

# User support: lessons learned from HST

C. P. O’Dea<sup>a</sup>, K. A. Peterson<sup>a</sup>, and A. Koratkar<sup>a</sup>

<sup>a</sup>Space Telescope Science Institute, 3700 San Martin Dr., Baltimore, MD, 21218, USA

## ABSTRACT

The goal of STScI’s user support is to provide HST observers with the tools, documentation and assistance they need to maximize the scientific return of their observations. This includes pre-observing support to design feasible observing programs which meet their scientific goals and post-observing support in the calibration, reduction, and analysis of the data. The current model for user support evolved over the first five years of HST operations and culminated in our Contact Scientist (CS) and Program Coordinator (PC) team. The CS is a professional astronomer as well as an instrument scientist for one of the HST instruments. The PC provides technical support as an expert in the language and tools of HST observation specification, implementation and scheduling. The underlying philosophy is that (1) the CS/PC team supports the observer from “cradle to grave” of the observation and (2) the team is a “single point of contact” for the observer. This means the observer can contact the CS/PC team during any phase in the life cycle of an HST program to receive assistance. It also ensures that the user obtains help from the two people at STScI who are the most familiar with the program, without being shuffled among many different experts. The STScI Help Desk provides parallel support for requests which do not deal with a given HST program. Requests are received, tracked, and assigned to the appropriate expert for reply. Our wholistic approach combines CS/PC support with documentation, software and tools, and the help desk to create an efficient and powerful support structure for observers.

**Keywords:** User Support, Hubble Space Telescope

## 1. THE GOALS OF USER SUPPORT

The high level goal of HST user support is to achieve the maximum scientific return from HST observations. This implies support of the observers from the pre-observation phase of designing the observations to the post-observation phase of calibration and reduction. Because of the large capital investment in HST, observing time must be used optimally and efficiently. HST time is too expensive to waste it by executing observing programs which are inefficient or which are improperly designed and will thereby not achieve the scientific goals of the PI. HST scheduling and observing is rather complex compared to most ground based observatories or other space based missions. Thus, most observers require assistance in creating schedulable and well designed observing programs. After the observations are taken the observers must be able to properly calibrate and reduce the data using the latest calibration reference files and expert knowledge of the performance of the telescope and instruments. These considerations set the requirements for HST user support.

Although other observatories may not face in detail or magnitude the same problems and issues as HST, the overall approach may prove useful since most have the same goals of efficiency and high scientific output. First we set the stage by presenting the lifecycle of an HST proposal. Next we describe how the current implementation of user support evolved at STScI. We discuss the rationale behind the creation of the current user support team, the Program Coordinator (PC) and Contact Scientist (CS). We describe the roles of the PC and CS. We discuss the entire suite of user support provided by STScI, including software tools, documentation, and the help desk. Finally we close with a summary of what we have learned.

---

Other author information: (Send correspondence to C.P.O.)

C.P.O. : E-mail: odea@stsci.edu. O’Dea is a Contact Scientist in the WPC2 group and former head of the User Support Coordinating Committee.

K.A.P. : Email: peterson@stsci.edu. Peterson is a Program Coordinator.

A.K. : Email: koratkar@stsci.edu. Koratkar is a former CS and is now project scientist of the Project to Re-Engineer Space Telescope Observing.

## 2. THE LIFECYCLE OF AN HST PROPOSAL

Responding to STScI's roughly annual Call for Proposals, astronomers apply for time on HST to do a particular project. In addition to stating the scientific goals, the Phase I proposal must address the observing strategy in sufficient detail that an estimate of the required telescope time can be provided. Thus, the need to provide support for observers starts with the preparation of the Phase I proposal. In order to support the observers in this activity, STScI provides

- documentation of the features and limitations of every instrument as well as the observatory as a whole (e.g., the Instrument Handbooks and Call for Proposals and Phase I Proposal Instructions),
- web-based tools for the calculation of exposure times,
- and staff astronomers and other experts who are available before the deadlines to answer questions.

Successful proposers are chosen through review by the Time Allocation committee (TAC) and must then construct a feasible and schedulable script of the observation (the Phase II program). User support for this consists of

- documentation of the HST scripting language (the Phase II Proposal Instructions),
- software which assesses the scripts, performs feasibility and schedulability analysis and transforms them from a high level description to a detailed parameterization of the observations (Remote Proposal Submission 2 or RPS2),
- technical support from a PC and scientific support from a CS (including support for visits to work on the Phase II proposal),
- and several utilities on the WWW such as exposure time calculators and target acquisition simulators.

