, tooth, muscle, tendon, ligament, cartilage, skin, prostheses, blood flow, air flow, eye movement, joint movement to whole body movement. In human movement biomechanics, topics include injury, clinical assessment, rehabilitation, ergonomics and sport.

Sports biomechanics uses the scientific methods of mechanics to study the effects of various forces on the sports performer. It is concerned, in particular, with the forces that act on the human neuromusculoskeletal system, velocities, accelerations, torque, momentum, and inertia. It also considers aspects of the behaviour of sports implements, footwear and surfaces

Performance Improvement & Injury Prevention

With the help of Quintic, we aim to provide answers to performance related topics:

What is the best run-up for a high jumper?

How should they knee angle be modified for the delivery stride of a fast bowler in cricket?

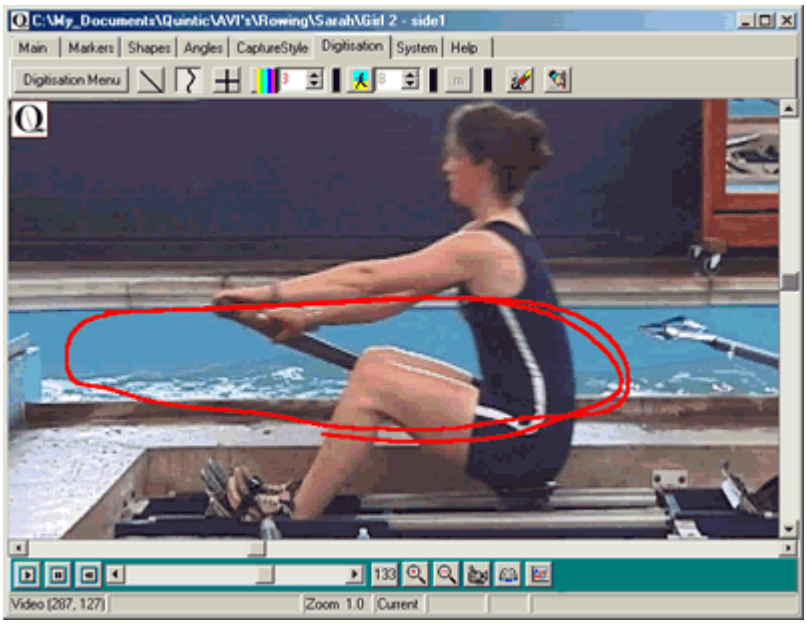
What is the velocity of the swimmer after the tumble turn?

These questions are of the form: What is done? How is it done? Why does it work? The answers to What? How? and Why? are important to the athlete, coach and scientist, respectively...

"Biomechanics is the science concerned with the internal and external forces acting on a human body and the effects of these forces..."

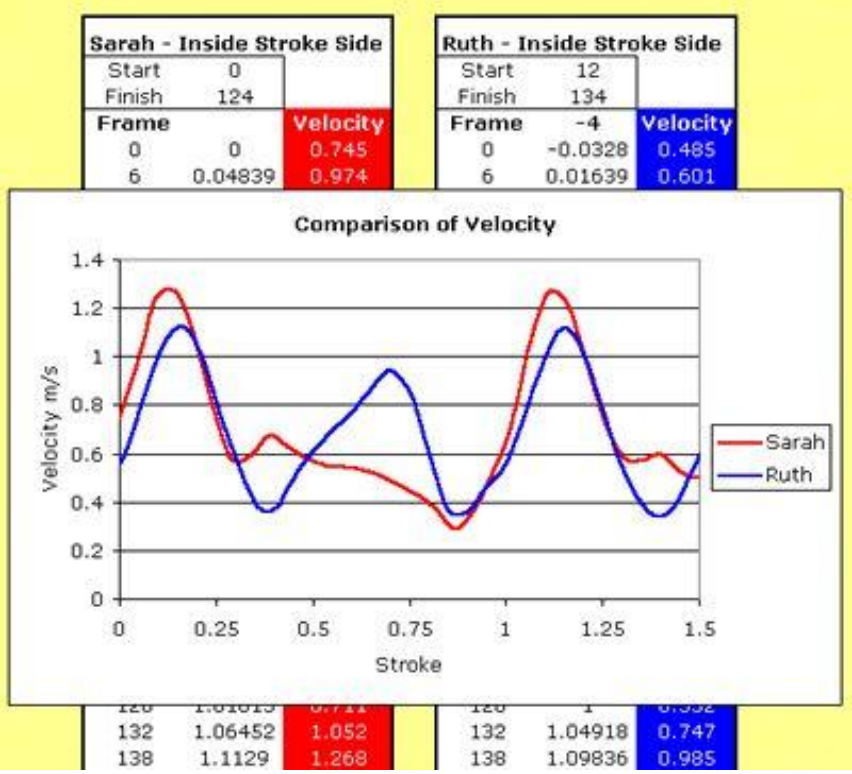
Example of Quintic Biomechanics in Rowing:

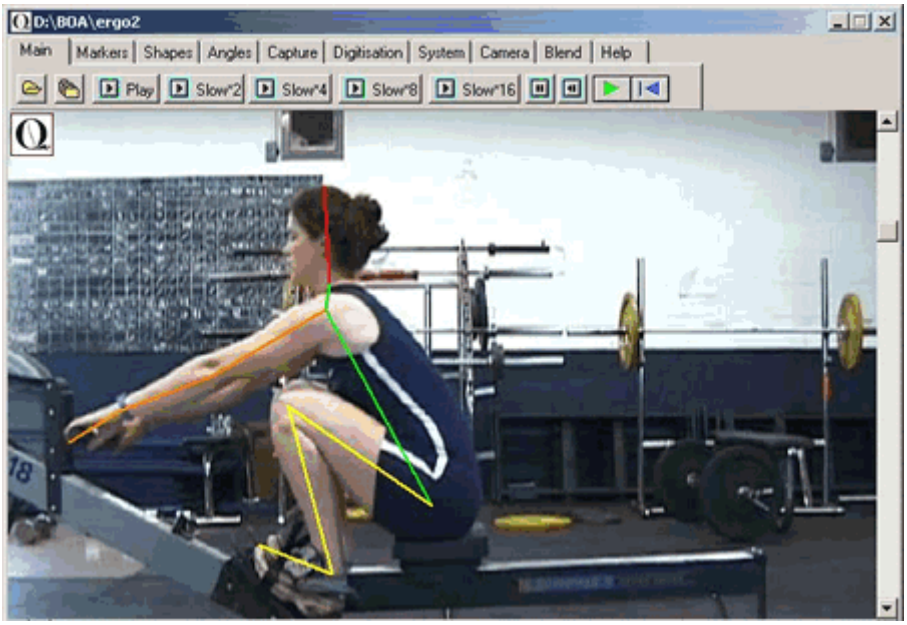
From video footage of rowing tank training, the Quintic software enabled techniques of different rowers to be analysed and compared. Further to that, the Quintic Biomechanics enabled the velocity of the oar handle to be monitored and compared for the different rowers.



The figure above shows a Quintic trace of the oar handle through two strokes. The analysis program calculates velocities and accelerations along this line, which can be directly analysed. The velocity and acceleration data displayed in the analysis program can be exported into a spreadsheet. This allows a more detailed and specific analysis to be conducted.

The figure below shows an example of this. Two velocity traces of two different rowers, working at different stroke rates are compared below. The velocity traces are shifted in time so that the beginning and end of each stroke coincides. This enabled the direct comparison of velocity and acceleration. The velocity graphs below, generated from the Quintic Analysis program, show the higher speeds generated by Sarah in the driving phase of the stroke, and the significant difference in the velocities in the return phase.


Sarah - Inside Stroke Side
Start 0
Finish 124
Frame
Velocity
0 0 0.745
6 0.04839 0.974
132 1.06452 1.052
138 1.1129 1.268
Ruth - Inside Stroke Side
Start 12
Finish 134
Frame -4
Velocity
0 -0.0328 0.485
6 0.01639 0.601
132 1.04918 0.747
138 1.09836 0.985
Comparison of Velocity
Velocity m/s
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 0.25 0.5 0.75 1 1.25 1.5
Stroke
Sarah
Ruth


D:\BOA\ergo2
Main
Markers
Shapes
Angles
Capture
Digitisation
System
Camera
Blend
Help
Play
Slow*2
Slow*4
Slow*8
Slow*16

How can a Sport Psychologist help you?

There are many myths about Sport psychology. What does a Sport Psychologist actually do? The reality is that applied Sport Psychology is based on very simplistic principles. One principle endorsed by many practitioners is the **KISS** approach **(Keep It Simple Stupid!)**.

Such an approach is important as many individuals experience problems with their mental game simply because they 'over complicate' things. Part of the Sport Psychologist's job is to simplify an individual's approach to the mental game, so that they feel 'in control' of their performance.

Much of what we do in Sport Psychology is taken from the experiences of those individuals who have made it to the top of sport. There are many mental skills, which can be enhanced through mental training; these include…

Controlling anxiety (nerves)
* Visualisation,
* Developing concentration,
* Confidence building,
* Performance analysis,
* Positive thought control,
* Improving body language,
* Developing pre-performance preparation,

Aspects of sports performance such as being able to control anxiety and the ability to stay focused at crucial times often dictate whether an individual is successful or not. However, very little time is spent working on the mental game. Mental skills need to be worked on just as physical skills are. Many sports performers are able to perform to a high level in practice yet seem unable to 'deliver the goods' when they compete.

Often the reason for this is that they have spent all their preparation time working on their physical game and neglected their mental preparation. Therefore, when they confront a pressure situation or they experience a loss of concentration they do not have the relevant coping strategies to stay in control of their performance. These individuals should be encouraged to spend time working on their mental game, to allow them to fulfil their potential physically by preparing mentally. Most individuals

find that very simple mental strategies help them to feel more in control of themselves and subsequently perform to a higher standard.

What are the Psychological benefits of the Quintic System?

The use of video analysis is important for a number of psychological reasons…

1. Visualisation.
Video analysis can help an individual to learn to visualise much more effectively. By observing yourself performing consistently well on video you can enhance the way that you see yourself perform in your mind. The use of video is particularly useful for developing external visualisation (where you see yourself performing as if on a television screen). This form of visualisation allows the individual to observe themselves performing from afar. Therefore, they do not experience the same thoughts, feelings and emotions that are felt when they visualise a situation through their own eyes. This form of visualisation is particularly important when building confidence and dealing with controlling anxiety.

