Restoring the Grandeur of the Great Refractor

Telescope, observatory restoration begun at the Center for Astrophysics

By William J. Cromie
Gazette Staff

Restoration of what once was the largest telescope in the United States is under way at the Harvard-Smithsonian Center for Astrophysics (CfA).

The eighth moon of Saturn and its inner ring were discovered with this 15-inch glass eye, and the first photograph of a star was taken with the instrument.

The work is glaringly visible, appearing like a copper sunset over Observatory Hill. The glare comes from sunlight gleaming off new metal sheathing on the dome of the three-story building that houses the telescope.

This sunset effect will gradually cool as weather paints the glistening copper with a dull green patina. (The dome will age to the same color as the copper Statue of Liberty.) CfA fundraisers hope to raise the money to complete planned renovations before that happens.

"We've received enough for restoration of the dome [approximately $135,000]," said Owen Gingerich, professor of astronomy and the history of science, who leads the effort. "Our goal is to find another $150,000 in private contributions to restore the telescope and construct some complementary educational exhibits. With more funding we could turn the building into a Public Education and Information Center for students, tour groups, and casual visitors."

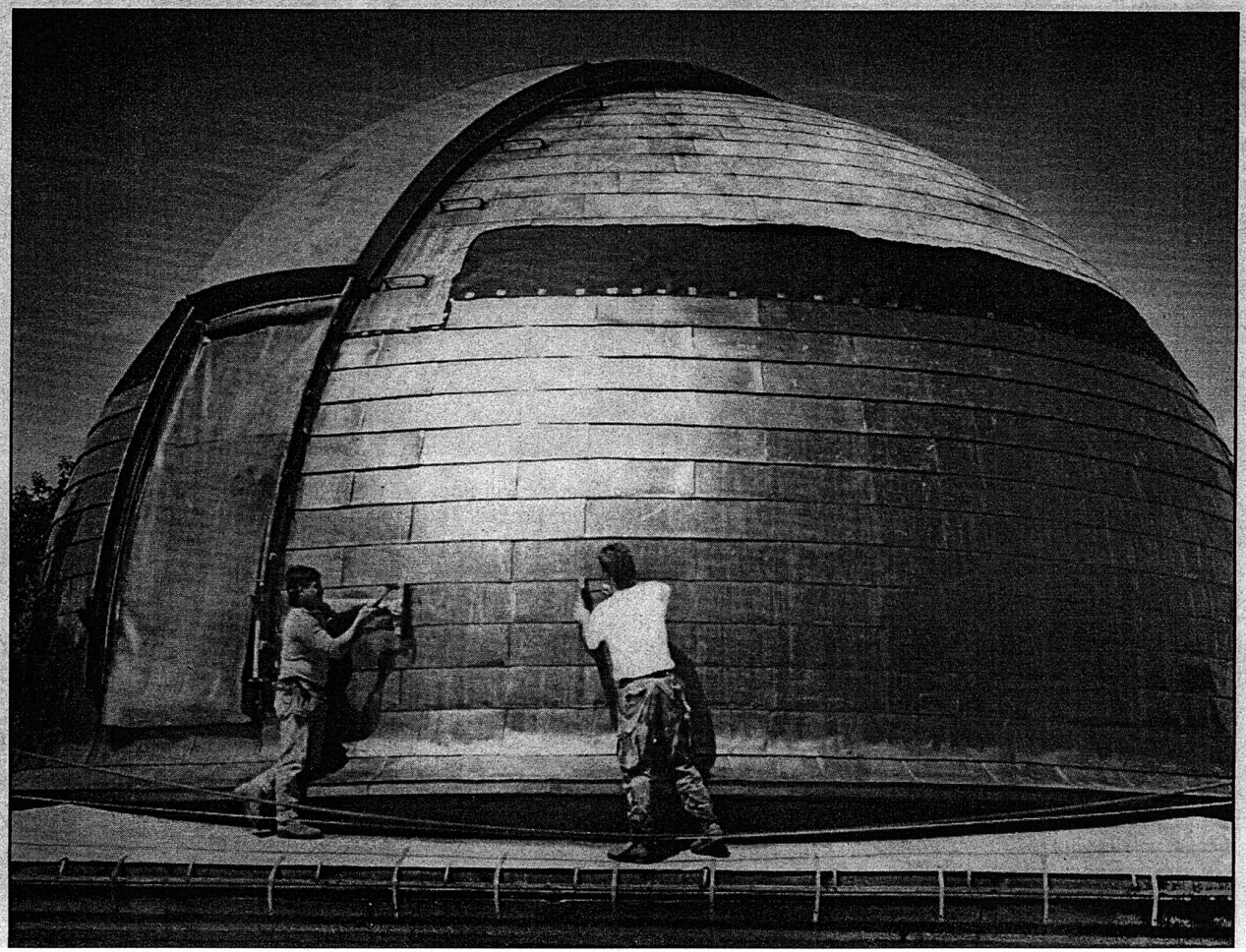


Photo by Joe Wrinn

Workers install protective copper plates on the dome of Sears Tower at the Harvard-Smithsonian Center for Astrophysics, 60 Garden St.

Early Discoveries

The telescope tied with a twin instrument in St. Petersburg, Russia, as the largest in the world in 1847, when astronomers made the first observations with it. Solicitors raised money for the telescope ($19,842) and a building to keep it in ($5,000) in a mere six weeks.

"One story has it that people were frightened into contributing by the great comet of 1843," Gingerich noted. "But I think it more likely that the prominent citizens of Boston did not want to slip into the backwaters of culture."

David Sears of the retailing family gave the first major donation so the observatory building became known as "Sears Tower." Local astronomers dubbed its occupant the "Great Refractor."

In 1848, George Bond used the telescope to discover the eighth moon of Saturn. Two years later, he found the so-called Crepe Ring, a dusky band of rock and ice inside the broader, brighter rings circling the planet, some 885 million miles from Harvard. (Bond Street, on the south side of Observatory Hill, is named for his family.)

In 1850, observers made the first photograph of a star with the Great Refractor—a daguerreotype of Vega, a bright blue-white star in the constellation Lyra. Later, astronomers made the first "wet plate" photos of stars, using a process that preceded dry plates and film.

To use the telescope, an observer would climb an iron staircase to sit in a wide, straight-backed velvet chair. He or she would move the chair up and down with a large hand crank. The 1,000-pound, 20-foot-long instrument is so finely balanced that it can be moved on its 11-ton granite mount with one hand. The 15-inch-diameter sky end, or objective lens, looks through a shutter-equipped slit in the 30-foot-wide, 14-ton dome.

The Great Refractor remained an active center of celestial studies until 1912. By then, the bright lights of Boston and Cambridge and the meteoric advance of technology eclipsed its value as a research tool.

The change led to a new role that emphasized education. Many students got their first close look at planets and stars though this telescope. It was once a spring ritual for Harvard College seniors to march from the Yard to Sears Tower for a glimpse of the heavens from the velvet chair.