Once the Phase II program has been submitted, it is reviewed by the PC and CS. They iterate with the observer on the program design if necessary. As programs become available, a long range plan (LRP) for scheduling is constructed. For the most part, user support at this stage consists of helping the user resolve problems that are encountered in the review and processing of the program.

Eventually the individual observations of the program are scheduled on the telescope. If all goes well the data with a preliminary calibration can be pulled from the archive by the user within a few days of an observation. User support at this stage consists of:

- a data quality review by the CS,
- updated calibration reference files for re-calibrating the data, if necessary,
- documentation on data reduction (the HST Data Handbook),
- updated information on instrument performance available on the WWW, and by e-mail
- support for observer visits to STScI,
- help as needed by the CS for reduction and data analysis questions.

### 3. THE EARLY DEVELOPMENT OF USER SUPPORT FOR HST

The user support for HST has changed significantly over the eight years of operations so far. Initially, responsibility for aiding astronomers in their use of HST was much more compartmentalized. There was a group of scientists and technical assistants that helped users write their Phase I and Phase II proposals. There was a separate group of scientists and technical assistants that carried out a feasibility review and initial processing of the Phase II programs. There was yet another group of scientists and technical assistants that handled instrument health and safety reviews and answered instrument specific questions (and after execution helped with data reduction questions also). Finally, there was a group of scientists and technical assistants that implemented the final preparation of the program for flight.

The problems with this system became clearer as operations became more routine. At first each of these groups was intently working to develop and improve their individual part of the process. But once operations settled into a routine it was obvious that the compartmentalization did not benefit the user. The following problems were evident:

- The large number of people involved in supporting an observing program resulted in responsibility for the success of the program being too diffuse.
- It was often difficult for the observer to know who to contact with a question or concern.
- Occasionally, problems with a program would be missed because of a lack of ownership of the program when the problem fell in the grey area between the different responsibilities of the groups supporting the program.
- Since many people were required to have a working knowledge of the program, there was considerable duplication of effort.
- Feedback was poor. Lessons about the proper design of the program which were learned in one group were not well communicated to other groups working on the same or similar programs.

The initial step to correct these problems came out of “Continuous Process Improvement” (CPI) efforts begun in 1994. The pre-execution support was consolidated within the Project to Re-Engineer Space Telescope Observing (PRESTO). The technical pre-execution support was provided by the group of PCs. A single group of scientists (the Liaison Scientists) provided scientific pre-execution support for observers. The Instrument Scientists in the different instrument teams still provided post-execution support as well as health and safety reviews. This scheme was proven successful in Cycle 5. And the final step was then taken before the beginning of Cycle 6 to add the Liaison Scientists to Instrument scientists in the instrument teams. These new “Contact Scientists” provide continuity of scientific support from the beginning to end of an HST program.

The current observer support paradigm has been judged to be successful based on (1) an email survey conducted in Cycle 6, and (2) the comments of the Space Telescope Users Committee in their report from their May 1996 meeting.

### 4. THE CONTACT SCIENTIST AND PROGRAM COORDINATOR CONCEPT

Since December of 1995, a PC and CS team has been assigned to every TAC approved GO program. This team is the “single point of contact” for the observer. The team has overall responsibility for ensuring that the program executes successfully and that the program has no obvious flaws which would prevent the science goals from being achieved.

The CS is a professional astronomer in one of the instrument teams who spends a fraction of his/her time carrying out original astronomical research. They are peers of the HST users and so are able to provide good scientific as well as technical advice in the design of the program. Because the CS is involved in the calibration and technical characterization of an instrument the CS can give up-to-date advice on instrument performance and reduction techniques. The CS is assigned for the entire “cradle-to-grave” life time of an observing program, so the user always knows where to go with science and instrument performance questions. In addition, knowledge of the outcome of the observations and novel reduction techniques can be fed back into improved design for future observations.

The PC provides professional technical support for the HST observer up to the point the data are taken. Bringing to the job a background in astronomy, physics or observatory support, the PC becomes an expert at all the steps

involved in specifying, implementing, and test scheduling HST observations. These responsibilities used to be handled by three different groups with time consuming handoff procedures, duplication of effort and loss of ownership. Now with a single PC working on a program, it is much easier for the observer to know who to contact with a technical question.