2. Positive Reminders.
Most sports performers are encouraged to keep some kind of performance analysis diary. A diary can be used to assess the strengths and weaknesses of recent performances and can also be used as a positive reminder of good performances. The Quintic system allows the individual to keep a library of positive performances, which can be recalled simply at the touch of a button. Using the memo pad feature you can also recall any important information regarding the video clip that you are watching. For example a golfer can record a library of their best shots with each club. The memo pad allows you to record any important information regarding each swing, for example ‘swing keys’ or ‘swing thoughts’. Thus, if they are beginning to struggle playing with a particular club the golfer can recall an image of themselves playing at their best with that particular club. Using the split screen function the player can then record their current swing and compare it to their best swing. By using the synch function and running these two images together the player can establish whether there are any technical differences between the two swings. Any differences can be identified by the coach and drills can be worked out to correct the fault.

"An example of the benefits of the Quintic system occurred when one particular golfer lost his confidence in swinging one particular club. When using the split screen function the coach could not identify any technical differences between the golfers current swing as compared to a good swing recorded three months previously. It was clear that the golfer had simply lost confidence in their swing. By seeing that there were no technical differences between the two swings the golfer was reassured that their technique was not at fault. This put any 'technical doubts' out of the golfers mind and ensured that he believed in his technical ability. The memo pad feature also reminded the golfer of their ‘positive thoughts’ and ‘swing keys’. In this case the

player had stopped using one particular swing key. The Quintic system had acted as a positive reminder for the golfer and helped him rebuild his confidence in his swing".

3. Body Language.
Through the use of video analysis sports performers can become much more aware of their 'behaviour'. For example a tennis player might want to study their body language after points that they have won or lost. Equally it is useful for studying the body language of opponents. A coach can use the split screen facility to show examples of both positive and negative body language as compared to that of the player that they are working with.

4. Skill Development.
Because of the systems slow speed function, individuals can receive direct feedback about a skill they are learning, immediately after performing the skill itself. Therefore, throughout the learning process the player can see a visual picture of what they are actually doing. This is very important, as often individuals are not actually doing what they perceive themselves to be doing. By using the systems spit screen function the coach can have a visual representation of the skill being performed perfectly on one side of the screen and the current image of the performer on the other. Thus the performer can see where the adjustments need to be made to the technique in order to perform the skill correctly. For more complicated skill development the lines / angles function can be used to demonstrate the 'fine tuning' of technical development. Such a visual representation can build confidence throughout the learning process.

Written by Dr Mark Bawden, Metaphorics Performance Consultants Ltd

Appendix F

Conversion Chart

Conversion Chart: Metres per Second > Miles Per Hour > Kilometres per Hour

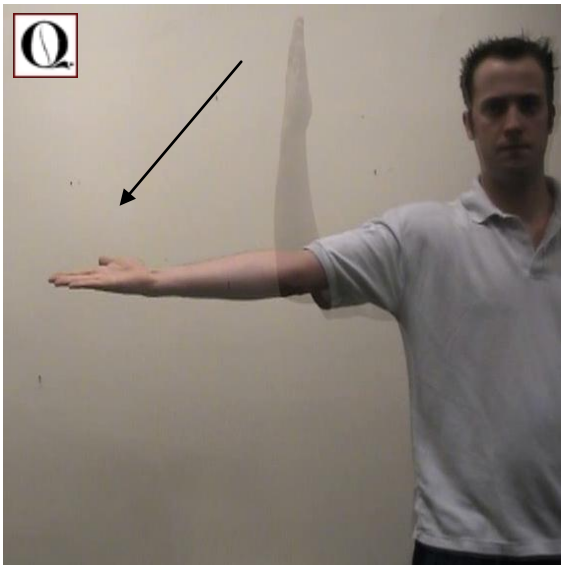
Metres/s	Mph	Kph
0.50	1.12	1.80
1.00	2.24	3.60
1.50	3.36	5.40
2.00	4.47	7.20
2.50	5.59	9.00
3.00	6.71	10.80
3.50	7.83	12.60
4.00	8.95	14.40
4.50	10.07	16.20
5.00	11.18	18.00
5.50	12.30	19.80
6.00	13.42	21.60
6.50	14.54	23.40
7.00	15.66	25.20
7.50	16.78	27.00
8.00	17.90	28.80
8.50	19.01	30.60
9.00	20.13	32.40
9.50	21.25	34.20
10.00	22.37	36.00
10.50	23.49	37.80
11.00	24.61	39.60
11.50	25.72	41.40
12.00	26.84	43.20
12.50	27.96	45.00
13.00	29.08	46.80
13.50	30.20	48.60
14.00	31.32	50.40
14.50	32.44	52.20
15.00	33.55	54.00
15.50	34.67	55.80
16.00	35.79	57.60
16.50	36.91	59.40
17.00	38.03	61.20
17.50	39.15	63.00
18.00	40.26	64.80
18.50	41.38	66.60
19.00	42.50	68.40
19.50	43.62	70.20
20.00	44.74	72.00
20.50	45.86	73.80
21.00	46.98	75.60
21.50	48.09	77.40

Metres/s	Mph	Kph
22.00	49.21	79.20
22.50	50.33	81.00
23.00	51.45	82.80
23.50	52.57	84.60
24.00	53.69	86.40
24.50	54.80	88.20
25.00	55.92	90.00
26.00	58.16	93.60
26.50	59.28	95.40
27.00	60.40	97.20
27.50	61.52	99.00
28.00	62.63	100.80
28.50	63.75	102.60
29.00	64.87	104.40
30.00	67.11	108.00
30.50	68.23	109.80
31.00	69.35	111.60
31.50	70.46	113.40
32.00	71.58	115.20
32.50	72.70	117.00
33.00	73.82	118.80
33.50	74.94	120.60
34.00	76.06	122.40
34.50	77.17	124.20
35.00	78.29	126.00
35.50	79.41	127.80
36.00	80.53	129.60
36.50	81.65	131.40
37.00	82.77	133.20
38.50	86.12	138.60
39.00	87.24	140.40
39.50	88.36	142.20
40.00	89.48	144.00
40.50	90.60	145.80
41.00	91.71	147.60
41.50	92.83	149.40
42.00	93.95	151.20
42.50	95.07	153.00
43.00	96.19	154.80
43.50	97.31	156.60
44.00	98.43	158.40
44.50	99.54	160.20
45.00	100.66	162.00

Appendix G

Anatomical Movements

Anatomical Movements



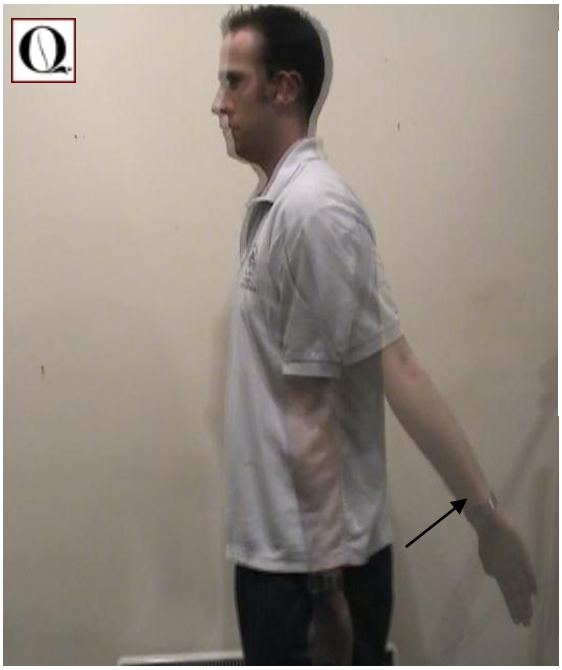
Movement: Elbow Extension
Start position: Elbow flexion
Finish position: Elbow extension

Movement: Suppination
Start position: Pronation
Finish position: Suppination

Movement: Forearm Pronation
Start position: Forearm Suppination
Finish position: Forearm Pronation

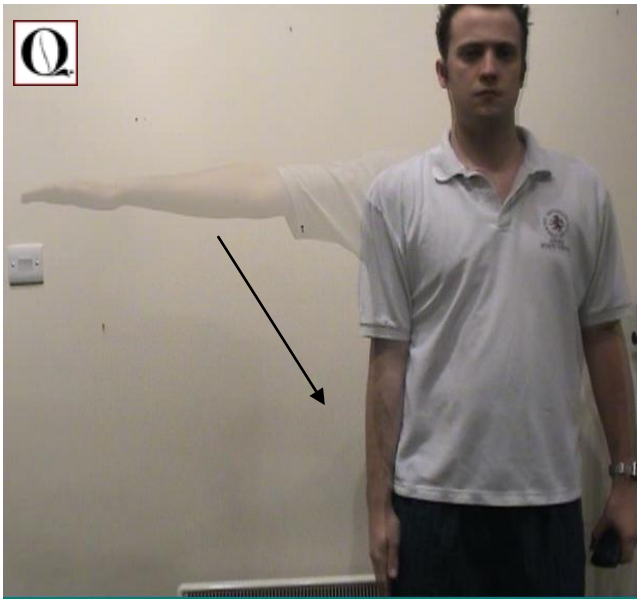
Movement: Shoulder Adduction
Start position: shoulder Abduction
Finish position: Horizontal Abduction

Movement: Shoulder Abduction
Start position: Horizontal Abduction
Finish position: shoulder Abduction

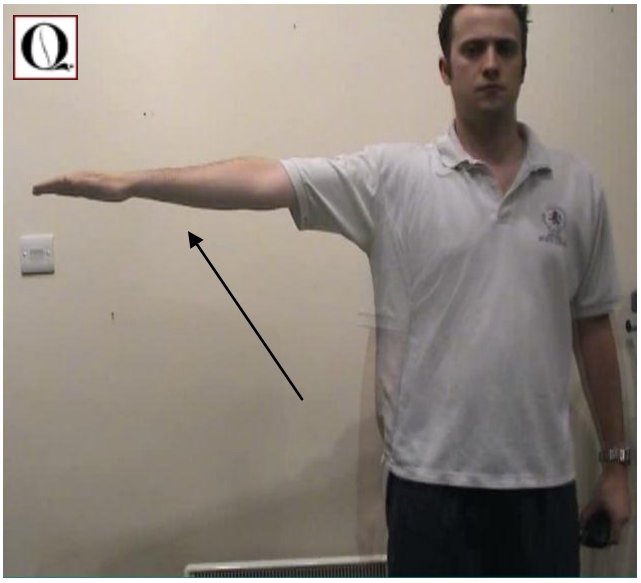


Movement: Shoulder Extension
Start position: Neutral Shoulder position
Finish position: Shoulder Extension

