Gait Lab Construction Guidelines

Updated February 20, 2011

The following is a list of general guidelines that Motion Lab Systems recommends for consideration when a 3D Gait or Motion Analysis laboratory is built or planned. This document is intended as a guide only although it draws on our experience of helping plan and setup more than thirty labs in the last ten years. Remember that every lab is different and that a solution that works well in one laboratory will not necessarily work well in another environment. These construction guidelines are not specific to any motion capture system manufacturer. It's a good idea to check with your motion capture system vendor for any specific requirements and always talk with other people running similar labs for their recommendations. Some pictures of Gait Lab environments can be found here and our links page has many gait and motion lab web sites.

The Analysis Area

We recommend an area at least 30 feet wide by 35 feet long with ten foot ceilings to allow flexibility in your camera positions. If you intend to study sports activities then you will usually require a larger area. For example, studies of runners will require longer areas while pitching or the high jump will need higher ceilings. The ceiling height will need to be increased to 15' or 45' if the lab plans to conduct studies of stair climbing or pole vaulting.

In any event the room cannot be narrower than 20 feet or shorter than 30 feet. If the room is larger but contains any columns then this minimum area must be completely unobstructed and free of columns, book shelves and storage cabinets. If the cameras are to be mounted on the walls then the walls will need to be of a solid construction. They must not vibrate or shake from any source such as heavy machinery in the next room or a door closing. Do not install mirrors in the lab and reduce the use of reflective items such as shiny door knobs and metal plates around switches and wall power outlets.

The Gait Lab Floor

A raised floor using computer tiling is preferable if you use a high quality floor tiling system. This provides for space to run cables and distribute AC power without resorting to placing conduits in the walls and ceiling. Note however that good quality computer flooring that does not squeak or move is expensive and that a cheap floor will cause more problems than it solves. If cost is an issue then you may want to simply raise the floor and install a false floor about 6 to 8 inches above the base floor so that the force plates are easily accessible. You must use a matte tile or linoleum to surface the floor to reduce reflections from the camera strobes. If static electricity is a problem in your area then you may wish to consider a conductive floor covering.

Conduits and Electrical Outlets

You cannot set the optimum position for video cable conduits in the wall until after the system is installed and camera positions have been established. Regardless of what a system manufacturer may claim - it is not possible to find the optimum camera locations until the lab has been in operation for a while. Consequently, it is a big advantage to use raised computer flooring to allow you to move cameras and other equipment to optimum positions within the lab. If you choose a raised flooring system then make sure that it is solid and that the tiles will not move or make a noise as the subject walks over them. Local electrical safety regulations may affect your choices. If conduits are to be placed in the wall, you can position the video cable conduits and electrical outlets in the following manner to provide comprehensive coverage. You will need at least one electrical outlet (110-120V) every six to eight feet. Dual electrical outlets are preferable. You will need to position AC power outlets next to the video cable conduits for the cameras. The power requirements for the lab are usually quite modest and a single electrical service will normally suffice. If other large equipment is used in the lab (such as treadmills etc) then we strongly recommend that it be powered by a separate AC power service.

If you have the room or an area of the lab reserved for the computers then you will need to provide more power outlets there and bring all the video cable and force plate conduits to that area. Ideally these conduits will terminate in a room opening off the main lab area. If the computers are to be placed in the main lab area then place them on one of the long walls of the lab, about a third of the way along. You should provide camera cable conduits (minimum 1.5-2.0 inch diameters) beginning at two feet above the floor surface. About eight of these will provide the maximum flexibility in positioning the cameras - place one close to each corner of the room and one in the center of each wall. Many modern system provide facilities to support more than eight cameras - if you anticipate using additional cameras at any point in the future then you will need to install additional conduits and cable facilities.

The conduits will all need to lead to a central location where the users plans to position the data collection system. Remember that the conduit down to the data collection system must accommodate all the cables - this will need to be at least four to five inches in diameter. A good rule of thumb is to specify all conduits to be at least 50% larger than your initial estimates to allow for future expansion. A second option for cable conduits is to provide pits (two feet square) in the floor in the locations of the anticipated camera positions. These pits may be used to store the camera power supplies, AC power outlets, spare cable etc. Each pit will need a conduit for the video cables to lead to a central location where you position the data collection system. An alternative to conduits is to use a "removable" baseboard around the whole room and run the AC power and video cables behind the wall baseboard. Many modern 3D systems now use a central power supply to provide power to the cameras and this may easy the lab design, allowing you to use smaller conduit and reducing the AC power outlet requirements. However, plan for the future - it's much easier to build a lab with additional conduit and AC power outlets than add then at a later date.

Force Plates

Almost everyone places the force plates in the middle of the gait lab area so that all the data collection cameras can see them. If the gait lab is on the ground floor, we recommend that you mount the force plates on a ten-foot square concrete slab that is at least five inches thick. If you are mounting the force plates in the floor, then a pit needs to be provided that is deep enough for the force plates. Check with the force plate manufacturer for the exact depth required. This must also be wide enough to provide flexibility in placing the movable plates and access to the signal cable connectors for force plates. The pit should be clean and dry.

