Motion Capture using Vicon iQ 2.5

Connecting to the System

Prior to beginning a motion capture session, it is essential to undergo a series of preparatory checks. These ensure the sessions run smoothly and maximise data accuracy. These procedures fall loosely into three categories:

1) **Connecting to the system and configuring the equipment**
2) **Creating a session in the software**
3) **Calibrating (or recalibrating) the system**

1) Connecting to the system and configuring the equipment

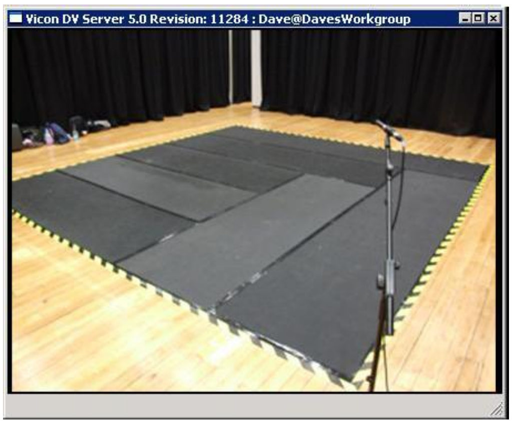
The procedure for setting up the equipment is as follows:

i) Power on the MX control unit and PC and open the Vicon iQ software

ii) Ensure the reference video camera is correctly positioned and focussed on the capture area.

iii) Using an analogue-digital converter to convert the analogue composite video signal into a digital signal, connect the device to the PC using a 1394 interface.

iv) Run the refvidserver application



v) Perform a visual check on the MX13 cameras to ensure their near-infra-red light is visible – if so, the camera is powered and functional.

NB// The functionality of the cameras can also be double-checked using the iQ software under the *Hardware Config* tab of the *Setup* pane **fig i)**

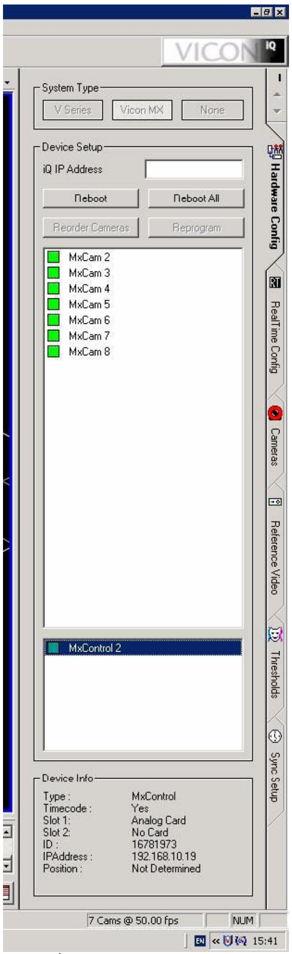
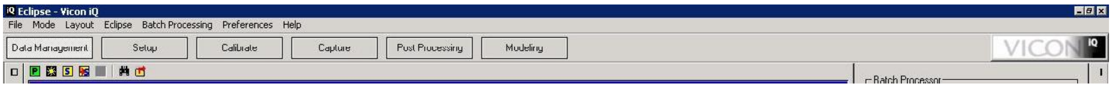


fig i)

Once the hardware has been initiated and the software has been opened, it is important to begin in the leftmost of its top series of panes. Vicon iQ 2.5 has six areas which broadly represent a left-to-right workflow.



Data Management is the area in which new projects are created and organised into capture days, sessions and sub-sessions. This area also provides detailed tabular data for each capture instance (or **trial**) as well as information pertaining to the status of each trial.

Setup is the area of the software where one is able to adjust variables such as camera strobe intensity, gain and circle quality. This section also provides controls for features such as the reference video, real-time engine and visibility thresholds. Setup also features a hardware configuration monitor, which displays all visible hardware.

Calibrate is ostensibly the most straightforward area of the software, but arguably the area which has the most significant impact upon the quality of the final data. As well as providing a streamlined calibration process (details below), this pane allows the user to save out and load in calibrations as **.cp** files.

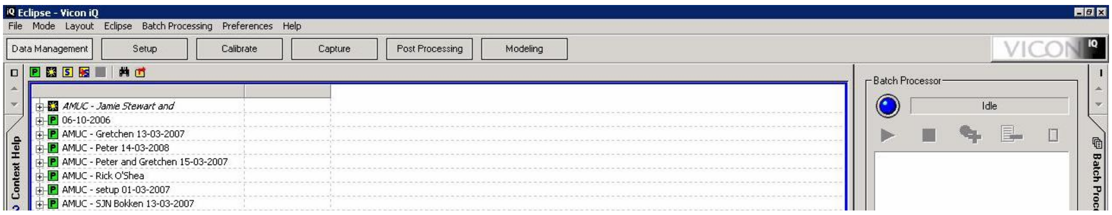
Capture is the area in which the motion capture is undertaken. Prior to capture, the Setup area also allows the user to create objects which can then assist in the labelling section.

Post Processing allows you to reconstruct data, label and edit trajectory data and create and edit subjects, either based on the Vicon Skeleton templates (**.vst** files) , or bespoke models (**.vsk**), which can be created in the Modelling section.

