



The Vicon Manual

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This manual describes the following software and hardware:

- Vicon Workstation software (version 4.2 or higher)
- Vicon Datastation:
 - 460
 - 612
 - 624
 - V6
 - V8i

Intended Audience

This manual is intended for operators of Vicon systems who are familiar with Windows operating system software.

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BodyBuilder, BodyLanguage, DynaCal	OMG Plc

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Introduction

Motion capture is the recording of movement by an array of video cameras in order to reproduce it in a digital environment. This three-dimensional reproduction has many uses:

- Medical assessment of movement disorders
- Understanding of athletic techniques
- Generating lifelike character animation for movies, video games, broadcast and webcast.
- Incorporating motion into virtual environments for engineering design

The Vicon system includes hardware (cameras etc.) and software applications for the complete control and analysis of motion capture. This manual guides the user through the entire process, from setting up and handling hardware through capturing movement to analysing and processing the data.

How Vicon Works

A typical motion capture space comprises an area – the **capture volume** – surrounded by a number of high-resolution cameras. Each camera has a ring of LED strobe lights fixed around the lens. The **subject**, whose motion is to be captured, has a number of reflective **markers** attached to their body, in well-defined positions. As the subject moves through the capture volume, light from the strobe is reflected back into the camera lens and strikes a light sensitive plate creating a video signal. The Vicon **Datastation** controls the cameras and strobes and also collects these signals, along with any other recorded data (sound, analogue signals such as those from force plates for gait analysis). It then passes them to a computer on which the Vicon software suite is installed.

Workstation is the central application of the Vicon software suite used to collect and process the raw video data. It takes the two-dimensional data from each camera, combining it with calibration data to reconstruct the equivalent digital motion in three dimensions. This can be viewed in Workstation as a virtual three-dimensional motion. After this reconstruction the data may be passed to other Vicon applications for analysis and manipulation or to third party applications such as those used for digital animation or virtual environments.

Your Vicon System

Several systems are currently available from Vicon Motion Systems Ltd. They differ in their appearance, the number of cameras that may be used and the software. Your choice of system will have been influenced by the type of work you intend to do.

- Datastation** The Datastation controls the cameras and in turn sends data to the Workstation PC. In appearance it resembles standard desktop or upright computers. The system name is clearly labelled on the front of the Datastation case.
- Cameras** Vicon supplies a number of camera types for motion capture. Examples are the MCam series and LCam used for small volume work. Note that you cannot use third party cameras with a Vicon system and you cannot mix different camera types in a system.
- Software** Your Vicon Software Suite installation CD includes all available Vicon applications. The licenses you have purchased are controlled by the Dongle included and this should be plugged into the parallel port of your controlling PC.

The following may be included with your system:

Workstation

Workstation is the central application for motion capture. In addition to providing the control interface for your system it includes tools for editing and clean up of motion capture data.

BodyBuilder

BodyBuilder provides advanced editing of and modelling tools. It allows you to create your own kinematic and/or kinetic models. Vicon supplies example models for biomechanical analysis. Vicon also supplies animation models for creating Acclaim skeletal and motion files for import in to many of the common animation packages.

Polygon

Polygon is a multimedia reporting, analysis and presentation tool. It is similar to a web-authoring tool but allows the inclusion of all Vicon data e.g., reconstructed three-dimensional motion, interactive graphs and so on.

Plug-in Gait

Plug-in Gait is a sample Vicon 'Plug-in' that you receive when you purchase Polygon. It is used in the modelling of all kinds of human movement including gait, dance and sporting activities, etc.

Plug-in Modeller

Plug-in Modeller is a sample plug-in that allows you to run BodyBuilder models directly in Workstation. A sample model included with the Entertainment version allows you to create Acclaim Skeleton and Motion files from your motion capture data. If you have created models using BodyBuilder then you can use these with Plug-in modeller, saving you time.

Mobius

Mobius is an artistic tool for the manipulation of Acclaim formatted motion capture data. It includes a range of tools for skeletal adjustment and motion composition facilities.

Workflow

How you use the Vicon system depends mostly on the type of work you do, and to some extent, where you do it.

Whatever the system you use, you will still have the same general components and you will set these up and use them in much the same way. Some of the ways you work with one Vicon system, will differ - with differences being more apparent as you use more advanced methods and export the data to other applications.