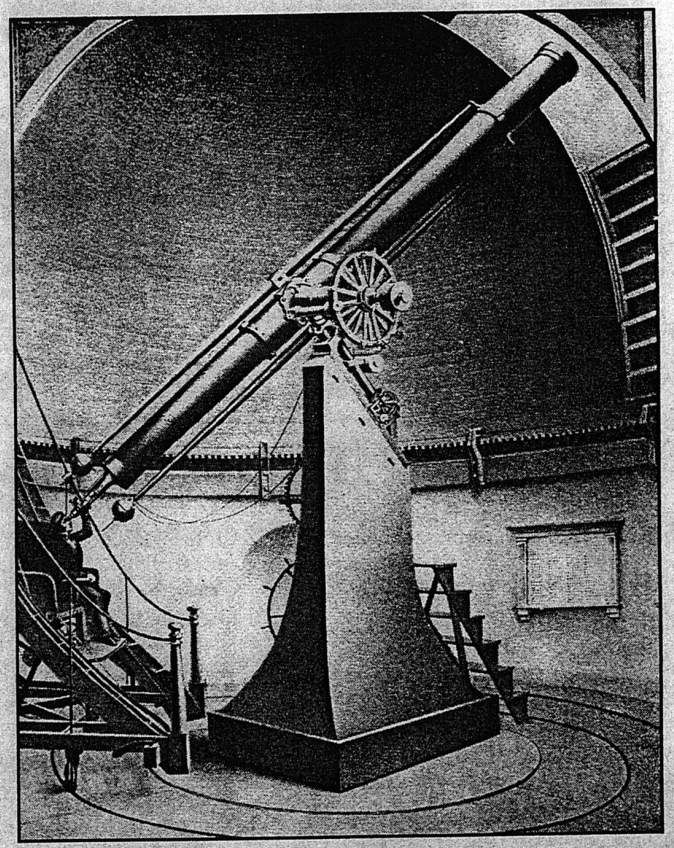
A Near-Disaster

In 1953, the telescope underwent a "modernization" which, by all accounts, qualifies as a near-disaster. Clumsy work destroyed the objective end of the mahogany-veneered tube and damaged the dome. Fortunately, the objective lens remained undamaged.

The renovation included replacing the mechanical drive that moves the dome with an electric drive. This apparatus moves the slit in concert with Earth's rotation so observers do not have to keep moving the slit, and long-exposure photos do not get blurred.

The 1990s renovation calls for discarding the motor drive and restoring the Great Refractor to its 19th-century condition, velvet chair and all. The original mechanical clock-drive has been reconstructed without charge by Russell Elwell, an amateur clockmaker in Florida with time on his hands.

Thus restored, the telescope will serve as a museum piece. Students and the public will be invited to look at it, not through it. However, Gingerich notes, it could be used for observing on special occasions such as eclipses. One proposal is to equip the telescope with an electronic eye that would send images of what it "sees" to a television screen for public viewing.



The 15-inch refracting telescope as it appeared in the 19th century

Below the third-floor observing room, down a spiral wooden staircase, sits the "Director's Office." Plans call for refurbishing this small room to look as it did in the early 1900s. That would include a rotating desk and a candelabrum. The desk, built like a lazy susan, allowed the director to rotate smoothly from one pile of papers to another. Sunlight refracted by the prisms of the candelabrum inspired astronomer Annie Cannon to do pioneering research in which she classified more than 270,000 stars by the patterns of light they emit.

The ground floor of Sears Tower holds outdated exhibits of Halley's Comet and other astronomical subjects. It's now a rather dark and cluttered place, but renovators expect to turn it into a well-lit room, featuring exciting displays of various aspects of modern astrophysics, such as the evolution of the Milky Way.

Once all these renovations are completed, Sear Towers could become an attractive visitors center for those interested in the exploration of the heavens. Without funding, however, the plan is just pie-in-the-sky. Anyone who would like to contribute to bringing it down to earth can call Owen Gingerich at 495-7216.

DEC 2 2 1997

RAY MUSEUM STUDIOS

Christopher Ray "Celestial Mechanic"
607 Elm Ave. Swarthmore, PA 19081-1119
(610) 543-1667
CRAYMUSEUM@AOL.COM

Dr. Owen Gingerich
Professor of Astronomy & The History of Science
Harvard/Smithsonian Center for Astrophysics
60 Garden Street
Cambridge, MA 02138
Dec. 17, 1997

Dear Dr. Gingerich:

Enclosed is my estimation of restoring the Merz and Mahler 15" "Great Refractor" to an improved condition as an historical ikon of 19th Century American Astronomy.

First, I should like to deal with the preparation of the dome space. The floor shall be clad in 1/2" plywood to protect it from mechanical damage and drips of paint, grease & etc. during the operation. Four scaffold towers will be erected to ring the telescope in a rectangle whose sides are aligned cardinally. Two secondary steel beams will run north and south, supporting the ends of a primary beam bearing a traveling hoist, which runs east-west over the top of the mount and pier (like an H). This will enable us to hoist various elements of the mount and lower them either on the east or west sides of the pier. The secondary beams enable us to move the primary beam north and south to unload the bronze side bars and the tube at their balance points. Once the tail-heavy sidebars are removed, the wooden tube will be very nose-heavy. The primary beam will then be moved north until we can hoist the tube at its center of gravity. The telescope will be strongly braced under the declination counter weights and with a temporary scaffolding underneath the wooden tube, during these demounting operations. I have gotten a quote from the Miara rigging company, of Wilmington, Mass, to handle demounting of the tube and mount as I loosten bolts and supervise lifting. The mount parts are heavy.

We also need to be able to open the dome slot and doors for ventilation especially when stripping off old lacquer and spraying on new. The exhibit display windows shall be covered with plastic sheeting to avoid any overspray on the glass.

Basic Order of Operation:
1. Remove the primary and finder objective lenses.
2. Brace the telescope.
3. Remove the bronze sidebars from the main tube.
4. Remove finder scope and brackets.
5. Remove steel tube splice and objective cell flange and tailpiece, if possible.

6. Lower wooden tube to floor.
7. Demount tube saddle.
8. Demount all the counter weights and assemblies from declination axis.
9. Demount declination shaft and housing from polar axis head.
10. Remove weighted bearing assemblies from polar axis.
11. Demount polar shaft.
12. Demount base of mount from pier to floor.
13. Fabricate ca 27" wooden tube section for broken end and splice onto old wooden tube.
14. Veneer tube patch and finish to match original tube. Refinish entire tube in antique manner.
15. Strip, clean and polish all bronze elements to as high a polish as possible (they are pitted).
16. Lacquer all non-bearing bronze parts with clear metal-bonding lacquer.
17. Remove rust from all steel pieces, paint or gun-blue as is appropriate.
18. Discard the declination power drive and other bits and pieces on the scope which do not correspond to its historical appearance.
19. Draw and fabricate various small pieces missing from the mount and tube.*
20. Remount the telescope. Lubricate bearings and draw tubes.
21. Attach replica clock drive to pier and connect to worm gear driver. Regulate.
22. Clean and remount lenses, install in tubes. Collimate.
23. Fabricate new lens cover for objective.
24. Take down scaffolding and steel beams, take up plywood floor, remove equipment.
25. Present restored telescope.

Estimate of
12/17/97.....$47,260.

As this renovation proceeded, I would take many photographs and make extensive notes and drawings. I would make finished technical drawings of the telescope and write a paper on the history and the renovation of the "Great Refractor" as part of the process.

I estimate that the restoration would take 4 months, 3 of which would be spent on site in Cambridge.

* I have included casting up a new RA setting circle and machining it, but not ruling the readings on it. Want it ruled? Do you want microscopes? Lanterns? A "tripod"? Verniers? Other details?