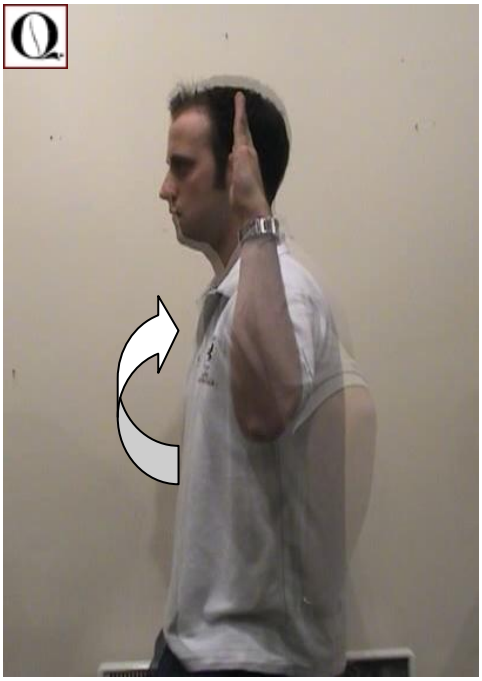
Movement: Shoulder Flexion
Start position: Neutral Shoulder position
Finish position: Shoulder Flexion



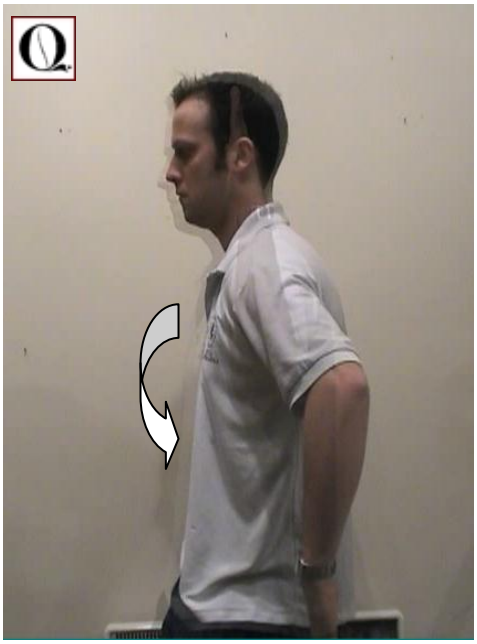
Movement: Shoulder Adduction
Start position: Horizontal Abduction
Finish position: Neutral Shoulder position



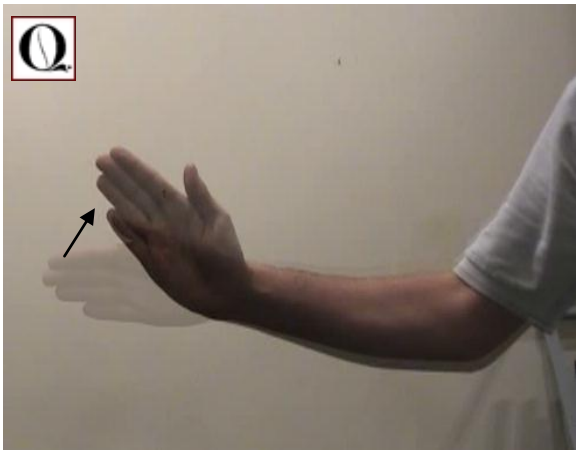
Movement: Shoulder Abduction
Start position: Neutral Shoulder position
Finish position: Horizontal Shoulder Abduction.



Movement: Outward Shoulder Rotation
Start position: Inward Shoulder rotation
Finish position: Outward Shoulder Rotation

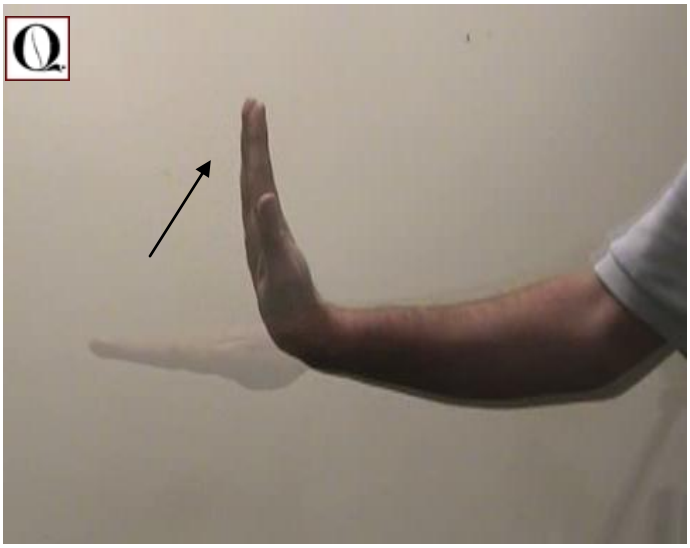


Movement: Inward Shoulder rotation
Start position: Outward Shoulder Rotation
Finish position: Inward Shoulder rotation

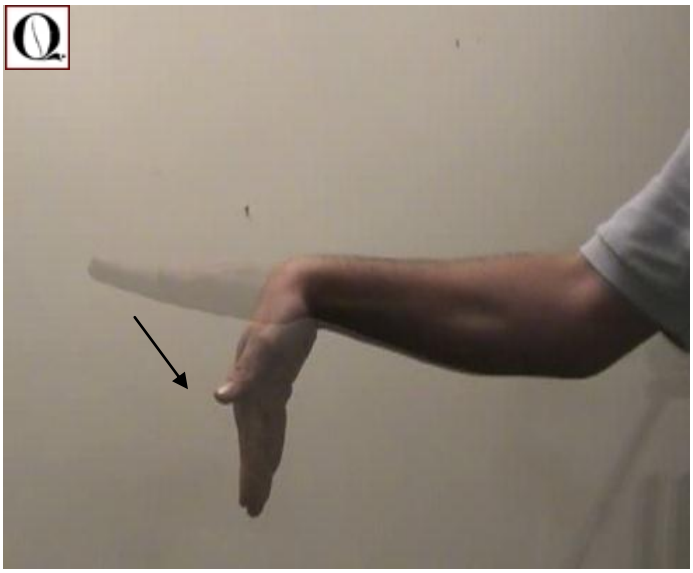


Movement: Wrist Abduction
Start position: Neutral Wrist position
Finish position: Wrist Abduction

Movement: Wrist Adduction
Start position: Neutral Wrist position
Finish position: Wrist Adduction

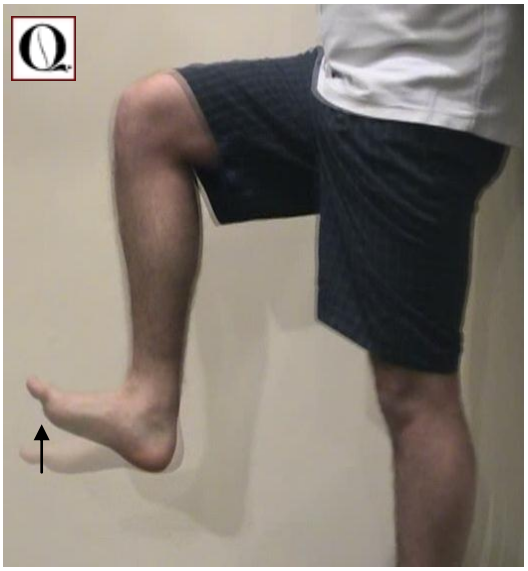


Movement: Wrist Extension
Start position: Neutral Wrist position
Finish position: Wrist Extension

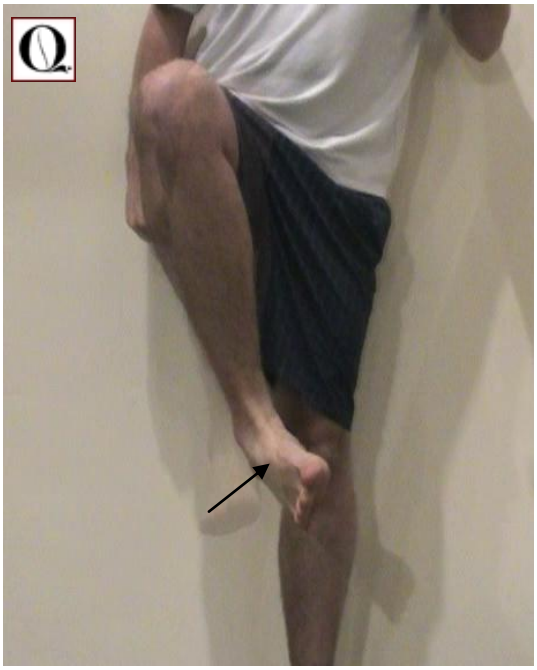


Movement: Wrist Flexion
Start position: Neutral Wrist position
Finish position: Wrist Flexion

Movement: Ankle Plantar flexion
Start position: Neutral Ankle position
Finish position: Ankle Plantar flexion

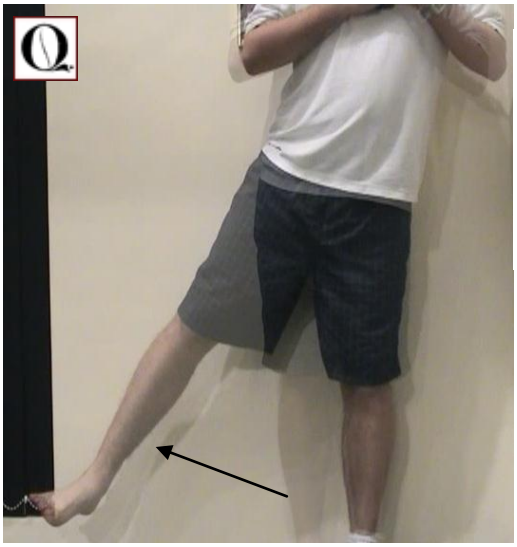


Movement: Ankle Dorsi flexion
Start position: Neutral Ankle position
Finish position: Ankle Dorsi flexion