In most cases you will start by considering the type of motion capture you intend to perform and the space you have available. You may have a permanent laboratory or studio with fixed cameras or you may have to change location every day. You will:

- Set up and connect the equipment, install the software
- Check all the connections are correct and that the system is working correctly
- Decide what movements are going to be captured
- Set up the data management system (Eclipse) in order to keep all of your data well organised
- Position cameras to cover desired capture volume while maintaining appropriate overlapping regions
- Calibrate the system.
- Prepare subject by taking any necessary subject measurements and then attaching the desired marker set.
- Make use of the Autolabel feature by calibrating the subjects
- Capture your data.
- Process and Edit the data
- Possibly model the data
- View the data
- Save and export the data to other Vicon or third party applications

This Manual

The layout of the Vicon Manual reflects this general workflow. It is divided into a number of sections. Each chapter in these sections is dedicated to a self-

contained task. Most chapters describe what you will do – a kind of tutorial system. Where it is important to understand underlying principles some chapters will be descriptive, in preparation for a task that follows.

Towards the end of the manual we include a reference section. This gives important information about the system and a problem solving section. The sections are described in more detail below.

Preparation	Everything to do with getting your Vicon System up and running: includes a description of the various parts, making the connections, what the software does and checking the system is working.
The Essentials of Motion Capture	A step-by-step guide to the basics of motion capture: setting up, handling data, preparing your subject, calibrating the system and – motion capture. Other essential steps are the cleanup and processing of your data and automating your work.
System Options	This section describes some optional features of the Vicon Motion Capture system: <ul style="list-style-type: none">• Analogue capture, e.g., using force plates or EMG• Audio capture• Timecode and Genlock• Movie Capture• Using Real-time• Using Plug-ins
Advanced Capture Techniques	Some advanced techniques: <ul style="list-style-type: none">• Capturing multiple subjects• Capturing in small volumes – with examples for facial and hand capture
Vicon Reference	A comprehensive reference including keyboard short cuts, flow chart guides for motion capture scenarios, glossary and file type definitions.

Technical Support

In some cases where you do not find a solution using this manual there are two support options available:

- Visit the Vicon support Web site <http://support.vicon.com>

On registering to use the web site you will gain access to all the latest support information and solutions.

- Call a Vicon support engineer
- Email support@vicon.com

Some Vicon Terminology

Although this manual includes a comprehensive glossary it will be useful to become familiar with a few important terms before you start using the system.

Datastation and Workstation

The Datastation is the hardware component that controls the cameras and captures the data. This is the box labelled with the name of the system you are using, for example V8i or 612. Workstation is the software running on the PC that controls the Datastation – for this reason the PC is sometimes referred to as the Workstation or (more clearly) the Workstation PC.

The Workstation PC is connected to the Datastation using a simple network connection, the Datastation to the cameras by a system of cables.

Cameras, Strobes and markers

The strobe is a circular set of light emitting diodes that fits snugly around the lens of an individual camera. Markers are reflective spheres attached to the body of the subject (the person, animal or whatever else) whose movement is to be recorded. Light from the strobe is reflected by the markers back into the camera. A filter ensures that only light the colour of the strobe (red or infra-red) is allowed to strike the light sensitive plate behind the lens. As such the camera converts the light into a video signal that is processed in the Datastation and then transferred to the Workstation PC for reconstruction.

Eclipse

Vicon's data management system is called Eclipse. Motion capture produces several data files, raw video data, processed (three-dimensional) data, movie data and analogue data. In addition the system uses several files – to hold data about the system, calibration objects, camera calibrations and so on. Eclipse allows you to manage all of these files. Eclipse is accessed through the Data Directory window.

Sessions and Trials

Within the data hierarchy used by Eclipse the levels are called Nodes. The most important of these are Sessions and Trials. A Trial is the name given to the data capture process and the group of files in which the data is stored. The amount of data captured depends on the speed of the cameras you are using, the length of time taken for the capture, and the kinds of data you ask the system to capture.

A session is in reality a folder on your hard drive containing a group of trials and all the system files associated with them. This allows you to recreate everything that went on in your studio or laboratory, just as it happened on the day of capture, at any time in the future. The name has been chosen to reflect what goes on in real life, a session being a single group of captured movements –

though you can create as many sessions as you wish at any one time.

Capture Volume and Calibration

The Capture Volume is the space in which the subject will move. Calibration is the process that linearises each camera and measures each camera's position relative to the others. The calibration data is used in the reconstruction process to create the virtual three-dimensional motion in Workstation.