Sincerely,

Christopher Ray

Harvard-Smithsonian Center for Astrophysics

60 Garden Street, Cambridge, MA 02138

A208 or Mail Stop 9 GINGER@CFA.HARVARD.EDU or CFA::GINGER (617) 495-7216
FAX (617) 496-7564

6 January 1998

To: Irwin Shapiro

From: Owen Gingerich

Subject: Restoration of Great Refractor

A few weeks ago Christopher Ray of Swarthmore, PA, made a careful inspection of our Great Refractor. Mr. Ray is the first expert on the restoration of early telescopes to have examined our historic instrument, and he has sent a proposal for its restoration. While he was here he investigated local rigging companies, and brought them in for an estimate of the cost of taking off the tube and the other parts. The total cost estimate is not cheap, but is the first detailed looked by a really qualified expert that we have had.

When Ira Heyman and Howard Baker were in the dome, you mentioned again the free offer that you had been given for the repair of the telescope. Nate Hazen and I had previously replied that we were suspicious of such an offer, which, while it would involve a wonderful spirit of helpfulness and generosity, would also come with the danger of someone not tuned into the nuances of historical preservation and whose bottom line could well be simply putting the telescope into shape so that it could be used by the local amateur astronomers.

I am not asking you for funding to restore the telescope, which is out of the question from normal Observatory monies. However, I would hope that you would approve the project in general, thereby opening the door to possible fund raising. Our previous attempt through the Development Office led only to dead ends, but sufficient time has elapsed so that there might be fresh ideas for a renewed fund raising attempt.

OG/jj
Attachment
Xc: Nate Hazen
John Huchra
John Wolbach

Ray, C.

RAY MUSEUM STUDIOS

Christopher Ray "Celestial Mechanic"
607 Elm Ave. Swarthmore, PA 19081-1119
(610) 543-1667
CRAYMUSEUM@AOL.COM

AUG 2 7 1997

Dr. Owen Gingerich
Professor of Astronomy and the History of Science
Harvard-Smithsonian Center for Astrophysics
60 Garden St.
Cambridge, MA 02138

Aug. 20, 1997

Dear Dr. Gingerich:

The restoration of the Great Refractor looks like an interesting project. I am willing to put forward my time and expense to come up to Cambridge to examine the telescope and make an estimate. At the moment, I am not sure of the scope of the work which you might expect me to execute. From your letter of the 15th, it would appear that the first phase would be to remove all the junk installed over the years. Then to replace the aluminum end of the tube with a wooden section spliced onto the original wooden tube. Then to restore the weight driven clock drive with a replica. Sounds like you wish to go back to an early configuration. I am sure there are many other details to be considered which can be thrashed-out on site.

I shall return from restoring the Michigan 12" Fitz at the end of October. I shall call then to set a date for a visit.

Sincerely yours,

Christopher Ray

Christopher Ray

PS: One has to be very careful in demounting lenses and tubes from large refractors. A machinist at Haverford removed a tube from a small but heavy telescope without bracing the Dec axis and the counterweight came around and knocked him off a ladder onto the floor. Luckily, no serious injuries sustained. Long tubes should be held by 2 tethers at both ends to stop horizontal motion while raising or lowering by hoist.

Harvard-Smithsonian Center for Astrophysics

60 Garden Street, Cambridge, MA 02138

A208 or Mail Stop 9 GINGER@CFA.HARVARD.EDU or CFA::GINGER (617) 495-7216
FAX (617) 496-7564

15 August 1997

Mr. Christopher Ray
Ray Museum Studios
607 Elm Avenue
Swarthmore, PA 19081-1119

Dear Mr. Ray:

I enclose xeroxes of two pictures of our 15" Great Refractor. The earlier one is our only photograph showing the sector drive on the north face of the pier that was constructed by Alvan Clarke soon after the arrival of the instrument. The second photograph shows the special drives and gear added to the telescope around 1953. At that time the telescope was disassembled, and after the lens had been removed (fortunately) and the tube was being lifted off the declination axis, the telescope got away from them and swung up against the dome, completely shattering the end of the mahogany veneer tube. Consequently the uppermost section of the tube, from the brass supporting rod to the lens, was replaced with an aluminum tube.

It is our intention to replace the end of the tube and at the same time remove all of the vestiges of the 1953 electrical additions, and finally to add a new replica clock drive to the lower part of the polar axis.

There are several details that I must clarify. First, I am not the Director of the Observatory, but simply the person most directly involved with the historical restoration of the telescope. At present we have no funding for the repair of the telescope. However, if we get an appropriate estimate, this will give us a good chance to seek the necessary funds for the

restoration of the instrument. However, I am not even in a position to offer you reimbursement for the trip to Cambridge, so you have to do it on speculation and for the interest of examining the telescope.

Finally I should draw to your attention that I will be in California from November 6-10 and in Philadelphia November 14-16. I hope that you can work around these dates.

Sincerely yours,

Owen Gingerich
Professor of Astronomy and the
History of Science

OG/jj
Enc.

AUG 1 2 1997

RAY MUSEUM STUDIOS

Christopher Ray "Celestial Mechanic"
607 Elm Ave. Swarthmore, PA 19081-1119
(610) 543-1667
CRAYMUSEUM@AOL.COM

Dr. Owen Gingerich, Director
Harvard College Observatory
60 Garden St.
Cambridge, MA 02128

Aug. 11, 1997

Dear Dr. Gingerich:

I had intended to come up to see the broken end of "The Great Refractor" in July. However, I have been tied up with another job which ends Saturday, the 16th of August. This leaves me only a week to prepare and depart for the restoration of the Fitz 12" at the University of Michigan's Detroit Observatory in Ann Arbor on August 23rd. It will take two months to take it all apart and to restore it to gleaming 1906 condition, when the wooden tube was replaced with a steel tube.

If you can wait, I will return in early November, at which time I could come up to Cambridge and estimate the task of repairing the wooden tube of the Great Refractor. I have been communicating with several people about wooden tube construction in the Antique Telescope Society and at the Smithsonian. I should know more about making wooden tubes by November. I am going to make a scale model of the Fitz 12" with its original wooden tube construction, looking for all the world like Fraunhofer's refractor at Pulkova, and also construct a cross-section of a typical Fitz wooden telescope tube for exhibit purposes in the Detroit Observatory this winter.

In the meantime, could you send me any pictures of the Great Refractor in its whole and then damaged condition?

I wish you pleasant late summer and early fall.

Sincerely yours,

Christopher Ray

Christopher Ray

Member, Antique Telescope Society

02/06/1991 18:52 FROM ASST. SEC./RESEARCH TO SHAP
02/06/1991 17:40 SMITHSONIAN ASTROPHYSICAL 617 4957105

cc's to: Owen Gingerich ✓
John Huchra
Fred Seward

TO: Nat Carleton FEB 7 1991

Nat: As far as I am aware nothing has yet been done. Also, it is my understanding that, with funds in hand, we would be able to tackle exterior work only. In any event, I will remain, and remain, dedicated to your Nate's service on this project.

REC'D. FEB 6 1991
DIRECTOR'S OFFICE

Harvard-Smithsonian Center for Astrophysics
Optical and Infrared Astronomy Division

MEMORANDUM
Wednesday 6 February 1991

To: Irwin Shapiro

From: Nat Carleton Nat

Subject: Sears Tower and 15-inch telescope restoration

John Huchra wrote you a somewhat cryptic note as a result of a conversation I had with him, concerning this restoration project. I had consulted John, in turn, because Nate Hazen had come to me to express a strong concern that the restoration was proceeding in a haphazard way, without proper planning or supervision, such that things in the tower might be in danger of real damage from enthusiastic volunteer help. I am now writing to you directly because John is out of town for a while.