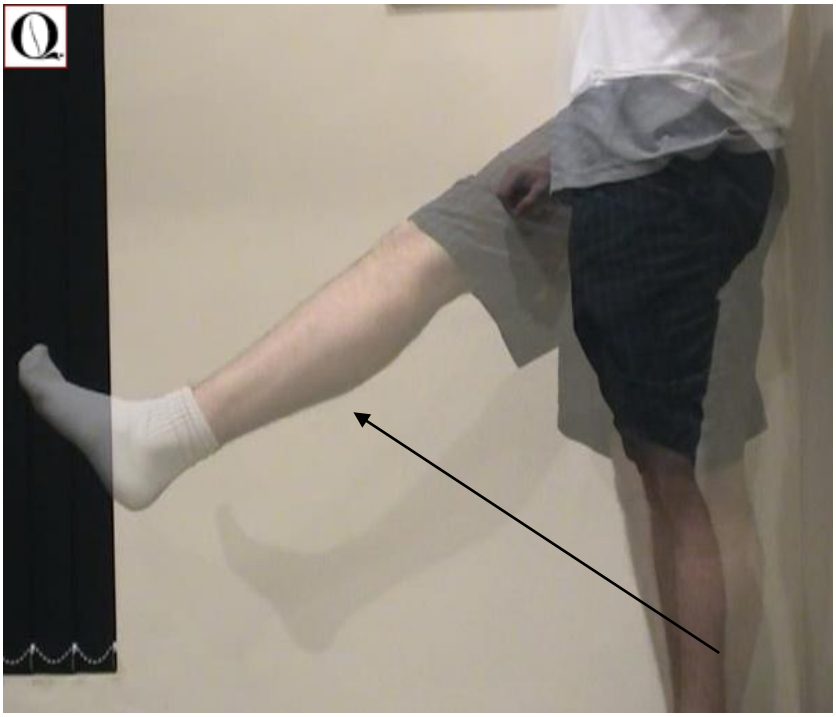
Movement: Ankle Inversion
Start position: Neutral Ankle position
Finish position: Ankle Inversion

Movement: Ankle Eversion
Start position: Neutral Ankle position
Finish position: Ankle Eversion

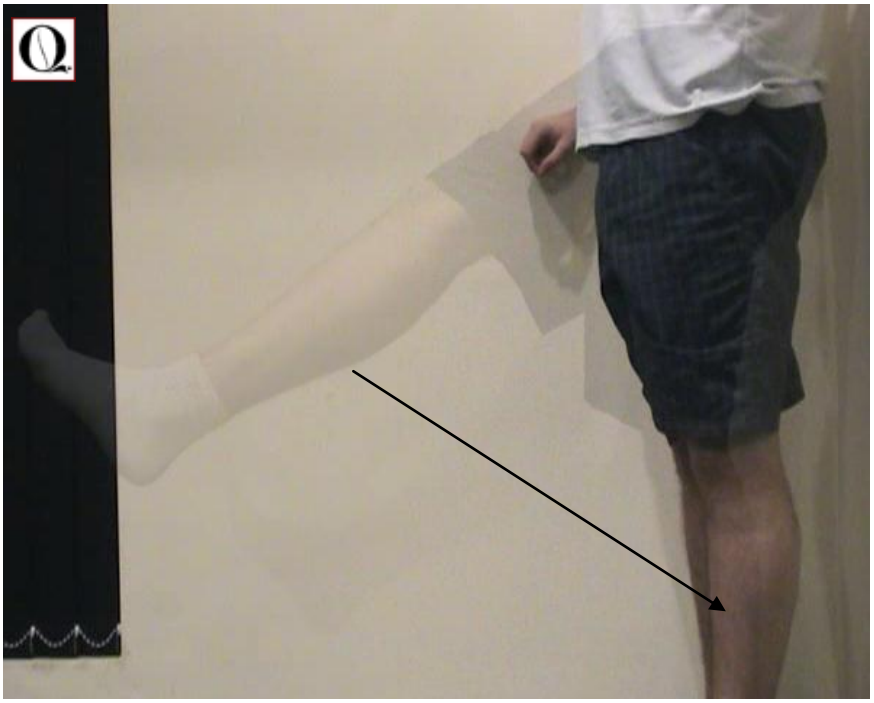


Movement: Hip Abduction
Start position: Neutral Hip position
Finish position: Hip Abduction

Movement: Hip Adduction
Start position: Neutral Hip position
Finish position: Hip Adduction



Movement: Hip Flexion
Start position: Neutral Hip position
Finish position: Hip Flexion



Movement: Hip Extension
Start position: Hip Flexion
Finish position: Neutral Hip position

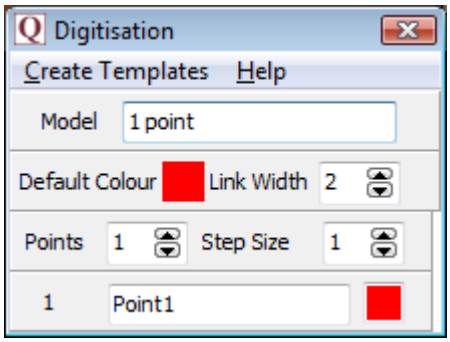
Movement: Knee Flexion
Start position: Knee Extension
Finish position: Knee Flexion

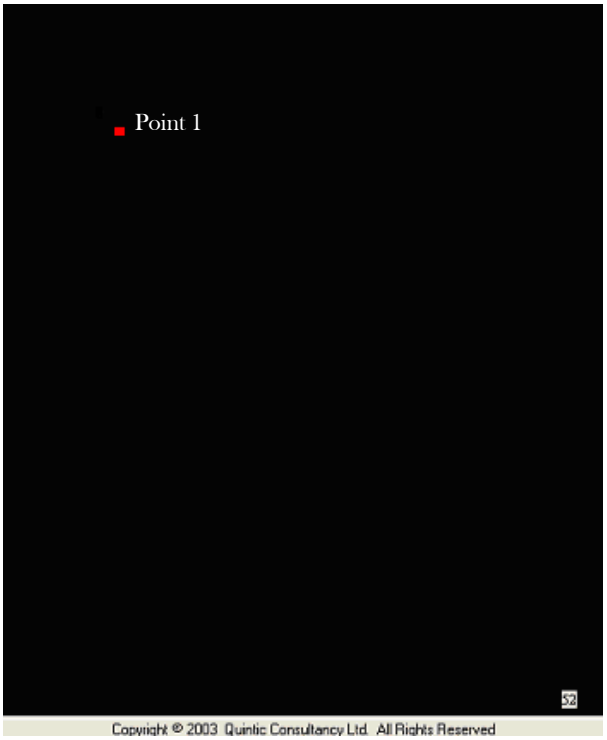
Movement: Knee Extension
Start position: Knee Flexion
Finish position: Knee Extension