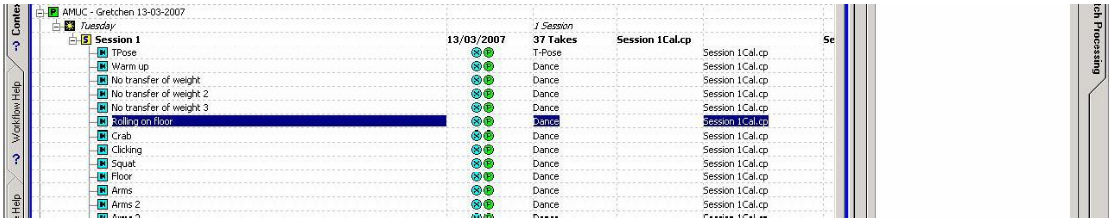
Modeling is an area which is not intrinsic to the motion capture process but does allow an added degree of flexibility in terms of creating (and relating data to) subjects. Modeling allows the creation of rigid 3d objects which can be used to append missing data to subjects at the post processing stage based on predictive algorithms and marker locations relative to adjacent markers. The models consist of **markers, segments, sticks and bounding boxes**. These are then given relationships to each other based on the standard joint-types (or variants thereof): ball and socket, hinge and pivot. The post-processing section can then make use of various additional algorithmic editing tools (**kinematic fits, associated fills** and **virtual points**)

2) Creating a session in the software

For each session, a new project file was created since the temporal distance between projects was such that new calibration files and camera positions were utilised:

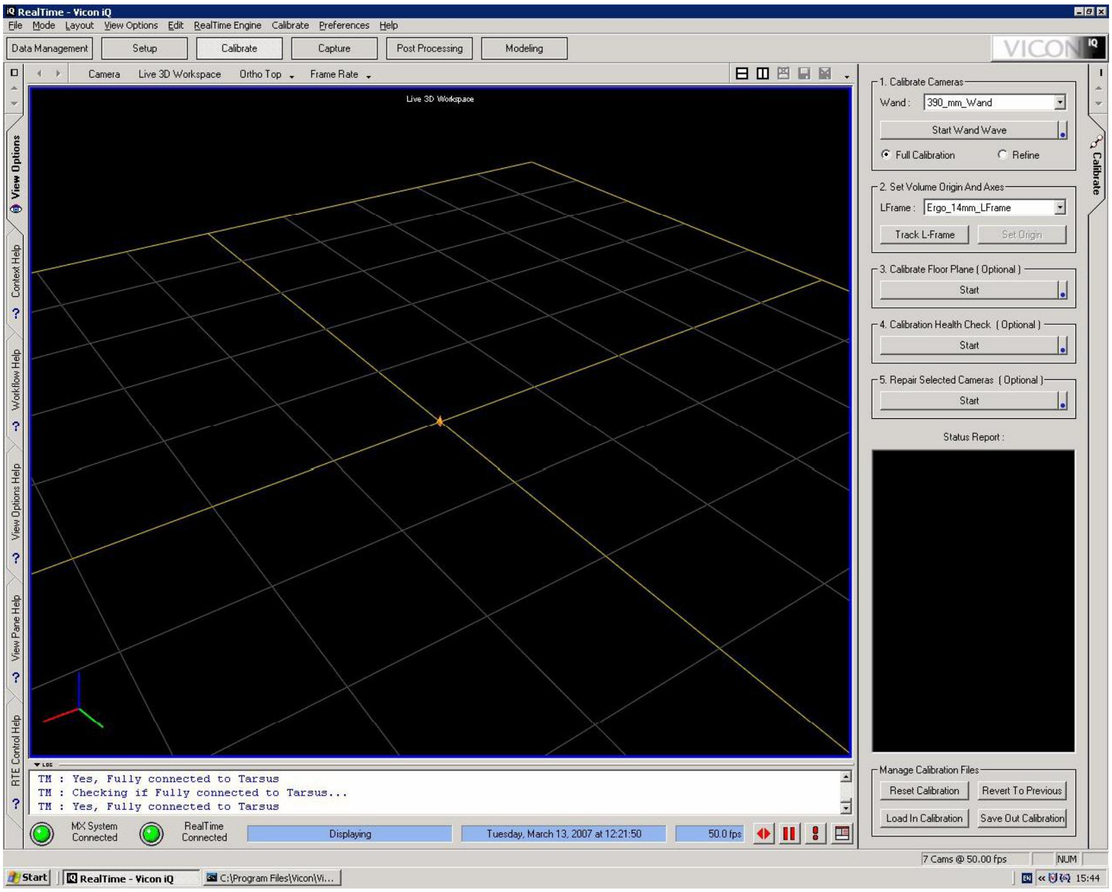


For each project a session is created, labelled with the day the capture took place.