*I will ensure that Nate is contacted. 2/6/91

I have always been interested in the potential restoration of the 15-inch telescope. Way back in 1974 or so, I saw some opportunities to raise money to do this, and got some effort organized, but Harvard enjoined us not to proceed, because they were about to start one of their large fund-raising efforts. A few years ago, as you may remember, John Huchra and I agreed to help some of the students in a very modest effort to make the telescope marginally operable. We again decided not to proceed, when we found that the dome had become essentially inoperable.

Indeed I do.

In both of these efforts, as in a notable earlier effort, Nate Hazen was the major technical resource that we counted upon. Nate was the senior engineer at HCO from 1960 to 1977, and is a superb engineer with a strong historical bent. He has now been working toward this restoration effort for 22 years.

In 1987 (see attached memo) I made another proposal, connected to the upcoming anniversary years, that I hoped would enable us finally to give Nate Hazen the opportunity to go ahead and lead this project. I was disappointed that nothing came of this proposal, but last year I was extremely pleased to find that an effort was actually under way under Fred Seward's direction and that Nate Hazen was taking a strong part in assessing the work to be done (as summarized in a long, detailed memorandum to the committee in May 1990).

Finally, after all these ups and downs, I was distressed to find that we are apparently not taking full advantage of the time that Nate is (I believe) donating to the observatory. It sounds as though he is ready and willing to assist us in drawing up a

ATMOB (Repair chair on 15")

William E Knight
7 Shornecliffe Rd
Newton, MA (617) 969-6548

MARION G. HOCHULI, PRESIDENT, ATM's of Boston
28 TASCHEREAU BLVD.
NASHUA, N.H. 03062 (603) 888-0141

9/07/90
10 w
Appt.
10:55 A.M.

OB

They came over to estimate cost of repairing 15" chair, not the upholstery; and to see what had to be done. ATMOB's meeting 9/13/90. Ms. Hochuli is their new president & wants to correct this job at no cost to SMO/HCO.

Harvard University/Atmospheric Research Project

Engineering Sciences Laboratory
40 Oxford Street, Cambridge, MA 02138
617-495-5922

MEMORANDUM

TO: Fred Seward, Owen Gingerich, Peg Herlihy
FROM: Nate Hazen NLH
DATE: April 12, 1990
SUBJECT: SPNEA proposal for 15" telescope body & chair work.

The enclosed are passed on for the completeness of your records. The data therein will be massaged and incorporated into a more concise proposal statement, along with data from Conor Power's report on the structural circumstances of the Sears Tower and other material on the instrument, which will be prepared anon.

I prepared a work statement covering most of this work in January (enclosed) and met with several representatives of SPNEA on two occasions since at the site. I think the proposal represents a good assessment of the defined tasks. Although (by request) it covers the additional work of cleaning and protecting the brasswork, it does not address any issues regarding the drives, optics or instrument details; these I will be dealing with separately.

encl: SPNEA Report
Work Statement - NLH, 1/18/90

RENOVATION CARPENTRY TASKS - HARVARD 15 INCH TELESCOPE

Task Statement by Nathan Hazen, January 18, 1990

TELESCOPE TUBE

This is a hollow wooden tube of 1 inch wall thickness, about 22 feet long, with an outer diameter tapering from about 12 inches at one end to about 16.5 inches at the other. The roundness is stabilized by a series of internal metal annular rings. The tube is constructed of a light fir-type wood, with the wall composed of strips, each approximately 1/3 inch thick and 1 inch wide, laid down in three layers with staggered joints. The outer surface is veneered with mahogany and the inside is covered with a cardboard-cloth laminate. The larger end of the tube was damaged some years ago, resulting in outright loss of about three feet. Since that time a metal tube has been bolted in its place.

The task is to restore the end of the tube in wood by scarfing in and laminating new staves out to the original length, covering the repair with new mahogany veneer, and doing some interior finish comparable to the original. There may be some small repairs elsewhere on the tube to be done at the same time. The work should aim to use material and adhesives comparable to the original or contemporary with them, but this is negotiable depending on cost.

I would expect that the tube would be removed from its mounting and stripped of all extraneous hardware by Observatory personnel. The restoration work could be sited on the floor of the observing room, elsewhere in the Observatory, or the tube could be crated and delivered to the carpenter's shop, whichever is most economical. In the last case, issues of security would have to be addressed.

OBSERVER'S CHAIR

This is an assembly about 10 feet high and 9 feet wide, with two narrow sets of stairs bounding a central two-person settee which can be cranked up and down on curved rails between them. The assembly is mounted on wheels which run on tracks imbedded around the observing floor. The structure of the Observer's Chair is heavy wood; the fittings and machinery (chains, pulleys, wheels, rails, etc.) are iron and brass. Red velvet cushions are used on the settee.

The task is to restore the Chair assembly and the mechanical devices to sound condition. There is some minor wood breakage, some of the fittings need re-seating, and many of the joints are somewhat loose. A judicious mix of

traditional and modern materials might be used, subject to negotiation, with the emphasis on restoring appearance and function. New cushions must be made.

Because of its size the Observer's Chair cannot be removed from the dome so most of the work must be done there, but some subassemblies could be detached.

Society for the Preservation of New England Antiquities
Conservation Center
Lyman Estate
185 Lyman Street
Waltham, Massachusetts 02154
617 891-1985

April 12, 1990

Nathan L. Hazen
Engineering Sciences Laboratory
Harvard University
40 Oxford Street
Cambridge, MA 02138

Dear Nathan:

Please find enclosed the proposal for the repairs to the 15" Telescope and the Observer's Chair in the Harvard Sears Tower. As you will see from the proposal, the work is complex and time consuming. It can, however, be modified and phased to meet your needs. The summary sheet in the proposal suggests ways that the work might be prioritized.

Please review this proposal with your committee and let me know your comments.

We look forward to working with you on this most interesting and challenging project.

Sincerely,

Andrea M. Gilmore/cah

Andrea M. Gilmore
Architectural Conservator

AMG/cah

HARVARD OBSERVATORY
Cambridge, Massachusetts

Proposal for Work

15" Telescope
Telescope Observer's Chair

Prepared by

Society for the Preservation
of New England Antiquities
Conservation Center

April 1990

INTRODUCTION

This proposal presents an outline and cost estimate for the work required to repair the wooden tube and clean the brass mountings on the 15-inch telescope and to repair the observer's chair. The work is described in some detail and several alternative methods of treatment are presented. General comments regarding our understanding of work commitments by the observatory staff and work space requirements are also included.

15-Inch Telescope

I. Extension of Wooden Tube

A. Procedure:

1. Remove objective and cell (Harvard staff)

2. Remove metal tube end (SPNEA)

3. Identify wood used in core of tube

4. Prepare end of tube for new softwood staves, perhaps using power router to cut new 5/16" deep by 2" long rabbet, and power router to cut some longer grooves running along the length of the tube into which some staves may be glued. This will increase the strength of the overlap between new and old tube sections.

5. New staves to be preshaped using set of convex/concave cutters to match arc of tube.

6. Construct a removable form that will extend out of the existing tube and around which a new section of tube can be glued and clamped. The new cardboard-cloth liner may be used as a barrier between the form and the new wood.

