

# How to buy a telescope for your institution



by Dr. Frank Melsheimer

DFM Engineering, Inc.  
1035 Delaware Avenue  
Longmont, Colorado 80501

phone 303-678-8143  
fax 303-772-9411  
[www.dfmengineering.com](http://www.dfmengineering.com)

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# Introduction

Astronomy is a unique science in that it appeals to the non-science person and yet has challenges at the extreme frontiers of scientific exploration.

Everyone who sees the rings of Saturn through a telescope for the first time is impressed. The recent comet impact with Jupiter had very wide appeal to the general population and the effects of the event far exceeded the predictions of the planetary scientists.

To read about science after the fact is not as exciting as being involved, and a telescope allows participation at all levels of expertise.

# What is a telescope?

An astronomical telescope can be many things.

- It can be a research tool.
- It can provide an inspiring discovery experience.
- It can be an introduction to science and technology.
- It can be used to attract students to science or to your institution.
- It can provide entertainment.
- It can be a bridge between your institution and your community.

The telescope is a platform for instruments to perform science.

The optimum telescope in its observatory is a tool with low operating and maintenance costs, is friendly to use, and does not become obsolete. The telescope is easily modernized by attaching new instruments and provides a flexible base for many different scientific and engineering pursuits.

These pursuits may range from astronomical observations such as imaging (with film or solid state detectors), photometry (brightness measurements in various colors), spectroscopy (measurements of the composition, temperature, velocity, distance, etc.), to studies of optics, computer control systems, and electronics of the instruments and the telescope itself.

# Why buy a telescope for your institution?

A modern computer controlled telescope is an excellent example of high technology, yet the usage of the telescope is easily understood. These factors are useful to attract entering students to your science program or to science in general.

The availability of a telescope and instruments may be used to attract research grants or educational grants bringing additional resources to your institution.

Alumni and the general population are also favorably impressed by a telescope as they can easily understand its function and the basic uses of a telescope. The advanced technology of the telescope itself does not detract from this understanding where other esoteric physics instruments are technically difficult to understand and to relate to everyday life. A proton accelerator may be a fascinating instrument, but only to a very small fraction of the population.

Telescopes and observatories have traditionally been associated with meritorious people. Naming the observatory or the telescope after a distinguished faculty member or philanthropist is often done as a means of appreciation or recognition. The telescope or observatory is suitable for this function as they have a long life, especially when compared to other instrumentation.

A modern telescope is far more efficient than previous telescopes. The excellent pointing combined with a built-in library of objects reduces the time required to find an object from minutes to only seconds. The result is much more time is spent observing objects and less time finding them. The use of a CCD camera can also allow many people to see the image at once and, with suitable filters, very good images can be obtained even on poor nights. This increase in efficiency makes the most of available clear hours or partly cloudy skies.

# Cost vs. Performance

Comparing costs for various telescopes is much more involved than looking at the price for a given aperture. The quality, performance, and features vary widely as there are no standards of comparisons.

There are basically two levels of telescopes: amateur and professional. The cost difference between the two levels is very large. A 0.4 meter telescope produced by a manufacturer of amateur telescopes may cost 1/4 the cost of the same size professional telescope. This difference is partly due to the quantity of telescopes produced, but is largely due to the step up in performance. The motors, position encoders, structure, controls, and finish are all a quantum step up in performance and quality.

The amateur telescope usually is installed by the owner while a professional telescope is almost always installed by the manufacturer. Installation includes polar alignment, collimation of the optics (optical alignment), and tuning up the pointing model. Without this attention to detail, the telescope pointing will be no better than 3 to 4 arc minutes and the tracking will be degraded. The cost of the installation is substantial, but is essential to achieve the performance of the professional telescope.

The cost is also a function of the features of the telescope. For example, adjustable mirror supports are essential for optical alignment but cost more money. The following features are common on a professional telescope and add to the cost:

- Prepurchase service including pier & dome requirements drawings and review of building drawings
- Installation including alignment and pointing model tune up
- A bolt pattern on the back of the primary mirror cell to attach instruments
- A mirror cell structure suitable for carrying heavy instruments
- A proper focal length illuminated reticle guiding eyepiece
- Limit switches
- An electrically operated focus with accurate readout (essential for CCD camera use). The motion resolution must be small enough so the image size is not restricted by the focus adjustment.
- A focus motion which does not produce image motion
- Cables long enough to run from the controller in the control room to the telescope
- Local and remote control capability
- A large instrument clearance and load-carrying ability
- Movable counterweights to balance instruments
- Automatic dome control
- Mirror handling equipment
- On-site training in operation and maintenance
- Complete documentation including "as built" drawings
- Software upgrades and factory maintenance
- Telephone technical support

# Purchasing Considerations

Professional telescopes are almost always built to order. The industry is small so the companies that provide these telescopes are mostly small businesses. Typically, these manufacturers will request prepayments and milestone progress payments. A final payment of 20% of the total due 30 days after acceptance is normal. The normal delivery time can run from 6 months to 18 months, depending on the size of the telescope.