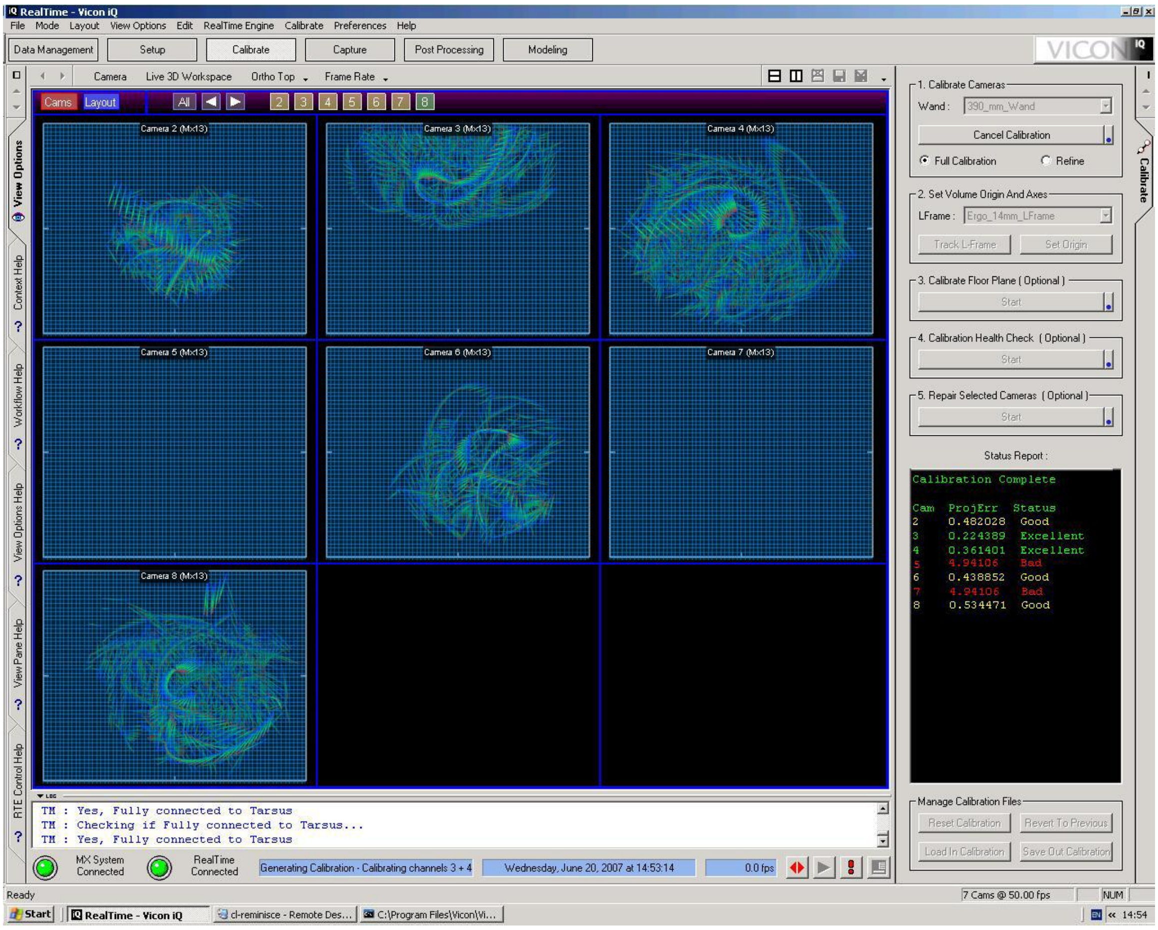


With the session selected, when capturing, files will automatically be allotted into the session folder. Notably, this folder hierarchy corresponds to the Windows hierarchy and the files are thus located in a hierarchy such as C:/Vicon/Users/AMUC – Gretchen 13-03-2007/Tuesday/Session 1/[filename]