Live Monitors

During data capture the Datastation generates and then uploads the coordinates of each marker. This is stored in your trial but can also be viewed in real time using the Live Monitor window in Workstation. This is a very useful diagnostic tool, allowing you to select the view from any camera and see the two-dimensional representations of the markers. For example you can visualise how much of the Capture Volume can be viewed by each camera, optimise camera sensitivities and strobe intensities and see whether there are any extraneous sources of light or reflections reaching the selected camera.

This view should not be confused with the Real-time feature available as an option with selected systems. You can read more about this option in the Advanced Motion Capture chapter.

Reconstruction, Trajectories and 3D Workspace

Reconstruction is the calculation of the three-dimensional position of each marker in each frame. Workstation does this using the two dimensional data from each camera, calibration parameters and a user defined set of reconstruction parameters that depend on the volume and the type of capture.

A trajectory is the path of a marker during the trial. Workstation calculates the trajectories by joining the positions for each marker from frame to frame. These are displayed in a window within Workstation called the 3D Workspace. You can view the motion as a number of unlabelled markers (white dots), create simple stick figure to represent the subject and view the trajectories over any specific number of frames. In addition the 3D Workspace window allows you to view the motion from any angle and zoom in and out by clicking and dragging the mouse.

Labelling

Although the eye can distinguish markers and trajectories, they are essentially meaningless for analysis until they have been identified. This identification is a two-step process. You must first manually label each marker once for each subject. You can then create an "Autolabel Calibration" that can be used to label the markers in your other trials automatically.

The Autolabel Calibration looks for consistent patterns amongst markers. You can create your own marker sets that can utilize the Autolabel Calibration feature for any type of subject or capture.

Real-time

Real-time is an additional feature that may be purchased with your Vicon system. This performs reconstruction of data in real time so that the motion can be viewed in the digital environment directly. This is excellent for instant feedback for biomechanical retraining and visualisation of animation scenes. Real-time needs additional hardware and software components.

Vicon Hardware

Before setting up it will be useful to familiarise yourself with the Vicon system components. The actual numbers and types of certain component will differ depending on the system you have purchased. This chapter covers the most common Vicon components needed to run your system.

The minimum Vicon system consists of the following major components:

- Vicon DATASTATION
- A host WORKSTATION PC
- A 100 base T TCP/IP Ethernet network connection
- Camera units with interfacing cables
- System and analysis software
- Dynacal calibration object
- Accessories kit
- Tripods or other camera mounting devices

There may be additional hardware and enhancements depending on the system you have purchased. These may include hardware for the interfacing of Video Tape recorders, GenLock, analogue or audio channels and a synchronised colour video channel.

A quick tour of the hardware

Full details of the hardware are given in the Hardware Manual (included PDF format on your installation CD). Here we provide a short description of the main components.

Cameras and Strobes

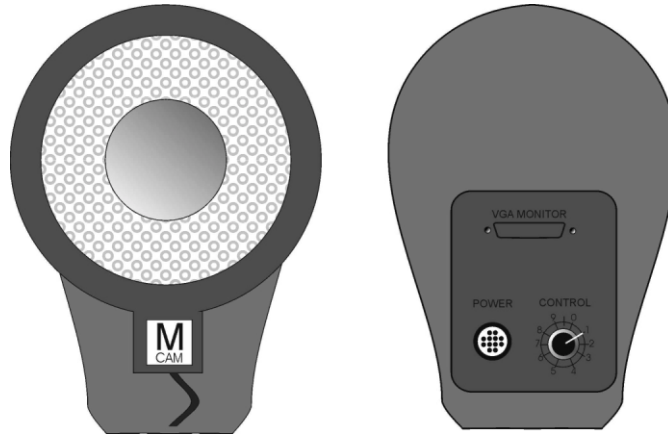
The camera and strobe unit is the part of the Vicon system that collects light from the reflective markers on your subjects. The strobe emits light in time with the camera, illuminating the retro-reflective markers attached to the subject. The markers reflect light straight back to the camera where they pass through a filter that allows only light of the same wavelength through to be focussed on the camera's sensitive plate.

The camera and strobe are separate units. On our M-Cam the strobe ring fits around the lens, being held in place by a magnetic strip. The strobe connects electrically via a short flying lead. Plug the lead into the socket on the front panel.