A good analogy for the philosophy behind the CS/PC team is the “old-fashioned” family practice doctor. The doctor knows your family, and gives you regular checkups. Your doctor may have to consult with other doctors or occasionally send you to a specialist, but in the end your well being is managed by your doctor. The previous system of support is analogous to using several overworked specialists who only see you when you have a specific complaint and don’t know you by name.

Currently, STScI provides 30 CSs and 16 PCs. In a given cycle we have roughly 600 general observer (GO) and guaranteed time observer (GTO) programs. Thus, each PC handles about 40 proposals per cycle. The CSs do not support most GTO programs, so the average number of programs being supported is about 15 programs per cycle. Cycles overlap, so generally the total amount supported by the PCs and CS is about 1.5 times higher. The support of these programs constitutes about 90% and about 10-20% of the total workload of the PC and CS, respectively. The rest of the CS time is spent on instrument calibration and characterization, documentation, etc.

#### **4.1. THE ROLE OF THE PROGRAM COORDINATOR**

Once a PC has been assigned to a program, the first step is to contact the PI. In this initial contact the PC will explain the role of the PC and CS, provide a partially completed template of the Phase II script, give instructions for retrieving the RPS2 software and give the PI a deadline for submitting the Phase II program. Up until the Phase II deadline the PC will be answering questions from the PI about RPS2, the Phase II program syntax, how to determine accurate target coordinates, etc.

After the program has been submitted, the PC verifies three things. The program must be essentially what the TAC approved (the same targets, instruments, and spectral elements). The program must use no more than the number of TAC-approved orbits. And the program must not duplicate previous observations or protected future observations of the GTOs. If any of these checks reveal a problem, the PC consults with the CS and they decide how to proceed.

The initial submission of the program is processed by the PC. This allows the PC to review the program with the very latest operational software. (RPS2 uses several components of the operational software, but that software changes with time: bugs are fixed, requirements change, the telescope itself may develop a new limitation or capability.) The availability of guide stars is an important scheduling constraint that is not available in RPS2 and that is factored in at this point. The PC also reviews the program for things that software can not catch such as inefficient structure or overly restrictive timing requirements. The products from this initial processing are used both for review and to make a long range plan for the telescope.

The PC also creates the target confirmation charts. In this step an image of the field is extracted from the digitized version of the survey plates used to construct the guide star catalog. Cross hairs are included which indicate the pointing specified in the program. These charts can be used to confirm that the target coordinates are good (with a source that has a visible component) or at least that the field is correct (with a source that has a faint or non visible component). This process is highly automated now. The request for charts pulls coordinates from the database, sends a request to a server that has the digitized plates in a jukebox and puts the completed charts in a directory that is accessible via the WWW.

As the planned time of execution approaches, the PC may reprocess the program with the latest version of the software. Changes in the instrument overheads, the status of the instrument, or the PI’s understanding of the target can lead to changes in the program at this point. When the PI, CS and PC agree that the program is ready the PC prepares the observation for flight.

The PI can monitor the status of the program from the WWW at <http://presto.stsci.edu/public/propinfo.html>. When an observation is scheduled, automated e-mail is sent to the PI. If there is a failure during the observation e-mail will again be sent to the PI. The PC is on call throughout this period to answer questions and to assist the PI in filing a request for reobservation in the case of a failure.

## 4.2. THE ROLE OF THE CONTACT SCIENTIST

The CS is available to help the observer during the design of the Phase II program. Once the program RPS2 script is submitted, the CS performs a review to ensure that the observations will not damage the instrument and to check whether there are any problems which would prevent the science goals from being achieved. Of course the observer still has the ultimate responsibility for the program. If the program needs to be modified, the CS reviews the changes to ensure that they are scientifically justified and consistent with the original goals of the program.

The CS reviews any possible duplication conflicts. Any real conflicts are forwarded to a review committee and then the Director of STScI for action.

Once the observations are executed, they are calibrated in the pipeline using the best reference files (e.g., flats, biases, darks) currently available and archived and sent to the observer. The CS reviews a “paper product” (which summarizes the status of the observations and their calibration and presents a graphical representation of the data) in order to ensure that there are no obvious problems with the data. In the rare event that an observation has failed, the CS and/or PC can assist the observer in filing a Hubble Observation Problem Report (HOPR) and requesting a repeat of the observation.

The CS can advise the observer on the latest knowledge of the instrument performance and calibration. Observers are also welcome to visit the STScI for a few days to work on their data. During these visits, they are supported by their CS and by a Data Analyst (DA) who is knowledgeable about calibration and reduction techniques.