3) Calibrating and re-calibrating the system

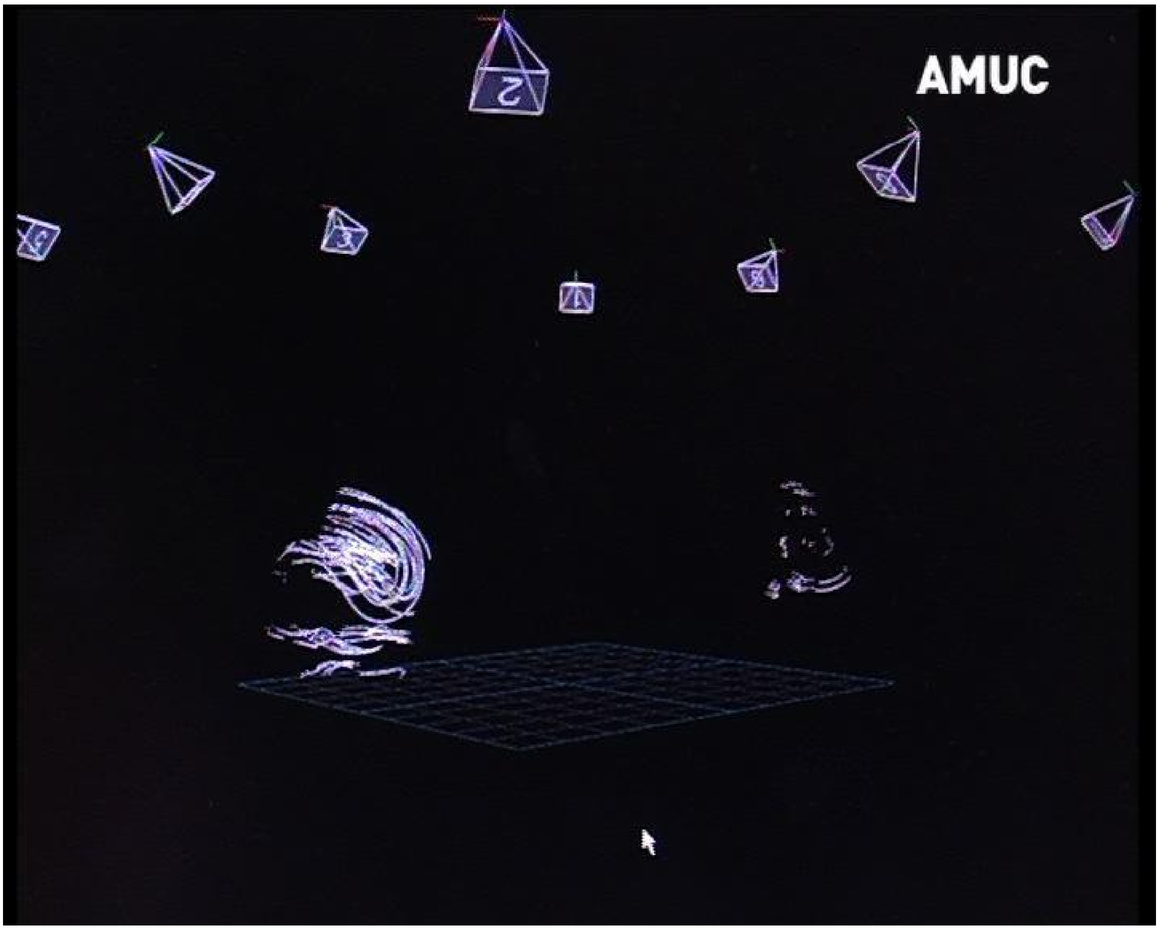


Calibration is required every time the cameras are moved or if the system has not been used for a significant length of time (for this project the cameras were recalibrated prior to each capture session.)



The software is pre-programmed with the positions (relative to one another) of three markers attached to a wand (see image). The first stage of the calibration is the 'wand wave', which allows the software to map the positions of the cameras (again, relative to one another) within a 3 dimensional space. The wand is waved around the capture area and, for each camera, an image similar to those shown above is created plotting the course of the wand. Using a series of algorithms, the software is able to calculate – based on comparisons of the wand positions at each synchronised frame – a 3 dimensional trajectory for the wand and thus, the camera position. This 3d map then becomes the basis for the more complex subject-based capture.

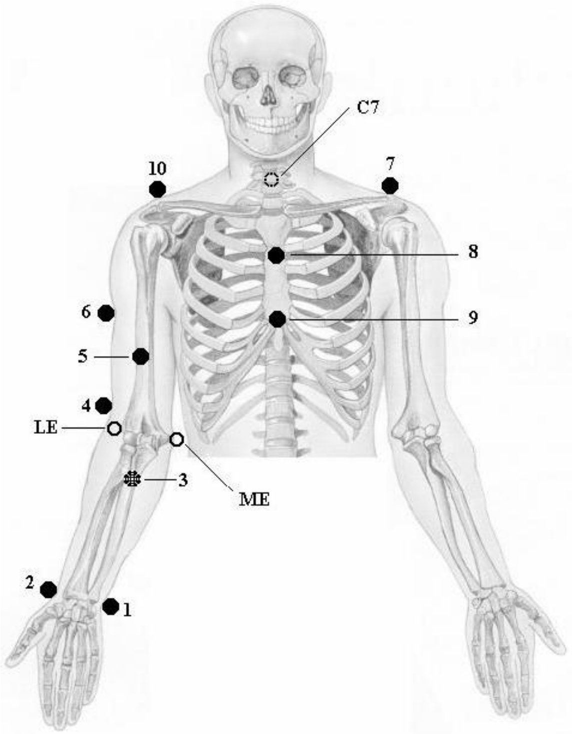
In order to allow analysis of the data relative to the floorspace and to make the reconstructions more recognisable to the user, it is often useful to calibrate the floor-plane. This is acheieved using the 'L-Frame' (see image). This is positioned in the middle of the capture area and the four markers provide a zero-point for the x and y axes, from which a z axis is then created perpendicular and at right andles to the intersection. This, then, positions the floor relative to the cameras and the 3d space becomes ready for live capture (see diagram below).



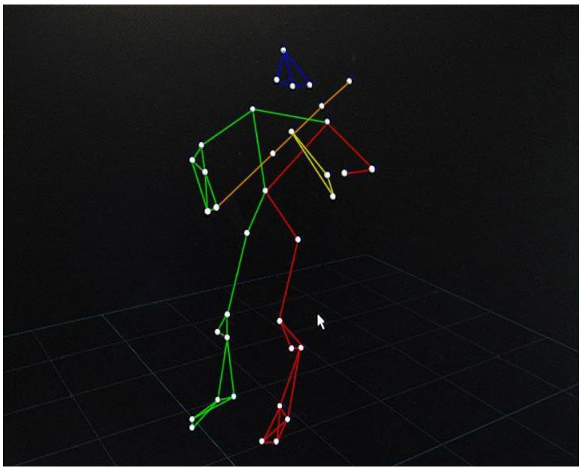
In the event of cameras being moved, the system can be easily re-calibrated using a 'Calibration Health Check'. This prompts another wand-wave, which effectively re-interprets the position of a selected camera relative to the (known) positions of other cameras.

Data Capture

Once the system is initialized and calibrated, data capture can begin. For the upper-body capture we carried out for this project, the following data model was used as a basis:



Marker No	Marker Symbol	Attachment point
1	US	Ulnar Styloid
2	RS	Radial Styloid
3	PU	Proximal Ulna at a palpable point slightly distal to the tip of the olecranon
4	BI	Insertion of Brachioradialis
5	BB	Biceps belly
6	DI	Insertion of the deltoid
7	LA	Left Acromion
8	MA	Manubrium
9	X1	Xiphoid Process
10	RA	Right Acromion
	LE	Lateral Epicondyle
	ME	Medial Epicondyle
	C7	7th cervical vertebrae



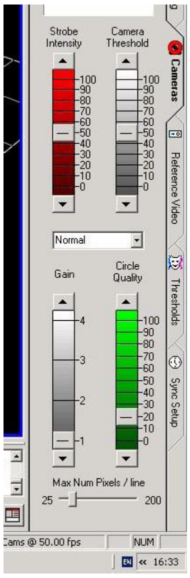
This marker set, when captured, provided results similar to the model shown on the right.