Appendix H

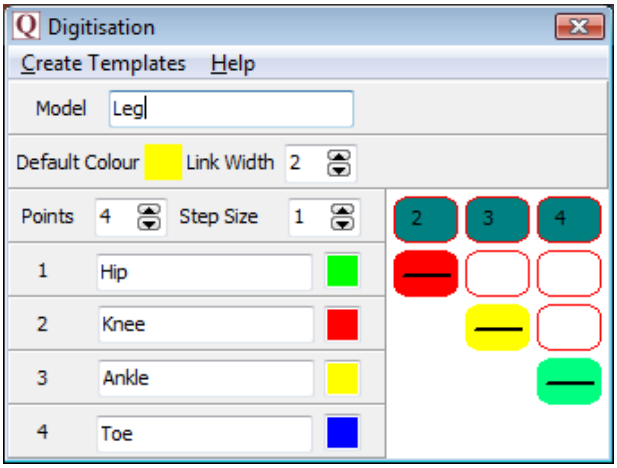
Digitisation Templates

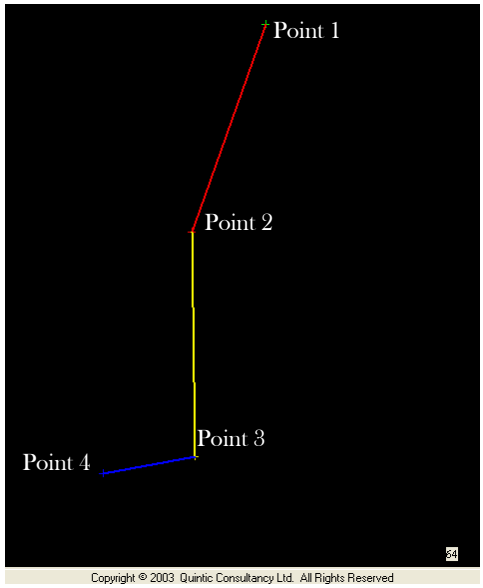
Digitisation Templates



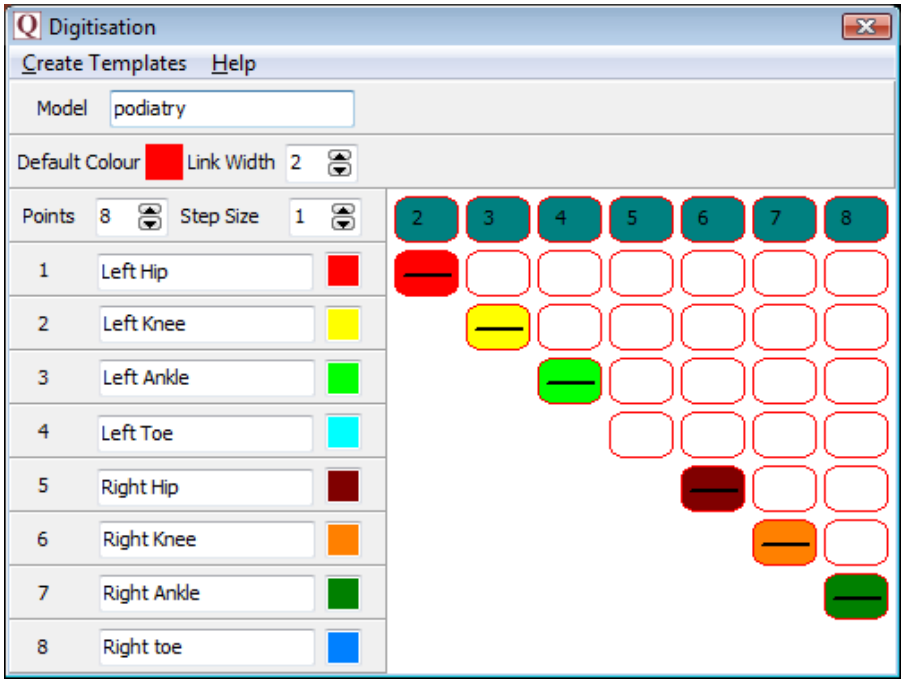


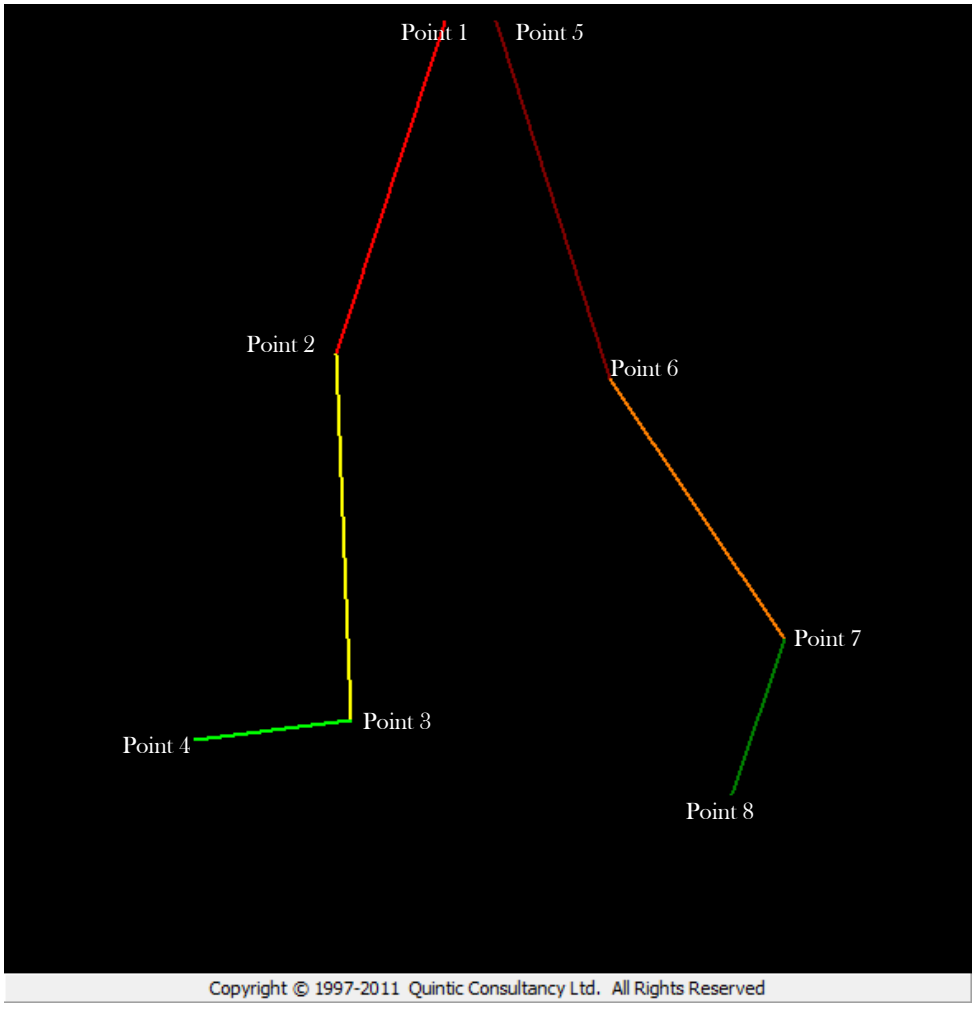
A digitisation template showing a 1point digitisation model



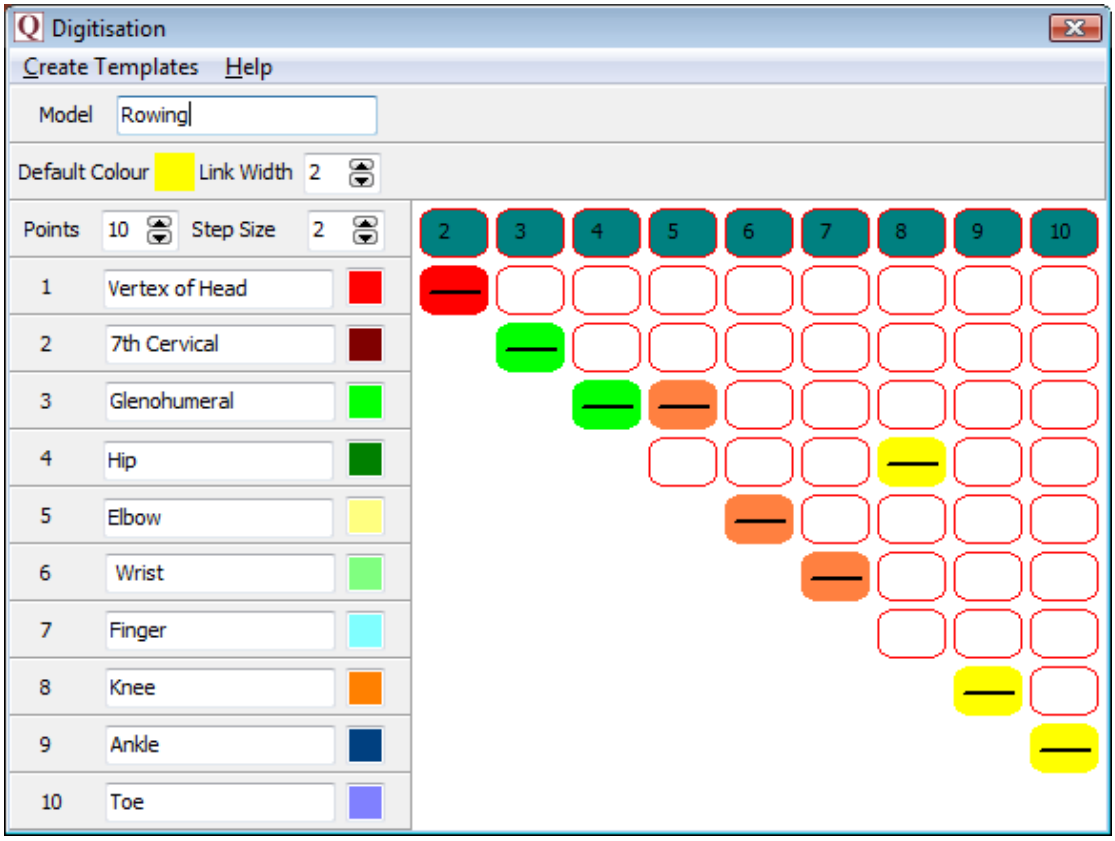


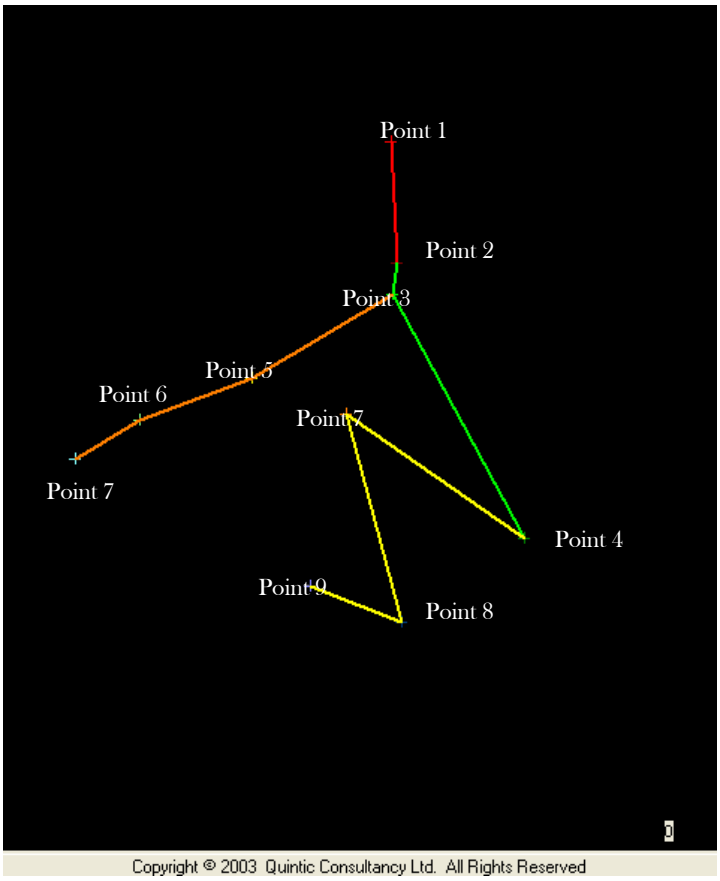
A digitisation template showing a 4 point digitisation model