Performance, materials, and labor bonds are sometimes made a part of the contract. These cost about 3% of the contract cost. Bonds are a way to protect the institution from financial loss due to the manufacturer defaulting.

To protect the institution from being disappointed with the performance of the telescope or the manufacturer, the institution really should send a knowledgeable person to another site where a similar telescope is in service. Calling or writing for references usually results in only conservative statements. No one wants to say anything bad about a manufacturer or their product. Pertinent questions to ask are:

- Have you received the telescope? (If not, go to the next reference)
- Was the telescope delivered late, and if so how late?
- Did the installation go smoothly?
- Did the telescope track and point to specifications?
- Does the telescope have a satisfactory adjustment system for the optics, and do they stay in alignment?
- Does the focus mechanism produce any image motion?
- Does the focus position readout have sufficient resolution?
- Is the focus position stable?
- Is the primary mirror cell adequate to support your instruments?
- Does the telescope accelerate and decelerate smoothly?
- Are the drives fully enclosed in dust tight covers?
- What do you know about other telescopes from the same manufacturer, and from other manufacturers?
- Is the control system easy to use? Friendly? Easy to modify?
- Does the limit switch system work smoothly and reliably?
- What documentation did you receive with the telescope?
- What service and factory support can you expect?
- How often will the telescope require service and can you do it?
- Did the manufacturer respond quickly to your questions?
- Was the telescope finished in a professional manner?
- How was the optical quality documented?

In your Request For Quotation you may ask each bidder to arrange for you to visit one of their customers' that has a similar telescope. Also request a copy of the pointing data for a similar telescope. The pointing model data analysis is typically performed on a computer and the data analysis program should provide a printout of the pointing errors. Ask the bidder if they perform the manufacturing and assembly in their own facility. Also, request a facilities list including test equipment.

# Quality Assurance

Quality assurance for a custom one-off system requires more than confirming that the "as-built" system conforms to the drawings. What you are really interested in is whether the telescope meets your specifications and expectations. A perfectly executed fabrication per drawings does not mean the telescope will perform well if the design is poor.

The site visit to a similar telescope can provide some of the information you need. This telescope may not have all of the features that you desire and it may even have more features than you need, but you can determine how well the features were executed. Discussions with other customers will also help you determine the manufacturer's track record.

One of the progress milestones should be completion of drawings. Insist on receiving the drawings before making the milestone payment. There should be assembly drawings and detail part drawings. Have the drawings examined for completeness. If there are areas which you don't understand, or have questions about, ask the manufacturer to explain or to provide additional information. If the manufacturer responds that "this is the way we have always done it", then ask for test data.

Another milestone should be "shop assembly complete". You can send someone to verify the assembly, or ask for a video tape or at least photographs. The telescope is typically partly assembled several times during the fabrication process and this will not be a big burden on the manufacturer.

Quality assurance also requires the tools to measure various parameters. Does the manufacturer have these tools?

Does the manufacturer perform in-house the design, fabrication, software programming, assembling, and testing or do they subcontract out these activities? The less the manufacturer performs in-house, the more difficult will be the quality assurance and service procedures.

The institution should assign a staff member to assist the manufacturer's people during the assembly and alignment of the telescope. This does not require a person full-time or the same person. A machinist would be a good choice during the assembly, while an astronomer would be a good choice during the polar and optical alignments and during the pointing measurements. This can be a good educational experience for your staff members as the procedures are not a common experience.

The manufacturer should also provide on-site operational training. The operations manual should be explained and typical observational techniques demonstrated. Most people never read the manual, but the manual should be reviewed by the staff.

# Service

A one year parts and labor (manufacturer's site) warranty is normal. The typical failure is electronic and not mechanical and usually involves substituting a circuit board or a component. Much of this type of service can be performed with telephone consultation and shipping parts back and forth. Usually, the manufacturer will maintain spares and ship them overnight to your site and then repair your circuit board later.

You may ask the manufacturer if they maintain spares and what test equipment they have to repair circuit boards. You might also ask who provides service, what skills they have, and their availability.

If the manufacturer subcontracts out much of the design, fabrication, software programming, assembling, and testing, then service response may be slow.