There are two obvious additions in this image which illustrate two minor problematic issues arising from the nature of the sought data – the lower limbs were 'markered' for ease of recognition and to provide a fuller picture of the upper-body movement (perhaps in relation to lower body movement).

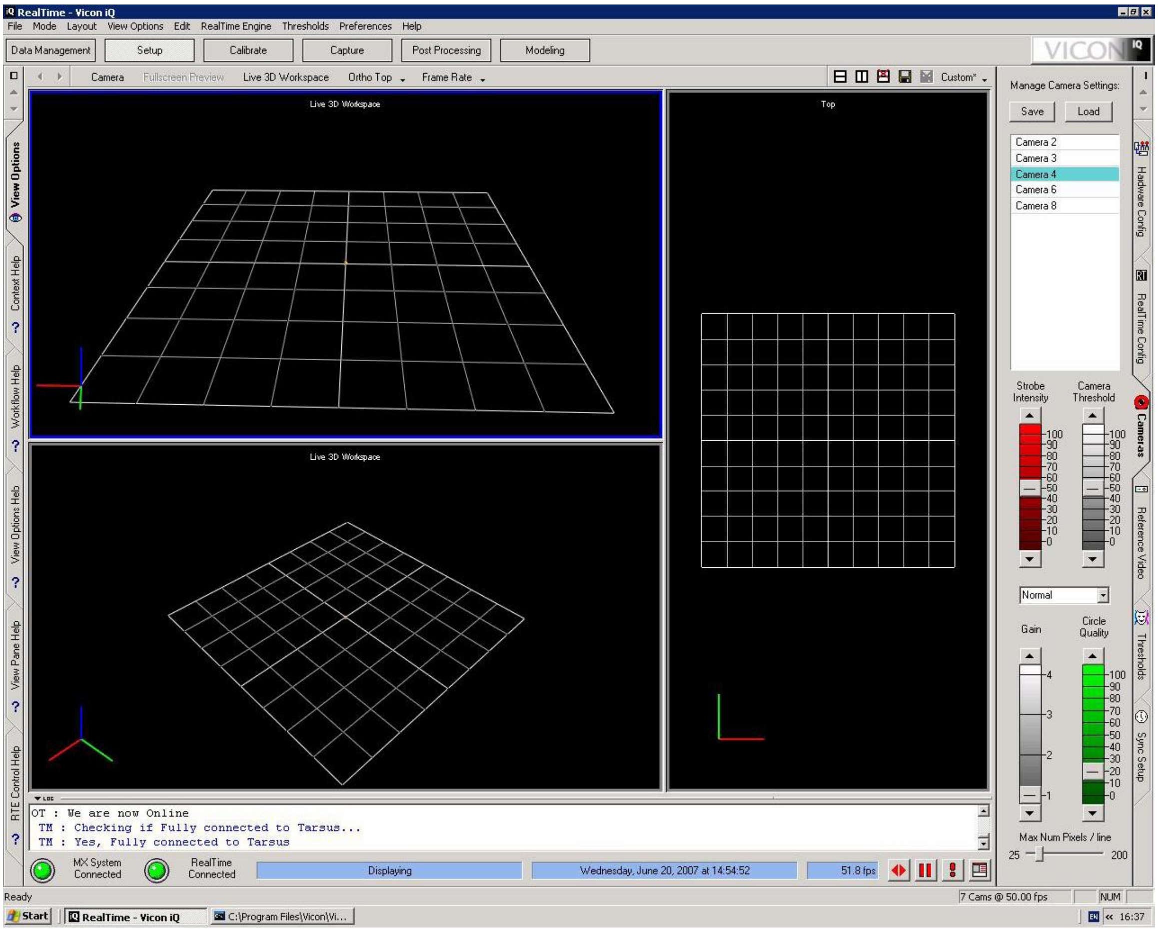
Additionally, for many of the subjects captured during this project, 'props' - a violin (as shown here), juggling balls, clubs, pois etc. were also given markers.

Once the markers are applied to the subjects, upon entering the capture space, the markers become visible on-screen as the real-time engine processes the data.