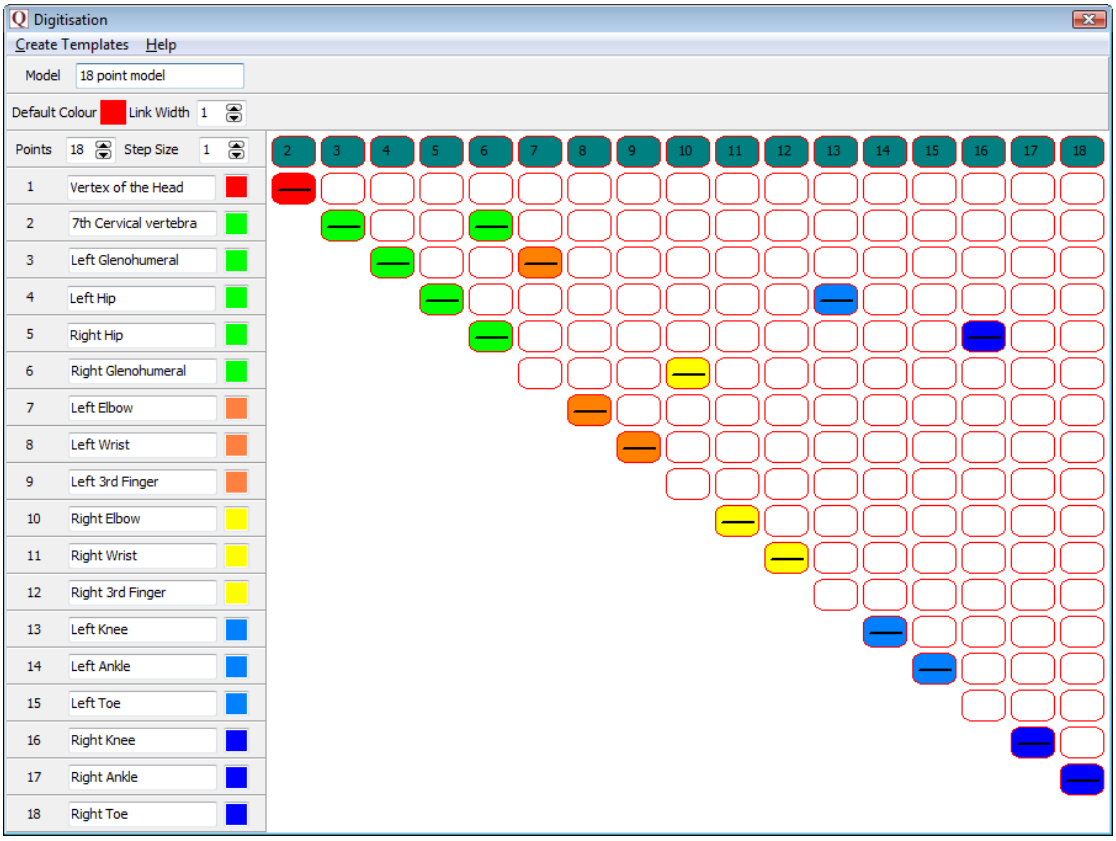


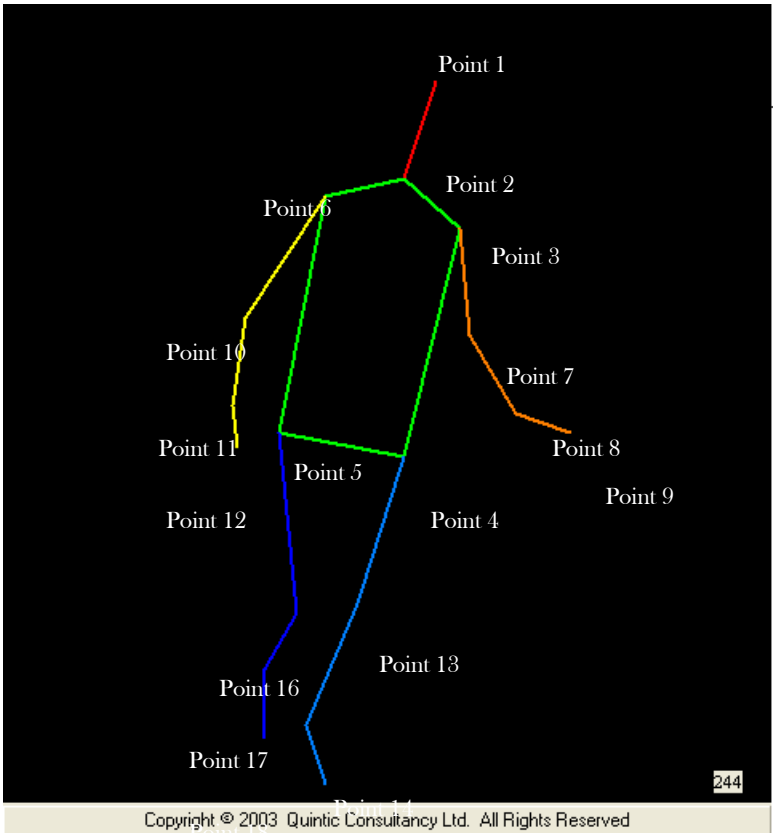
A digitisation template showing an 8 point digitisation model



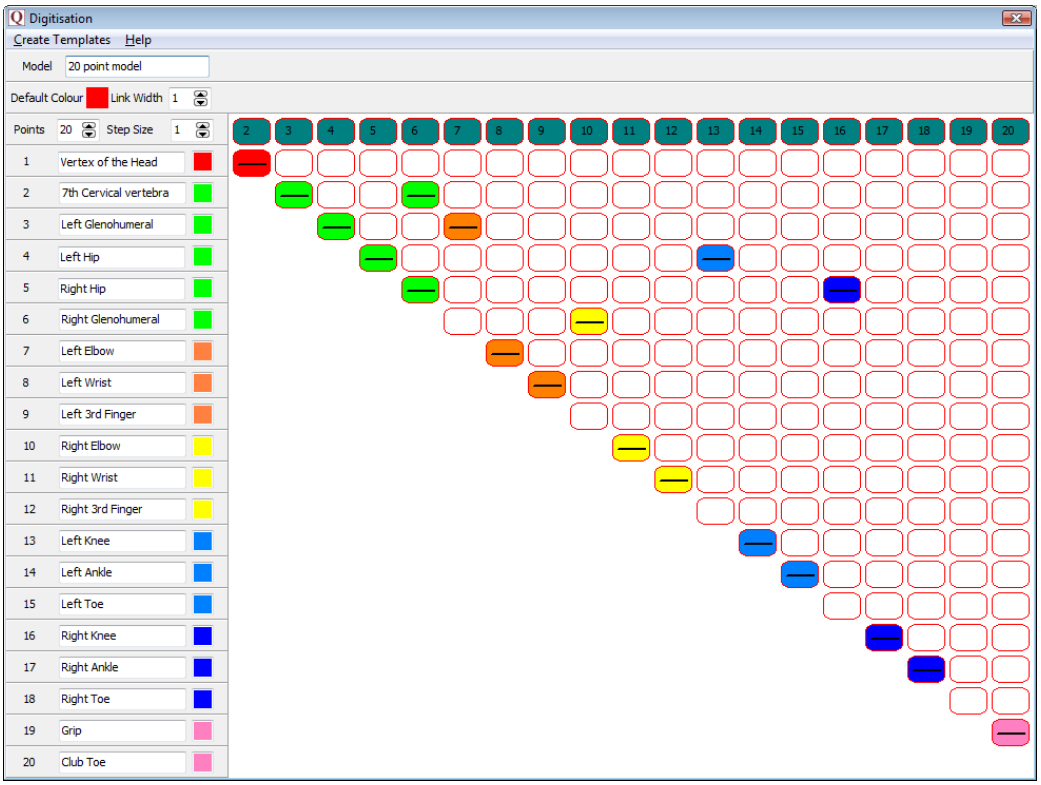


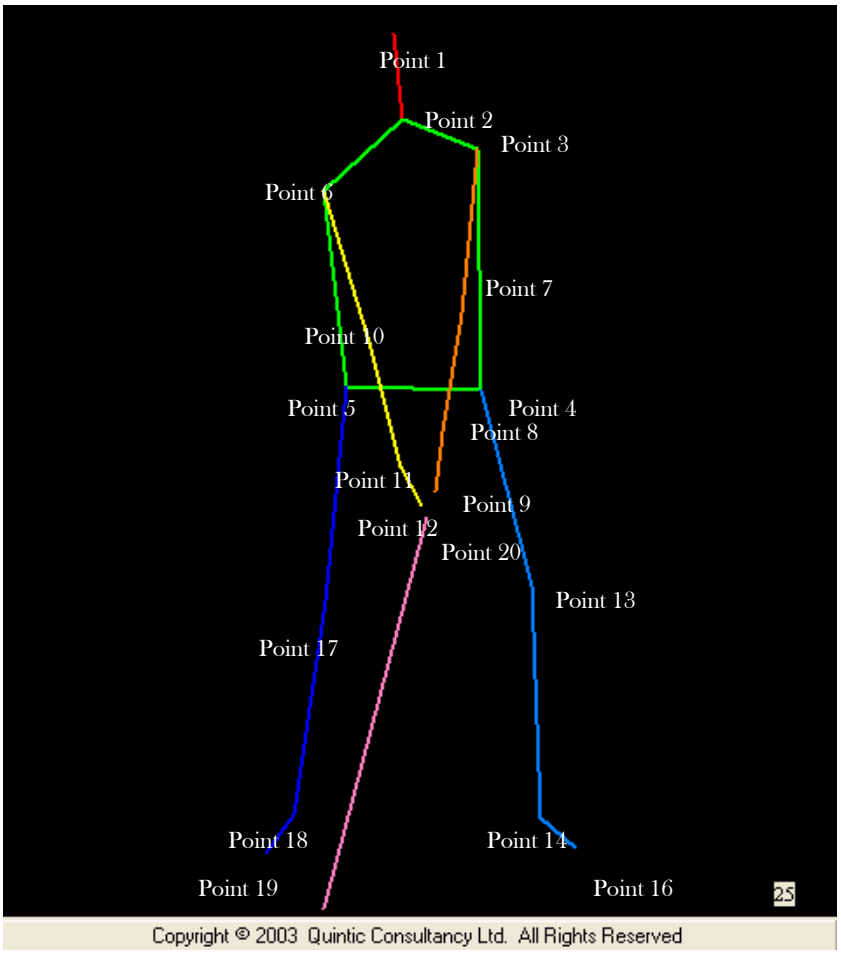
A digitisation template showing a 10 point digitisation model





A digitisation template showing an 18 point digitisation model





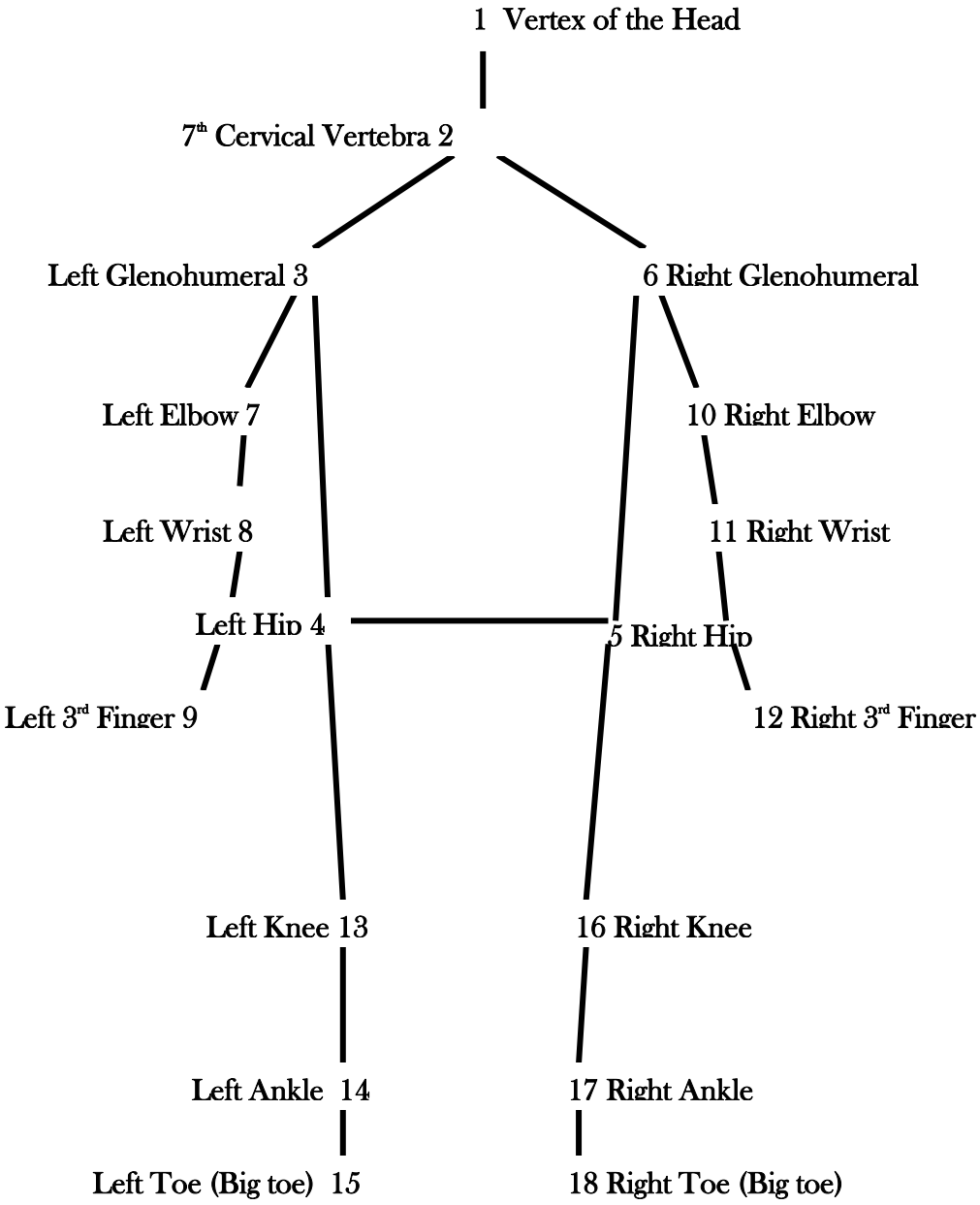
A digitisation template showing a 20 point digitisation mode

Appendix I

Digitisation Model

Digitisation Model

The below diagram shows an example of an 18 point digitisation model which takes into account all the major digitisation points on the human body.