Two types of strobe are available, **visible** and **infra-red**. In the case of the infra-red strobe you must exercise some caution. Prolonged, direct exposure of the

retina of the eye to infra-red light can be hazardous. Please do not look straight at the strobe for long periods of time when it is on (as indicated by a small green LED at the top of the strobe).

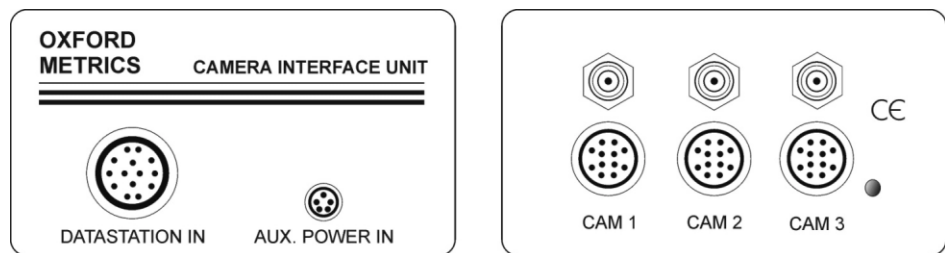
THE MCAM2 STYLE OF CAMERA,
FRONT AND REAR PANEL



Camera Interface Units

The cameras are connected via Camera Cables to Camera Interface Units, (sometimes called Break Out Boxes or BOBs). The Camera Interface Units combine the signals from three camera channels so they can be carried via one 14-pin trunk cable to the Datastation. The front panel of the BOB has three pairs of sockets labelled CAM1, CAM2 and CAM3. In MCam type systems each pair of sockets links to one camera. The 12-pin socket carries power and synchronising signals to the cameras. The phono socket takes video signals from the camera back to the Datastation. The 14-pin cables from the BOBs to the Datastation come in fixed pairs. In MCam 2 systems a single cable links the Camera Interface Unit to the camera.

SCHEMATIC DIAGRAM OF THE
CAMERA INTERFACE UNIT

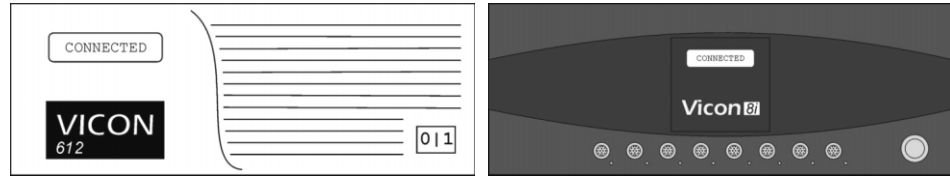


Datastation

The Datastation controls cameras and analogue devices used to capture data. It is the essential link between these and the computer used to process the data.

The Datastation resembles a personal computer without a monitor and is labelled with your system version number. The Entertainment and Animation series are black; the Science & Engineering series (612, 460) are white. The connectors may be on the front panel or the rear.

SCHEMATIC DIAGRAM OF THE CAMERA INTERFACE UNIT



Below are examples of some of our systems of the different systems. Note that configurations may be different depending on your particular system.

TYPICAL SYSTEM HARDWARE SPECIFICATIONS

System	Primary use	Max. no. of cameras
460	Science and Engineering	6
612	Science and Engineering	12
624	Science and Engineering	24
V6	Entertainment / Animation	6
V8i	Entertainment / Animation	24

Workstation PC

Workstation is the software application for controlling the Datastation and the data capture process. It is also a common name used for the PC on which it is installed. You may have purchased this from Vicon Motion Systems Ltd, or you may be using a computer of your own. The Workstation PC should be linked through a network to the Datastation. You will need to have Workstation software installed on this computer. The software license is controlled using a dongle plugged in the parallel port of the PC.

Software

All control and analysis software is included on your Vicon Installation CD. However, you will only be able to run the applications that are licensed in your Dongle. The table below briefly describes the purpose and uses of each application.