You will need to construct a cover for the pit (around the force plates) after you install the force plates. This cover should be flush with the floor surface so that any walking aids will not catch on it. If you are mounting the plates under a raised computer floor then you'll need to make sure that the plates lie in the centerline of the floor tiles so that the floor supports are clear of the force plate mounting platform. If it is not possible to construct a pit then you can mount the force plates on the floor surface and either build a raised walkway or use a computer floor. A conduit for the force plate cables needs to run from the pit to the area chosen for the computers. This conduit must be four inches in diameter with no sharp bends so that you can run the force plate signal cables through it without problems. The conduit must enter the force plate area at the edge of the pit or via a side wall.

Most force plates do not require AC power within the force plate pit area although placing an AC output under the floor in the force plate pit is occasionally convenient and highly recommended if you are in the basement of a building and there is any possibility that the force plate pit may be damp. Contact the manufacturer of your force plate for specifications about your plate and further recommendations for mounting the plate. Always check that the surface of the force plate will be flush and level with the finished floor when the lab has been completed.

Ceiling

The ceiling should be a tiled suspended ceiling, and may need to support a metal frame or butterfly hooks to hang a calibration object if you plan to use a static calibration object. If used, the metal frame should have several cross members and cover the anticipated calibration area with holes every six to twelve inches to support the calibration objects. This will provide some flexibility in adjusting the width and

length of the calibration volume that helps position the cameras for a good field of view. If the lab intends to use a safety harness then you should install crossbeams in the ceiling perpendicular to the length of the lab. The optimum arrangement is one beam above the center of the calibration volume and two beams positioned five feet on either side of the center beam. Many 3D system now support dynamic calibration and do not require a static calibration object but it is occasionally useful to be able to visually define the calibrated data collection volume with hanging rods or strings.

Lighting

Provide for control of the lighting in the lab. It should be possible to turn off any lights directly over the calibration volume and still leave a reasonable lighting level in the lab. Being able to dim the lighting levels around any computers to reduce screen glare is also very useful. It must be possible to turn off any incandescent lights and still maintain a reasonable lighting level in the lab. We recommend recessed fluorescent lights with diffusers. This may make it necessary to provide more lights in the area than if normal surface fluorescent lights are used. No lights should be directly over the calibration volume area. Light switches should be near the entrance door and may be duplicated by the motion capture system control area.

Windows

No skylights should be placed in the gait lab area. If windows are placed in the lab, you must provide a method for covering the windows to totally block out light (i.e., black drapes).

Patient Examination Area and Facilities

You should attach these areas to the subject analysis area so that the subject can be prepared and moved directly into the lab without passing through any public area. You will need a patient examination area with an examination table and storage for supplies such as tape, markers, electrodes, etc. This area is often used as patient changing area. A wheelchair accessible bathroom with a sink needs to be close to the lab. If this area opens off the lab then it can also be used as a changing area.

Other Points

The main door to the lab must be wide enough to allow easy wheelchair access. Try to keep additional entrances at a minimum and make sure that you can lock all entrances. If any doors can open directly into the lab, recess the door and plan a curtain in front of the door for patient privacy. If you anticipate having the subjects' parents or guardians attending the testing then you will want to allow for some extra chairs and an area where they can comfortably wait.

If you are working with children then plan on having a small area with toys where young siblings can play while their brother or sister is tested. If you are working with children then try and make the whole lab area friendly and comfortable for them with stuffed animals and murals so that your subjects will relax during the testing or studies.

Many gait related tests are performed with a minimum of clothing on the subject so it is important that the laboratory area is maintained at a comfortable temperature for the subject during the testing.

Consoles and Desk space

A console or desk space of some sort is necessary for all the computers and peripherals used in the gait lab. Most labs will need at least two 60" desks as a minimum. The following equipment is likely to be positioned on, or very close to, the desk:

- Computer and monitor (17" or larger).
- Color printer (large printers and inkjet printers may require a separate table)
- A force plate amplifier for each force plate (can be rack mounted if specified when the order is placed)
- An EMG system or live EMG display (another PC and monitor).
- Optional third-party video equipment - a video mixer, live camera monitors etc.

We have found the "Iceberg Enterprises Aspira Modular Workstation" furniture (formerly "WorkManager" by Rubbermaid) to work well in typical gait lab situations. This modular furniture is lightweight, sturdy, versatile and provides covered channels for cable management at an affordable price. You will also need several chairs - remember to provide chairs for visitors as well as the people working in the lab. We recommend good quality office chairs with casters.

Video Equipment

We recommend that optional video equipment, such as VCRs, Camcorders, monitors and mixers are purchased locally wherever possible. Overall you will obtain better support for your video subsystems through a local dealer in this constantly changing market.

Computer Network (LAN)

It is important to plan for the computer network when the lab is built. While it is possible to use a number of different LAN types we recommend 100MHz "Twisted Pair" with a local hub or switch for the best reliability and speed. Since virtually all the computers and printers in the lab may be connected to the LAN network it is important to provide plenty of LAN connections within the gait lab and any connecting offices or work areas. Make sure that LAN cables can be run between the various lab areas. We strongly recommend that the gait lab maintain its own network switch or hub within the lab for reliability.

Preparing for an Installation

There are a number of things that you can do to make an installation quick and painless. The majority of installations involve a PC computer and LAN network and it is possible to spend a great deal of time on these items if they have not been completely installed and tested prior to the installation date. In addition, if you are hiring people to work in the lab, it is a good idea to have them start work at least a week before the installation is scheduled to take place so that they can be present without interruption during the training. Please feel free to call Motion Lab Systems if you have any questions about an area under consideration for your laboratory. We would be happy to look at any drawings for potential lab space and provide more detailed comments.

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