Appendix J

Quintic Analysis

Linear Analysis

Origin

The origin of the graphs can be set as relative or absolute.

Relative uses the first digitisation point as the origin (0,0) and all measurements are relative to this point.

Absolute uses the origin (0,0) bottom left hand corner of the screen.

Calibration

All videos that are used in the Linear Analysis must be calibrated. This is a method of relating pixel distances on the video with an actual scale – i.e. metres, feet. Various options exist within the analysis screens for showing velocity as mps, feet/sec, mph and kph.

Smoothing

It is recommended that filtering is used to smooth the raw digitisation data. See Appendix K - Butterworth filters for more details.

Distance

Distance can be illustrated as horizontal, vertical and/or linear measurements.

Horizontal is the horizontal distance from the origin (absolute or relative)

Vertical is the vertical distance above the origin (absolute or relative)

Linear is the actual distance of the digitisation point from the origin.

Note:- horizontal and vertical distances can be positive or negative but the linear distance will always be positive.

Splines

Splines are methods of fitting continuous curves through a series of data points. Quintic splines are then used to show the horizontal, vertical and linear distance graphs. It is the spline fitting that allows interpretation of distances between frames.

Velocity

The rate of change of distance gives velocity. If slight errors occur in distance measurements then these can be amplified in the velocity calculations. So an averaging method is used to help calculate velocities. The distance before each point and the distance after each point are used to get an average velocity.

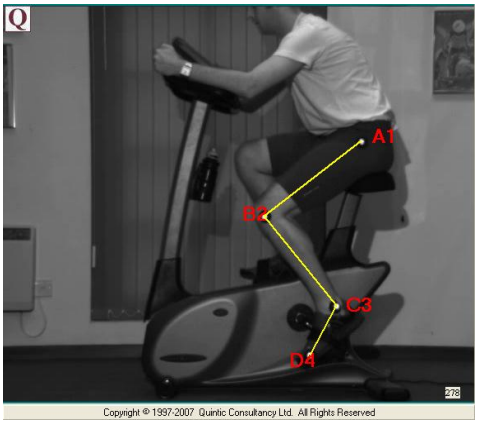
Acceleration

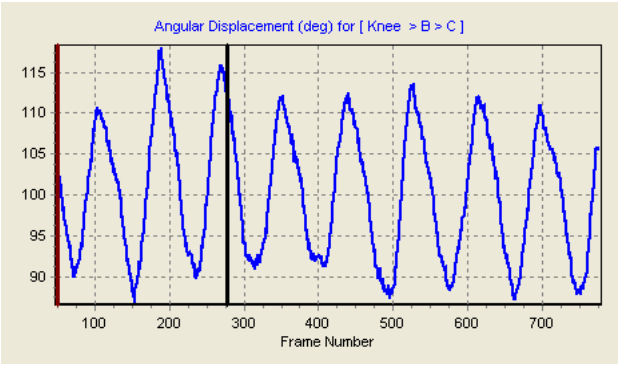
The rate of change of velocity gives acceleration. Similar averaging methods are used to get average accelerations.

Angular Analysis

The picture below shows the results for angle B2>C3>D4

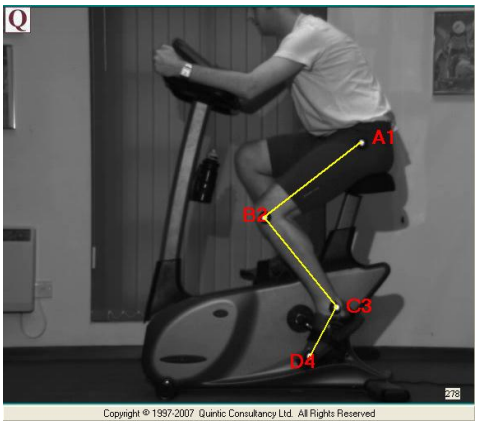
The angle of the ankle varies from approx 87° to a max of 120° degrees.

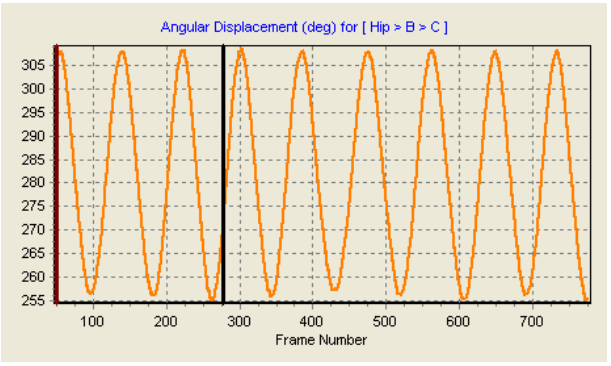




IMPORTANT – All angles are measured using the standard anti-clockwise convention. I.e. the angle from B2 to C3 to D4 (in the anticlockwise direction). The angle of the ankle is in the range 87°-120°.

Now look at the angle A1 to B2 to C3. This is a **reflex** angle and is in the range 255°-310°. **The reflex angle is now shown by default.**





To display the acute angle within the graphical analysis, select display from the menu and unselect **Reflex Angles**

Appendix K

Butterworth Filters

Butterworth Filters

It is important to smooth data, which has been produced by Quintic manual digitisation or automatic tracking. Markers are usually attached to a subject to make the digitisation process easier and more accurate, from these markers the digitisation of the subject can occur. Errors in the digitisation process are possible, for example, actual errors while digitising (when locating the marker using manual mode) or due to skin and muscle movement over a joint centre. It is important to smooth the data to try and eliminate these errors.

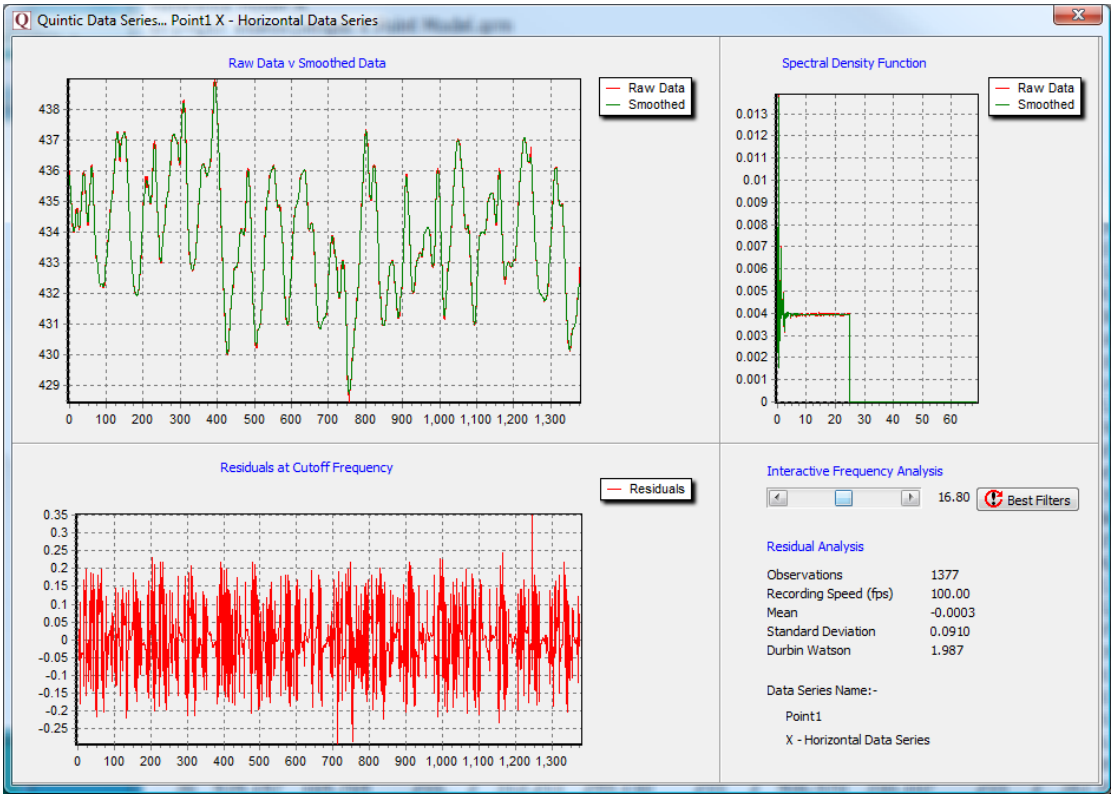
A common method of smoothing data is to use Butterworth filters.

These filters tend to reduce the 'noise' in any signal and hence are better at obtaining the true underlying trend in any data series. The typical time series data signals from any (human) movement tend to occur at low frequencies while any errors are more likely to be at much higher frequencies. Low Pass Butterworth filers reduce the 'noise' from high frequency signals but keep the low frequency signals.

There are many other digital filtering methods such as Fourier smoothing although Butterworth filters are robust and tend to give good results when applied to data series for human movement.

Quintic uses a method that looks for the optimal smoothing of any data series by comparing the difference between the raw data and smoothed data while still retaining a smooth data series as output

Quintic Data Smoothing Screens



"Raw Data v Smoothed Data"

This graph displays the smoothed and raw series. If they look similar then the optimal smoothing method would appear to give sensible results.

"Residuals at Cut-Off Frequency"

This graph shows the difference between the smoothed and raw data. Looking at this graph is important because if the residuals are small and randomly spread about zero then this indicates that the smoothing method is not biased and is not removing any "spiked values" from the raw data series. It could be that these spike values are important in any analysis.

"Spectral Density Function"

This graph shows the different frequencies that make up the digital signal of the "Cycling Video". Most of the frequencies are low i.e. less than 5 Hz.