7. Build up three layers of softwood core.

8. Veneer new core with new mahogany veneers, aiming to approximately match grain and thickness of existing veneers.

9. Glues: probably epoxy on the staves, due to its strength and gap filling abilities; PVA glue to attach the veneers.

10. Prepare end of new section of tube to receive objective mounting bracket. While this bracket may be installed by SPNEA, the objective will be installed by Harvard staff.

11. Finish to match appearance of present finish, which appears to be linseed oil. We would probably use some kind of varnish since it is more removable at a later date than linseed oil and can be more easily and controllably tinted.

B. Comments

1. Shop Space: This stage of the project can most easily, safely and productively be done in a woodworking shop rather than at the observatory. Ideally it would be done in David Webb's or SPNEA's shop, but we are willing to work at a Harvard University facility. We will need good lighting, several easily reached grounded 110 W outlets, and adequate ventilation for any dust we make.

2. We understand the justifiable concerns for loss or damage to the tube while in a non-University building. We feel the tube is probably not the most sought after element of the telescope, and thus could be quite safely housed away from the University, especially if the objective remained at the University. Other than to fit the mounting bracket for the objective to the new section of the tube, we see no need to handle any part of the objective, and do not want to be responsible for its storage.

3. Removing the tube from the Observatory and moving it to another location should probably be overseen by the Observatory staff.

4. Some care will be needed to prepare a cradle for the tube while it is being worked on. We expect that we will be responsible for this. The cradle, designed to hold the tube without its brass mountings, should allow the tube to be rolled without damaging the wood or finish of the existing surface. It will be necessary to roll the tube during various stages of fitting and gluing the new staves.

5. Most of the stages of the project will be quiet and clean work. The power router will make some noise and dust. Shaping the staves will probably be done on one of our own machines in one of our shops. During the finishing stage, it will be important to have a fairly dust-free area, and may be necessary to have a spray booth.

6. The estimate is designed to include the extensive amount of time we predict will be needed to set up and perform a difficult and new type of procedure, and to carefully appraise each step in progress.

C. Work to be done by David Webb and Joe Twichell

D. Time Estimate: 180 hrs. at $50/hr. - Total $9,000.00

E. Materials Estimate: $500.00

II. Metal Cleaning

A. Procedure - Two methods for cleaning the brass are presented. One proposal is for work to be done by SPNEA staff and the other by a commercial cleaner.

1. SPNEA staff

a) All brass parts will have remains of previous coatings removed by solvents (lacquer thinner, if the existing coating is lacquer).

b) Polishing will be done by hand using a commercially available metal polish, such as Nevr-Dull, Magic Wadding or Quator.

c) Before final coating, the polished brasses will be rinsed to remove cleaning residues and degreased using lacquer thinner.

d) Finally, the cleaned brass will be coated with several heavy coats of sprayed on lacquer, either an acrylic, such as Incrylac, or a nitro-cellulose, such as Agateen lacquer.

2. Comments on SPNEA treatment

a) The goal of SPNEA's treatment will be to protect the existing quality of the metal finishing (machining marks, fine incised details, etc.) on the surface while using materials that permit us to do the cleaning fairly expediently.

b) Nevr-Dull, Magic Wadding and Quator are commercially available metal polishes made of cotton wadding containing a small amount of a mild acid as well as a small amount of an extremely fine abrasive material. Abrasions caused by these cleaners are only visible through a microscope.

c) Some research to determine the most appropriate polishing method will have to be done once the parts are removed from the telescope. It is possible that it will be deemed appropriate to use an electric buffer to polish parts of the brasses. Decisions on what polishing technique will be used will be reviewed with Harvard staff prior to any treatment being undertaken.

Those parts requiring special cleaning procedures, such as the eye piece, the silver vernier-calibrating ring and some of the fine knurling, will be cleaned, as necessary, with more conservative techniques.

d) Since most of the cleaning is expected to be simple but tedious work, we plan to train interns or other qualified people to help with the cleaning. These people would work under the constant supervision of an SPNEA staff person and their work would be limited to non-technical parts of the treatment, particularly the cleaning.

e) The estimate includes 40 hours for set-up, photo-documentation, and testing (existing coating, degree of surface degradation and appropriate cleaning methods), 120 hours for actual polishing, and 100 hours for removal of existing coating and application of new one. Another 40 hours has been allocated to procuring materials and to making a mobile spray booth and ventilation system for use during various stages of the cleaning if these systems are not available at the spot where the treatment is to be done.

f) The brass fittings will be demounted and moved to the cleaning site by Harvard staff. SPNEA will be responsible for properly supporting parts during cleaning. Harvard staff will remount brass parts.

g) There is no clear preference to using nitro-cellulose versus acrylic coatings. The acrylic ones may be tougher, but the nitro-cellulose ones, in our experience, are easier to apply and seem to be less visible on the metal. Given the lack of UV light and air pollution in the observatory, weathering capabilities are probably not of paramount importance.

3. Commercial Metal Cleaners

There are several commercial metal cleaning companies in the Boston area who can polish and coat the brass mounts to varying degrees of care and time -- and thus cost. To summarize their techniques, they would strip the existing coating with lacquer thinner, polish with a commercially available polish that contains an abrasive (probably, as we presently understand, coarser than that in Nevr-Dull) and coat (after thorough rinsing with lacquer thinner) with either a nitro-cellulose or acrylic lacquer as directed.

We expect that they will be able to do the work at a lower price than we can, and, if interviews with them are to be believed, some of them will do high quality, careful work. They have the equipment already prepared for working on site, are familiar with working on site, and, in some cases, have worked on high quality objects (as opposed to brushed metal interiors, hand railings, etc.). Finally, their schedules may be more flexible than ours and they can probably do the work in fewer days if they have a large staff.

It is worth considering how well you can control the quality of work done. Commercial polishers tend, understandably, to be extremely budget-conscious, although there will be differences among them. A safe rule of thumb is that the lower the estimate, the less control you will have over their work. If the company has done work before on "art objects," they may be more used to having their work overseen by owners, or other knowledgeable people. The best commercial people should be as open to having their work reviewed and suggestions made as a museum-oriented staff such as ours.

B. Work can be done by SPNEA staff, perhaps with interns or other help appropriately trained by SPNEA, or it may be sub-contracted to a commercial metals cleaner.

C. Time Estimate: 300 hr. at $50/hr. - Total $15,000.00

OBSERVER'S CHAIR

I. Repair of the Observer's Chair Assembly

A. Procedure:

1. Refasten steel track to floor.

2. Research and install rope drive.

3. Repair/replace broken parts of the wooden portion of the chair.

B. Work to be done by David Webb.

C. Time Estimate 200 hrs. at $50/hr. - Total $10,000.00

D. Materials Estimate $300.00

II. Cleaning of Handrailing

A. Procedure:

Same as for telescope mounts.

B. Work to be done by SPNEA staff.

C. Time estimate 16 hrs. at $50/hr. - Total $800.00

III. Identification of Paint on Observer's Chair Assembly

A. Procedure:

Paint on the observer's chair would be studied microscopically to identify its original color.