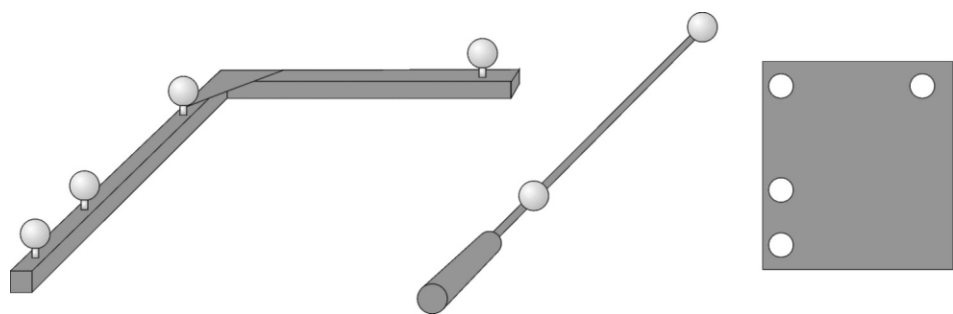
THE VICON SOFTWARE SUITE,
MAIN COMPONENTS

Application	Primary use
Workstation	Control of Vicon system; calibration, data capture, data management, data reconstruction, basic data editing
BodyBuilder	Advanced data editing and modelling
Polygon	Multi-media presentation, analysis and Reporting tool – allows development of presentations using all Vicon data including reconstructed three-dimensional motion.
Mobius	Acclaim formatted skeletal and motion composition such as blending separate moves into one motion and transforming the motion of a performer onto a different size or shape CG character.
Real-time	Allows user to reconstruct, label, model and view motion data in real time.

Dynacal Calibration Objects

Calibration of the Vicon system is one of the most important steps in capturing motion and recording data. Calibration allows the system to define the capture volume and the relative positions and orientation of the cameras. This information is then used with the data from each camera to create the three-dimensional motion on your computer – a process called reconstruction.

TYPES OF CALIBRATION OBJECT:
L-FRAME (LEFT), WAND (CENTRE)
AND FLATCAL (RIGHT)



There are two types of calibration: static and dynamic:

Static calibration is used to set the origin and the direction of the axes. The L-Frame and FlatCal are used for static calibration, the former being used for full

body capture, the latter for small volumes. They both have an L shaped arrangement of reflective material, three on one arm and one on the other. The L-Frame is transported as separate arms and should be constructed when needed using the locating pins and thumb screw. The clinical version of the L-Frame includes alignment devices so that the frame can be aligned accurately with force plates positioned in the floor.

Dynamic calibration is used to calculate the relative positions and orientation of the cameras. The dynamic calibration object is called a wand. For medium and large volumes this is a rod with two 50mm reflective balls placed 500mm apart. For small volumes use the rod with 14mm spheres 100mm apart.

The act of dynamic calibration involves moving throughout the capture volume, waving the wand so that it passes through as much of the Capture Volume as possible allowing each camera to record the wand in several orientations.

APPROXIMATE DIMENSIONS OF
CALIBRATION OBJECTS

Object	Length
Large Static or L-Frame	104cm
Small Static or L-Frame	~50cm
Facial	28cm
Large Wand	500mm (large markers)
Small Wand	100mm

For static calibration objects the length given is that with the single marker.

Accessories Kit

This includes all the additional equipment needed to use your Vicon system. These include:

Vicon Markers

Retro-reflective markers come in various sizes from 25mm spheres down to 3mm hemispheres (used for facial or small subject captures). Also included are soft hemispherical markers, useful for movements where subjects may contact each other, the floor or other hard surfaces.

Spare Marker Material

Spare marker material is used for repair and recovering damaged markers. You can also order spare marker sets from Vicon Motion Systems Ltd. or one of their agents.

Adhesive Tape

Your kit includes special tape for attaching markers directly to the skin without creating an allergic reaction.

Camera Number Labels

By virtue of the order of their connection to the Datastation cameras are given

an identifying number. Externally the cameras appear identical so these labels will help you identify each camera after they are connected.

Cables

For connecting the various parts of your Vicon system. Includes:

- **Video monitor cable** (beige in colour) for connecting a monitor to your Datastation or camera. Although not necessary in general use a monitor can be useful in fault diagnosis
- **Straight Through 100 base-T Network Cable:** For connecting the Datastation to a network hub or switch.
- **Cross-over 100 base-T Network Cable (grey):** For direct connection of your Datastation to Workstation PC

Tool Roll

We include a set of tools to help ensure that the system is always running to specification.

Gaffer Tape

General purpose gaffer tape can be used for anything such as marking out the capture volume on the floor of the studio or lab. Whatever you use it for do not use gaffer tape to try and fix markers to subjects!

Additional Parts

The plastic parts are used to build marker assemblies for custom marker attachments. The kit includes such items as adapters and ball joints.

Velcro

Velcro is typically used as part of the marker kit, to attach markers to clothing.