Interactive Frequency Analysis

The program has calculated the optimum filter for this series. I.e. 16.8

If the residuals have a mean which is close to zero and a low standard deviation then this indicates a good cut-off frequency. As a further test if there is no bias in the residuals then the auto-correlation between successive values should also be close to zero. The Durbin Watson (DW) statistic is used to assess the auto-correlation. If the DW statistic is close to 2.00 then this indicates no significant auto-correlation.

It is possible to interactively change the cut-off frequency by moving the scrollbar.

i.e. if the scrollbar is moved to the left (say 4.0) then this cut-off frequency still gives a low mead and standard deviation. However the DW statistic is close to zero, which indicates an auto-correlation in the residuals. I.e. this is not a good cut-off frequency for this data series. There is also a visible difference between the raw and smoothed data also indicating a cut-off frequency of 4.0 is poor result.

Try moving the scrollbar to the right. I.e. increasing the cut-off frequency. If the cut-off frequency approaches 30.0 then the smoothing becomes unstable and these smoothing frequencies should not be used. It is well known that Butterworth cut-off frequencies can become unstable. So it is always important to "eye-ball" each series to make sure you are using sensible smoothing parameters. The optimum cut-off frequency produced by the program should give a good starting point for checking each series.

Appendix L

Uninstall Quintic Software

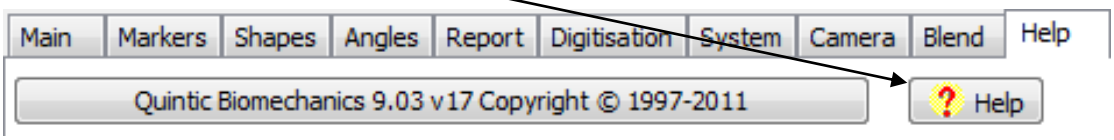
Uninstall Quintic Software

Through Quintic Security each licence is dedicated to recognise one computer. Any change in or of that computer means the **software** will not recognise it and therefore not function. To allow for changes Quintic Security allows you to uninstall the **software** twice in any 12 months and reinstall it on the changed computer. NB – Change means a change of components within a computer or a change to a different computer.

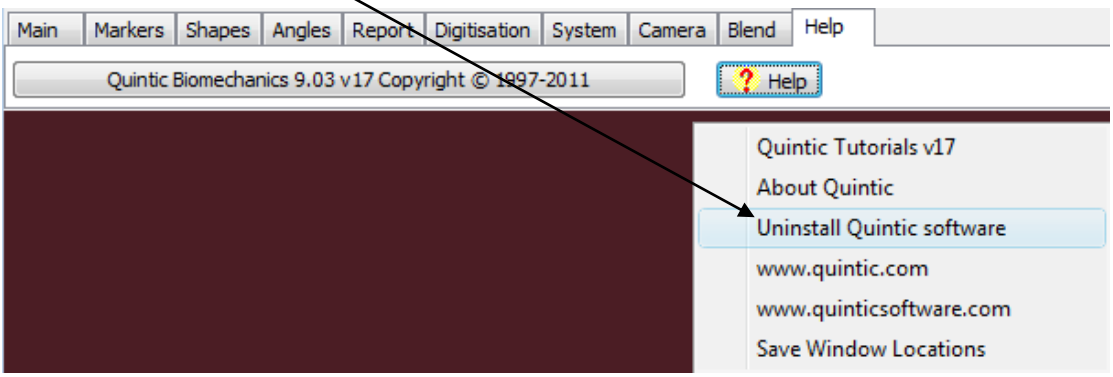
There is an automated system for which the computer must be connected to the Internet to use.

To uninstall Quintic software off your computer please follow these step by step instruction, **ensure you are connected to the Internet**.

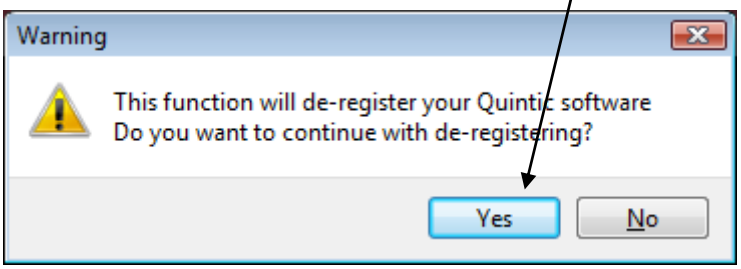
1. Select the help tab off the main menu bar and left click on the help button as illustrated below.



2. Highlight the Uninstall Quintic software and right click to start the unistallation process.

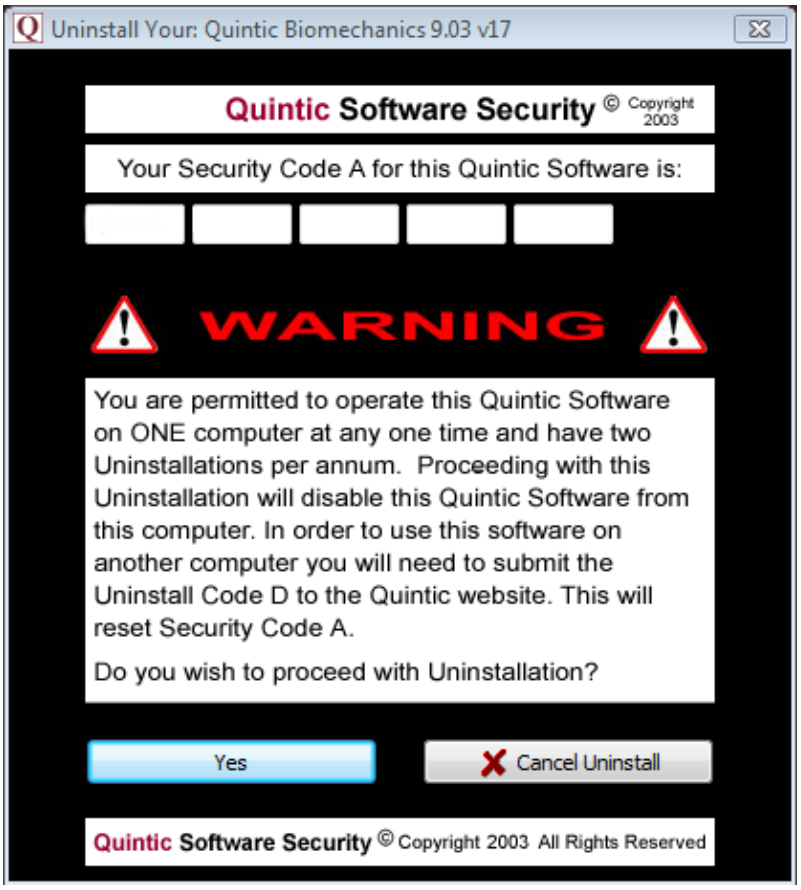


3. A warning box will now be loaded asking you to confirm the continuation of the de-registering process. Right click on the yes button to continue the process.

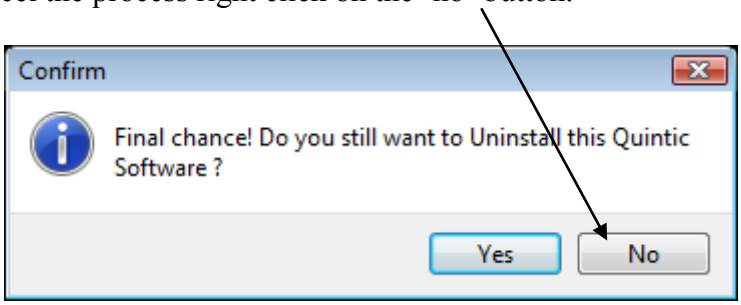


4. The computer will now generate your original security Code A in the 5 boxes at the top of the generated window.

   Read the warning box located in the window after you have read this you have another opportunity to cancel the uninstall process. If you wish to continue the uninstall process right click on the 'Yes' button.



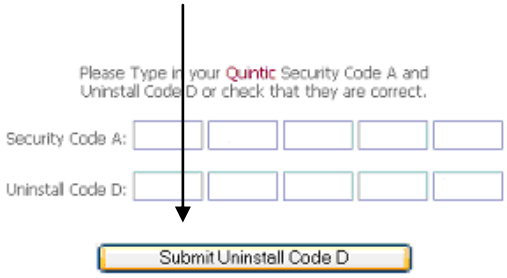
5. The next pop up window that is generated is your final chance to cancel the uninstall process, if you wish to continue right click on the 'Yes' button if you wish to cancel the process right click on the 'no' button.



Ensure that you are connected to the Internet for this next stage.

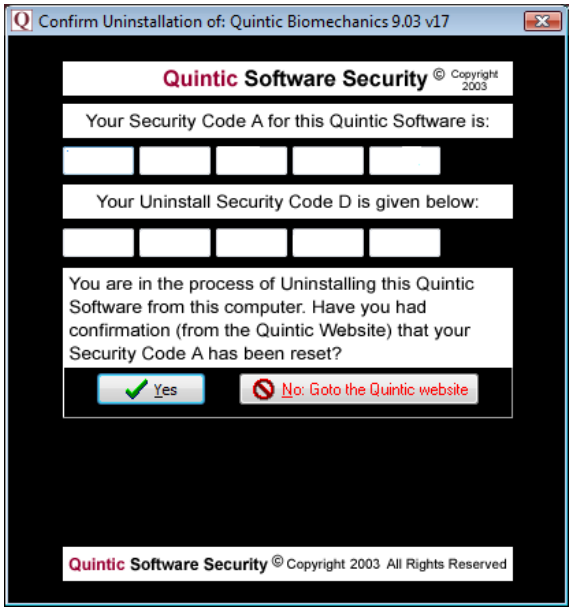
6. Your Quintic software has now been disabled from your computer and will not run. Uninstall security code D has been generated. The generated D code must now be submitted to the Quintic website so that your original A code can be reset so that you may install the software on another computer. This is achieved by right clicking on the 'Uninstall Code D' button or by accessing the website: www.quintic.com/software_security

7. The next window you see will ask you to type in you're Security Code A and Uninstall Code D or to check that they are correct. After this has been done right click on the 'Submit Uninstall Code D' button



8. After submitting you're Security Code A and Uninstall Code D to the website you should receive an email to your registered email account confirming that your Security Code A has been reset if you have received this email right click on the 'Yes' button.

   If you have not received this email after a couple of minutes right click on the 'No: Go to Quintic website button' and follow the instructions.



9. The uninstall process has now been completed and your Security Code A has been reset. You may now install the Quintic software onto another computer. We suggest that you go to START/SETTINGS/CONTROL PANEL/ADD-REMOVE PROGRAMS to delete the Quintic software from the original computer.