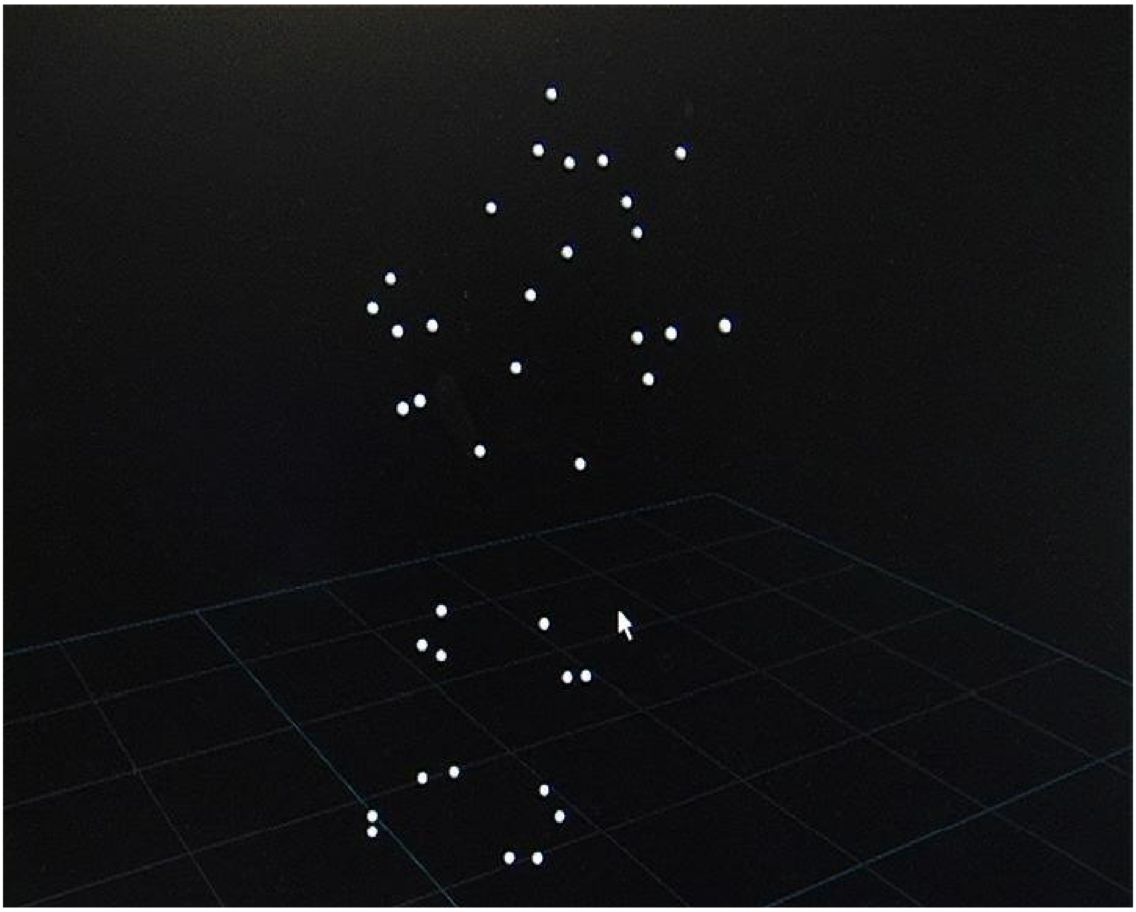
It is sometimes necessary at this point to review (in the Setup pane) the Camera variables as markers can easily become occluded by limbs (exposing one of the weaknesses of optical-based motion capture technology), clothing or other non-marker reflective items in the capture area.

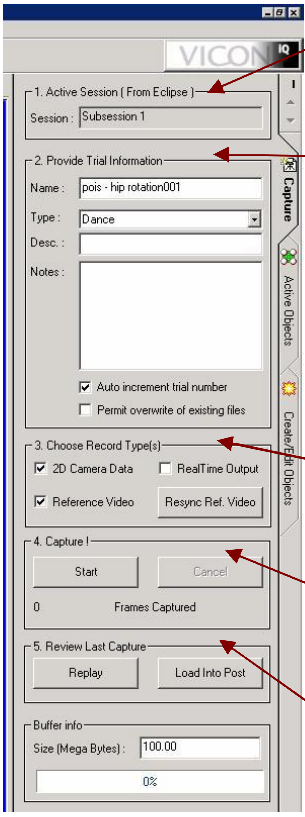


It is possible to view the data in a number of ways, including multiple views as shown below.



The marker data is recreated as white dots. If there are **active subjects**, the real time engine will also link markers with the **segments, sticks and bounding boxes** if a complete set is found. Since the labelling was completed *after* the capture process, the capture subjects appeared as below.





- When ready to capture, the active capture session is shown in the Capture Pane, under the Capture tab – *Active Session (From Eclipse)*.

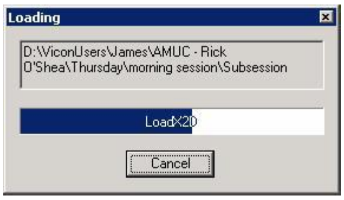
- It is significantly beneficial to the labelling process to include as much information in the *Trial Information* as possible. This provides the raw textual description of the captures. Particularly when capturing repetitive gestures, a simple numbering system is sometimes insufficient. The notes section allows comments such as 'good take', 'bad take', 'drops baton' can improve recognition of data at an early stage and avoid confusion later on.

- Here, the option to record additional reference video is enabled. This requires the aforementioned refvidserver application to be running.