B. Work to be done by SPNEA staff.

C. Time Estimate 8 hrs. at $75/hr. - Total $600.00

IV. Upholstery of Observer's Chair Seat and Foot Rest

The upholstery and textile portions of this project will be a small investment in proportion to the treatment of the telescope itself. The visual impact, however, of the properly restored observer's chair unit (inclusive of carpet) will heavily impact the ambiance of the period you are trying to achieve. Initial investigations did not reveal any original materials but it is likely the first cover was a wool or linen plush. Archival photographs will help determine the style of carpeting for the foot rest. It is likely some kind of blankets and possibly pillows were also apart of the original ensemble. Even this small amount of color and texture will carefully illustrate the interior space as an identifiable 1850 date.

A. Procedure

1. Deupholster chair and analyze for original information. Secure archival photographs of the chair. Complete condition report, inclusive of dimensions.

2. Investigate replacement fabrics for chair and trim and carpet for footrest.

3. Purchase, inspect and prepare fabrics for installation.

4. Install replacement fabrics recreating the form in the archival photograph.

5. Write a treatment report.

B. Work to be done by SPNEA staff.

C. Time Estimate: 60 hrs. at $50/hr. - Total $3,000.00

D. No materials estimate is included since selection of fabric and trim will determine these costs. Typically this sort of replacement fabric costs $100 - $135 per yard. Five yards of double width fabric will be required for recovering the observer's chair.

WORK SUMMARY

15-Inch Telescope

1.	Extension of Wooden Tube	$ 9,500.00
2.	Metal Cleaning	$15,000.00

Metal cleaning will require the disassembly of the telescope, therefore it is advantageous to do this work when the wooden tube is extended. However, metal cleaning is not necessary for the successful repair of the wooden tube.

Observer's Chair

1.	Repair of the Chair Assembly	$10,000.00

This work should be done to prevent further damage to the chair and for safety reasons.

2.	Upholstery of the Observer's Chair Seat and Foot Rest	$ 3,000.00
3.	Cleaning of the Hand Railing	$ 800.00
4.	Identification of Paint on Observer's Chair Assembly	$ 600.00

Harvard University/Atmospheric Research Project

Engineering Sciences Laboratory
40 Oxford Street, Cambridge, MA 02138
617-495-5922

MEMORANDUM

TO: Owen Gingerich, Pam Lodish, Fred Seward
FROM: Nate Hazen, x5922 NZH
DATE: February 22, 1991
SUBJECT: Repair/ Upholstery of Observer's Chair - 15" Telescope

At this writing, the Observer's Chair for the 15" telescope has been removed from its frame and been partially disassembled. The left hand wrought iron portion of the chair support frame has been separated so as to allow the repair of break (temporarily covered in 1955 with an aluminum doubler plate).

After consultation with people aware of such things, I approached an upholsterer - The Fabric Showroom - to advise on appropriate ways to deal with the "restoration" of the furniture portion of the chair; i.e. the wooden frame and the upholstery. This firm came highly recommended for quality and sensitivity to historical aspects, while at the same time offering a pragmatic solution. I met with one of the partners, Barry Shapiro, on 2/5 in the dome and we looked over the chair quite carefully. The end result was his recommendation to re-upholster the chair and cushion in a way very similar to their present character - antique velvet over horsehair filling, finished with decorative gimp - as this was representative of the practices in 1845. We further agreed that a utilitarian replica cushion - of naugahyde with polyurethane filling - might be useful if significant public exposure was anticipated. Mr. Shapiro subsequently sent a written budgetary proposal describing this approach; a copy is enclosed.

I intend to go ahead with the welding repair (perhaps a $100. item), if it's OK with you all, and would like to go ahead in due time with the upholstery.

Please advise.

P.S. I also have fabric samples.

Proposal

Page No. of Pages

THE FABRIC SHOWROOM

Brighton Upholstering Co., Inc.
319 Washington Street
BRIGHTON CENTER, MA 02135
(617) 782-3169 783-4343

787-0350

5/14/93
c/o Donna

PROPOSAL SUBMITTED TO: HARVARD UNIVERSITY		PHONE: 495-5922	DATE: 2/5/91
STREET: 40 OXFORD Street		JOB NAME: OBSERVATORY - BENCH	
CITY, STATE AND ZIP CODE: CAMBRIDGE, MA 02130		JOB LOCATION: GARDNER ST. CAMBRIDGE	
ARCHITECT: NATHAN HAZEN	DATE OF PLANS:		JOB PHONE:

We hereby submit specifications and estimates for:

REUPHOLSTER BENCH AS PER EXISTING: STYLE. TIGHT ARMS & BACK WITH HORSEHAIR FILLING, FINISHED WITH DECORATIVE MATCHING GIMP. BOXED & WELTED LOOSE FITTED CUSHION WITH CUT OUT AS PER STYLE. CUSHION FILLING: HORSEHAIR LABOR #550.00 + REQUIRES 8 YARDS — ADDITIONAL STRUCTURAL REPAIRS ADDITIONAL

ADDITIONAL LOOSE CUSHION FOR PUBLIC USAGE. FILLING: HIGH DENSITY POLYURETHANE, WELTLESS LABOR & FILLING # 135.00 PLUS 3½ YARDS VINYL

SAMPLES ENCLOSED

V000050 ANDREA ANTIQUE VELVET 27.50 PER YD

CRIMSON NAUGAHYDE (VINYL) 14.95 PER YD

WE HAVE A LARGE SELECTION OF NAUGAHYDE & VELVETS IN STOCK !

We Propose hereby to furnish material and labor — complete in accordance with above specifications, for the sum of:

APPROXIMATE dollars ($ 918.32).

Payment to be made as follows:

+ Mass Sales Tax

All material is guaranteed to be as specified. All work to be completed in a workmanlike manner according to standard practices. Any alteration or deviation from above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the estimate. All agreements contingent upon strikes, accidents or delays beyond our control. Owner to carry fire, tornado and other necessary insurance. Our workers are fully covered by Workmen's Compensation Insurance.

Authorized Signature: Danny Shapiro

Note: This proposal may be withdrawn by us if not accepted within _____ days.