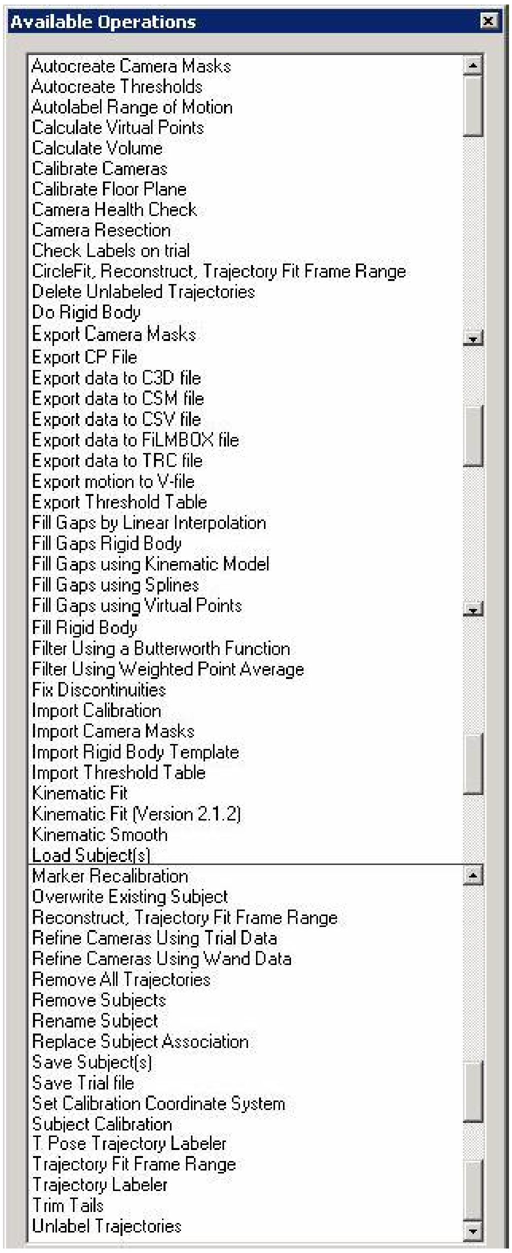
- Here, the capture can begin and the number of frames captured is displayed underneath the Start button. This software captures data at a rate of approximately 50 fps.

- Once the data has been captured, it is possible to review it, or load it directly into post production.

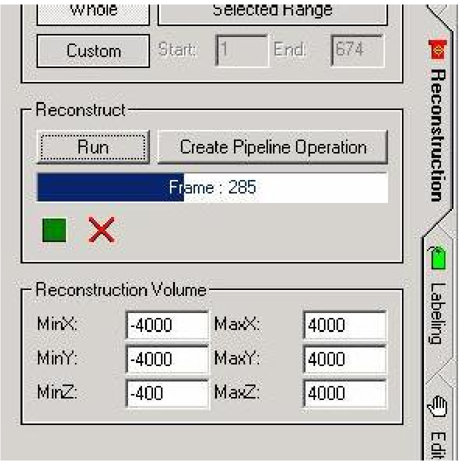
The *Load into Post* button loads the **x2d** data (the raw coordinate data) into an equivalent 3d space to the live space in the Post Processing pane.



Once the data is loaded into postproduction, a pipeline operation can be set up and run on the data. There are a number of pipeline operations (see below), but in order to reconstruct the data at this stage, only the generic 'GeneralReconstruct' pipeline need be applied, which incorporates the 'Circlefit, Reconstruct, Trajectory Fit Frame Range' operation. Pipeline operations can be saved for future use as **.plf** files.