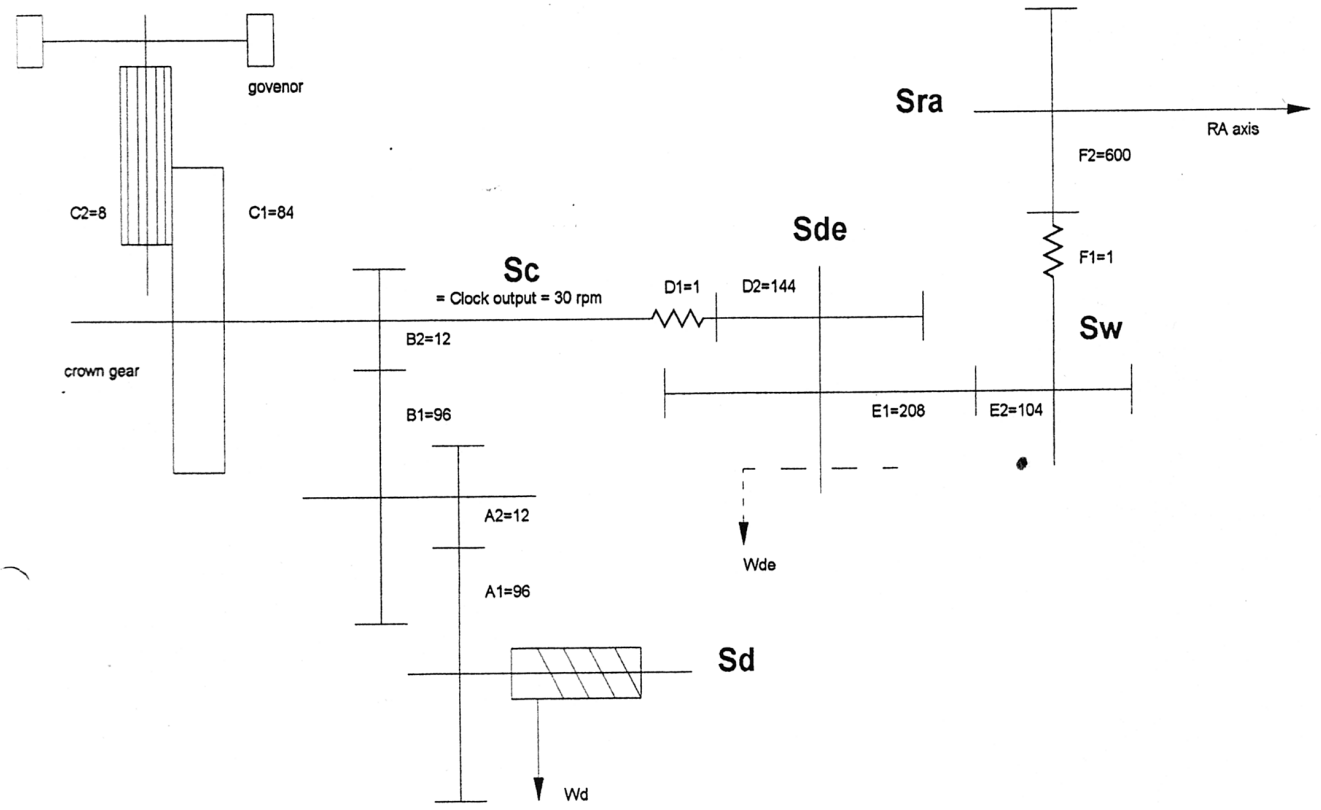
Acceptance of Proposal — The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.

Signature _____

Date of Acceptance: _____

Signature _____

Draft



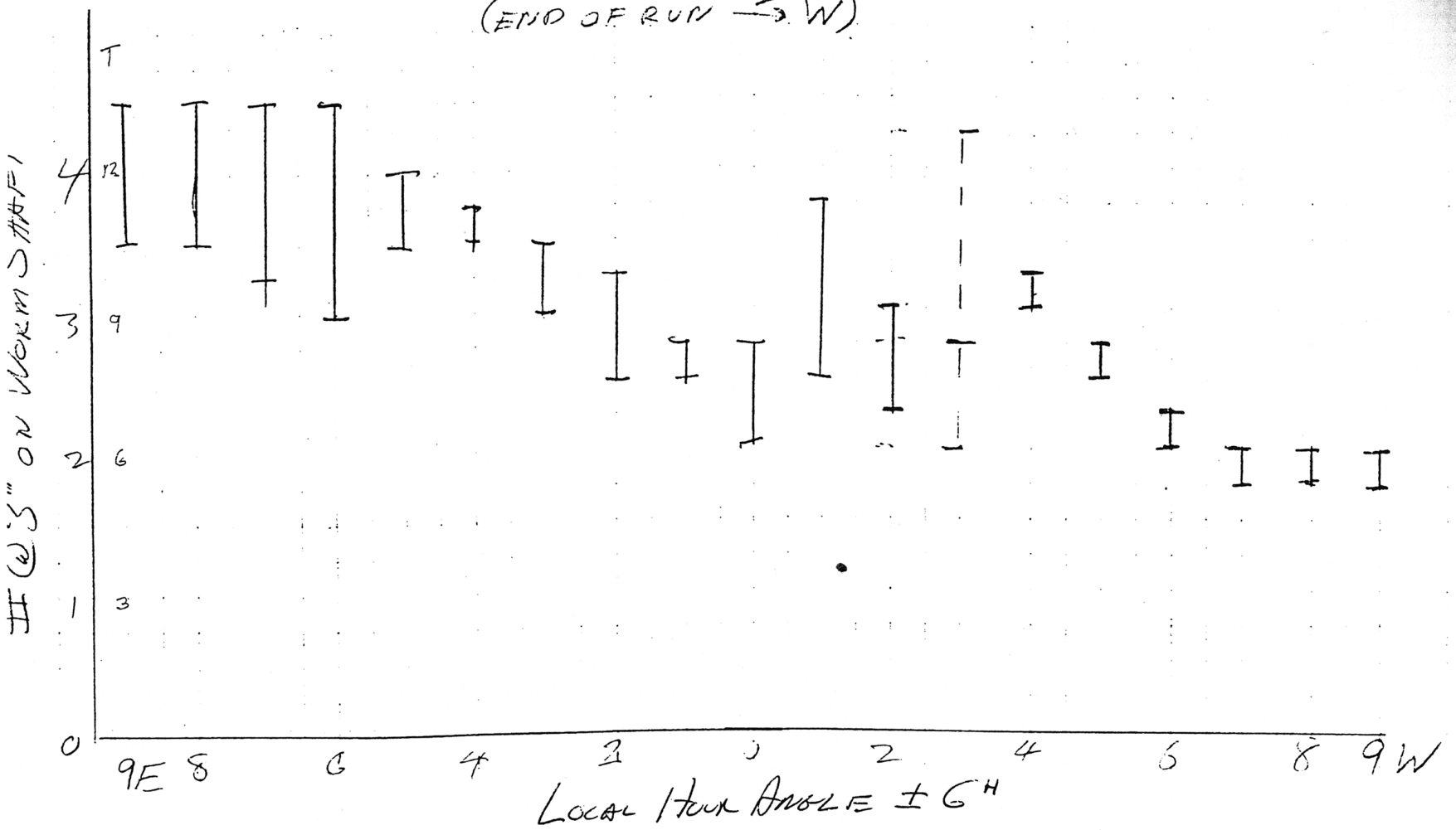
GEARING SCHEMATIC

FOR

HARVARD GREAT REFRACTOR

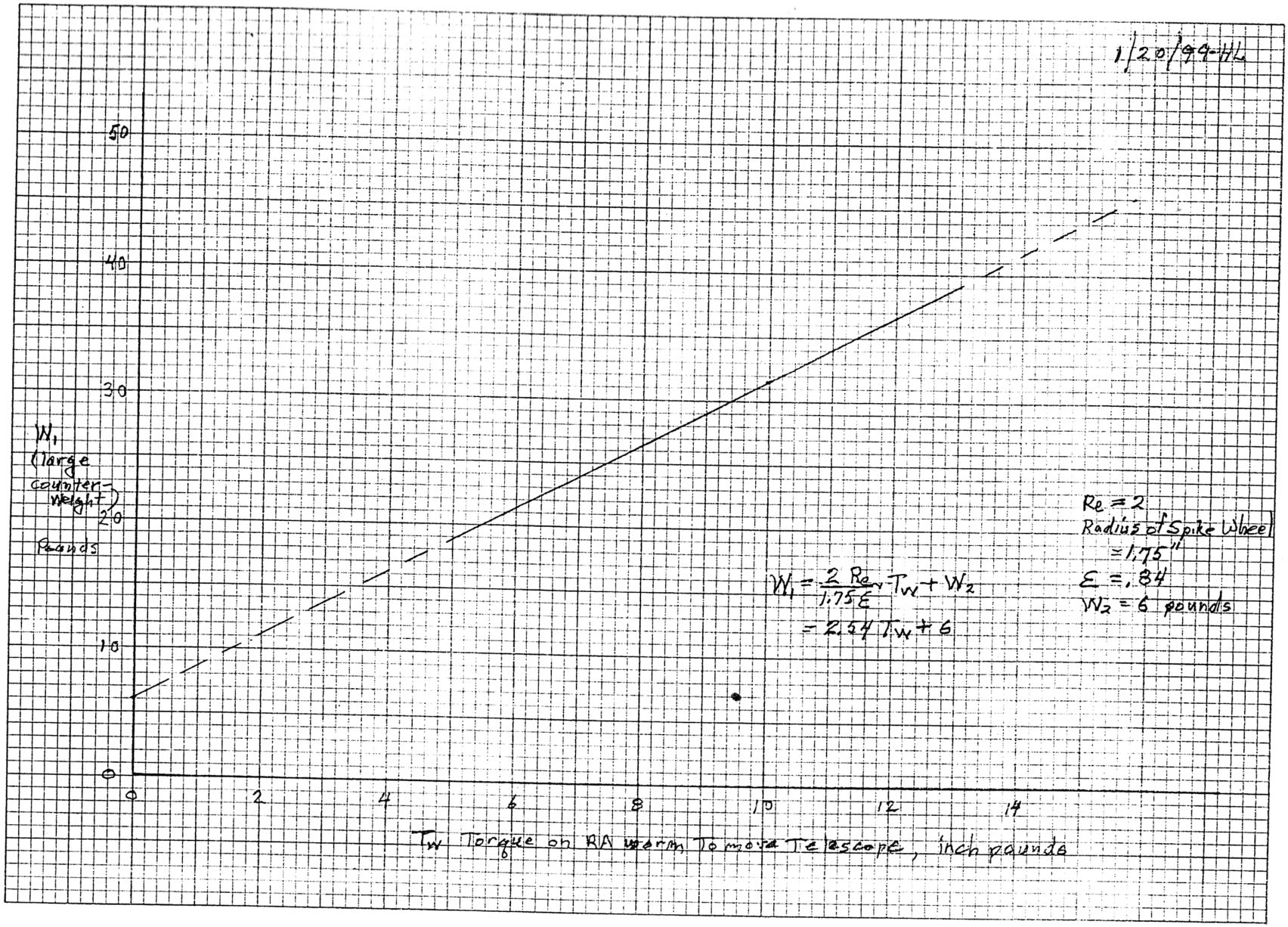
TORQUE ON WORM SHAFT
1998 NOV 11

SCALE READ $\approx \frac{1}{2}$ # HIGH
(END OF RUN → W)



11/11/98

1/20/99-HL



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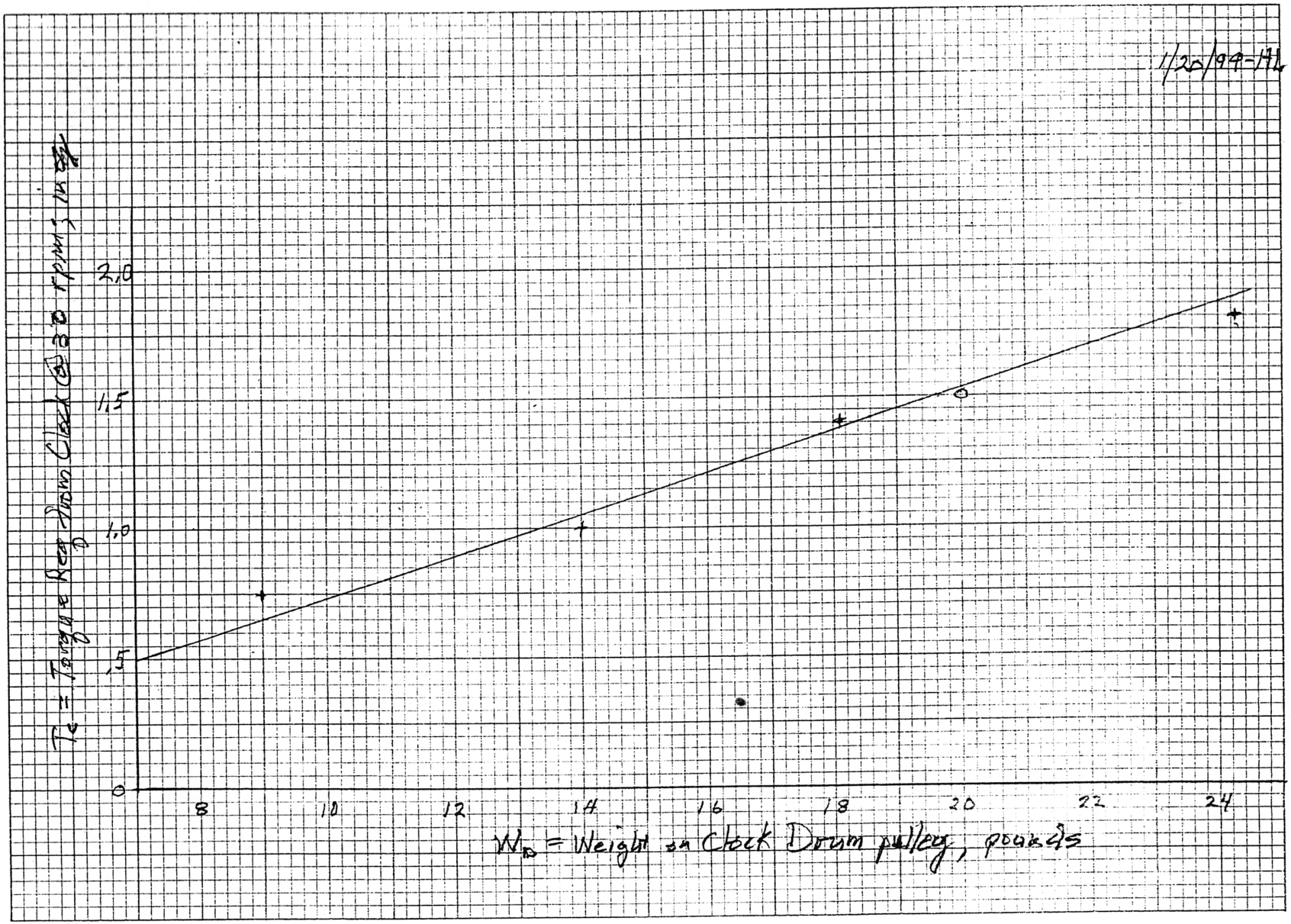

HARVARD COLLEGE OBSERVATORY
60 Garden Street, Cambridge, MA 02138
Sesquicentennial Year 1989

To: Irwin Shapiro

From: Pamela Lodish PL

Date: December 28, 1990

Subject: Sears Tower

It is difficult to give exact pricing for the repairs that are needed on the Sears Tower building. However, preliminary figures might include:

Repair the chimney & repaint the cornice	$3,500
Replace the dome roof and water table	$65,000
Replace the existing windows & doors	$10,000
Scrape, prime & paint the balcony	$5,000
Repair the interior floors, including bracing	$35,000

The big unknown that is not included in the above price is the cost to make the dome fully operational. I spoke to Owen Gingerich and he tells me that the mechanism is intact and he believes that the biggest obstacle at the moment is that the door to the dome is not easy to either open or close. If the cost of doing this should mount, we can try to cut corners on the floor repair.