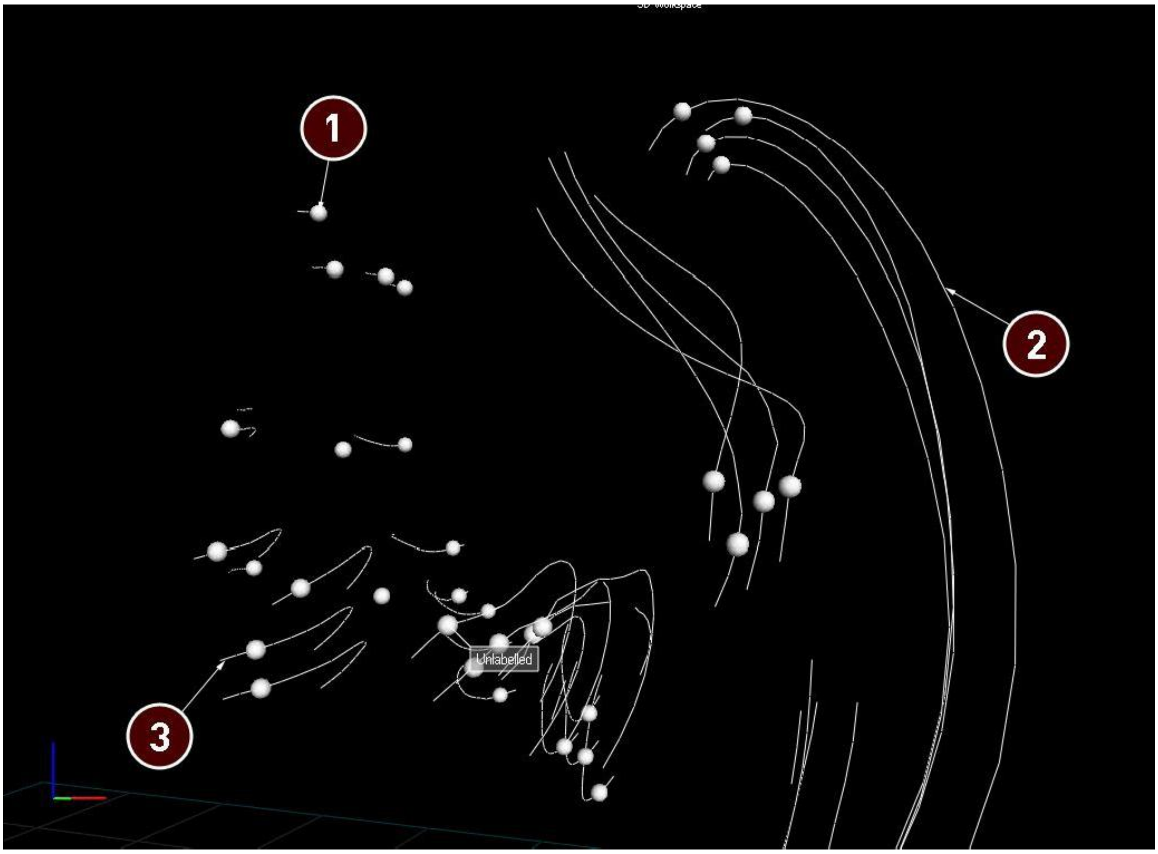


PIPELINE

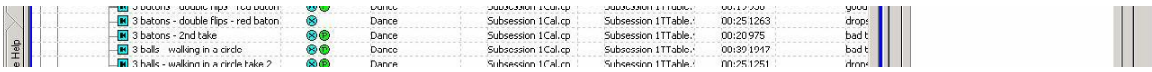


In the Reconstruct tab in post production, the pipeline operation is applied to the most recent data using the Run button. The **circlefit** aspect ensures that the central coordinate of the captured data is used. The **reconstruct** aspect recreates the data by applying the coordinates to a timeline. The Trajectory Fit Frame Range aspect plots the trajectories of the data and buffers the information to allow speed control and predictive and retro-trajectories, as illustrated in the image below.

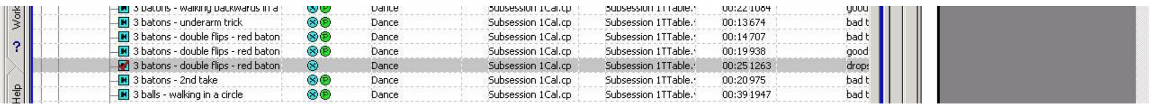
(1) Reconstructed data
(2) Trajectory
(3) 'Predicted' trajectory

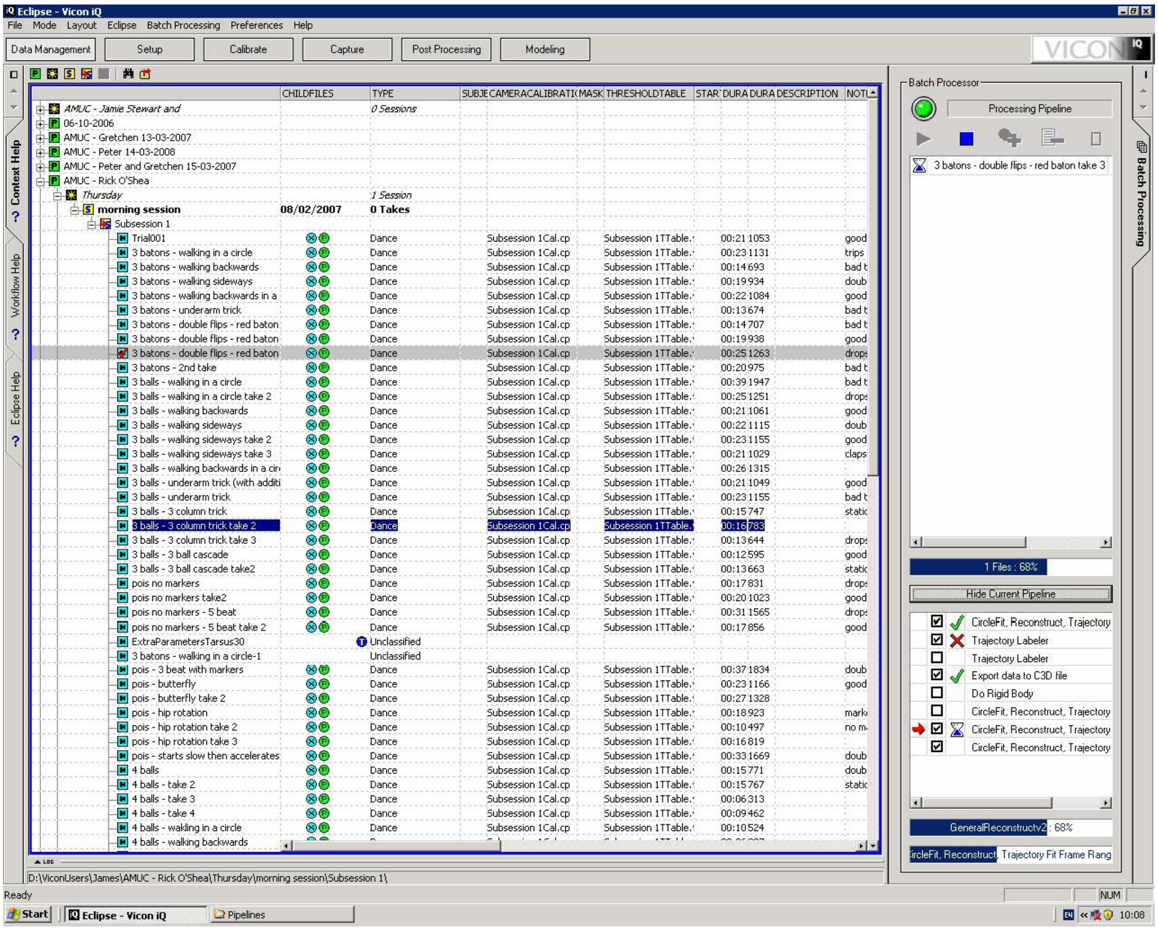


Once the data has been reconstructed, a new icon will appear in the Data Management pane.



This 'X' indicates that the x2d data is available. In order to export the data to the desirable c3d format, each clip is marked and the pipeline operation is set to include 'Export data to C3D file'.





Once the pipeline operation has been completed, multiple trials can be marked and batch-exported to create a unique C3D file for each gesture – labelled automatically with all the metadata input during the capture process.