## 4.3. THE RESPONSIBILITIES OF THE OBSERVER

Even though the STScI provides extensive support, it is important to remember that the observer has the ultimate responsibility for the success of the observing program. In addition to providing the scientific vision for the program, the observer has the following detailed responsibilities over the lifecycle of the program. In Phase I, a GO applies for time on HST to do a particular project. In the process of proposing a project, the observer must specify the targets that will be observed, the instruments, modes, and optical elements to be used and an estimate of how long it will take to execute. As part of the Phase I process, the GO is also required to check to see if any of the proposed observations have been done before, or are reserved by the GTOs. If a duplication is found, it must be identified and justified in the Phase I proposal. (Actual duplications found later on by the PC will result in the observation being disallowed.)

In Phase II all PIs (both GOs and GTOs) are responsible for specifying the details of the observing program by constructing the RPS2 script for the program. This involves

- measuring accurate target coordinates in the HST guide star reference system,
- (re)computing exposure times,
- downloading and installing the RPS2 software,
- completing the RPS2 script of the observations,
- checking the script with RPS2 and correcting any problems,
- submitting the RPS2 script by the Phase II deadline.

After the program has been submitted the PI iterates with the PC and CS to resolve any issues concerning intent of the program, potential duplications, variations from the Phase I proposal, and problems encountered processing the proposal. Changes in the instruments or the telescope as a whole may require reworking of the proposal by the PI later on.

The PI of a proposal is also responsible for checking the target confirmation charts. This allows the PI to double check their measurement of the coordinates and if the coordinates were correctly typed into the proposal. Before the proposal is made ready for flight, the PI reviews the galley proof (which is a revised version of the proposal with any changes (if needed) made by the PC and/or CS). The PI must confirm that the changes made during implementation do not interfere with the intent of the program.

The final PI responsibility is to check the data and if there are problems, to file a HOPR within 90 days of the execution date.

## 5. THE WHOLISTIC APPROACH TO USER SUPPORT

As discussed above, the PC and CS team are just one part of the support provided to HST observers. The PC and CS are complemented by documentation, software, WWW resources and tools, and the help desk. These additional resources

- provide some aspects of support more efficiently than the PC and CS,
- leverage and multiply the support provided by the PC and CS,
- reduce demand on the PC and CS time for direct user support, freeing them to do the other parts of their jobs, e.g., improve documentation and tools, process programs, calibrate and characterize the instruments.

In addition to the direct user support provided by the instrument scientists in their CS role, they also provide other critical support for users which facilitates extraction of the maximum scientific output from HST data.

### 5.1. CALIBRATION OF HST DATA

After the observations are taken they are calibrated in the pipeline, archived, and then sent to the observer. The pipeline calibration uses the best calibration reference files (darks, flat fields, biases, dispersion solutions, geometric distortion corrections, etc) which are available at the time. Because many calibrations are functions of time, the STScI's instrument teams (instrument scientists and data analysts) create new reference files as needed to ensure proper calibration of the data. At the beginning of each cycle, the instrument teams review each cycle's programs and construct a comprehensive calibration plan designed to calibrate the observing modes which are used. Using the calibration plan, the teams craft calibration observing programs which produce the data used to generate the calibration reference files.

### 5.2. DATA ANALYSIS SUPPORT

Because of their work to calibrate and characterize the instruments, the instrument scientists and data analysts become expert in the calibration, reduction and analysis of the data from their instrument. They provide updated information on the characteristics and performance of the instruments to the observers via documentation, e.g., the Instrument Handbooks, Data Handbook, and Instrument Science Reports which are readily available to observers. In some cases, the instrument teams create and/or implement novel data reduction techniques such as dithering and drizzling.

Observers are welcome to visit the STScI for a few days work on their data. During these visits, their CS can advise them on data reduction strategies which their DA can help them carry out.

### 5.3. THE HELP DESK

The STScI provides a help desk which can be contacted at [help@stsci.edu](mailto:help@stsci.edu). The help desk is an all-purpose resource which can be used by observers or archival researchers when they have questions. The help desk is monitored during business hours and questions are entered into a software tracking system. The questions are forwarded to the appropriate local expert who then responds to the observer and copies the help desk. The help desk tracks the questions to make sure that the questions are answered in a timely manner. The goal is to reply to questions within two working days. The questions are also tracked in order to determine what problems and questions observers and archival researchers have. This information is used, for example, to improve our documentation, generate Frequently Asked Question (FAQ) lists, and fix software bugs when necessary.

During 1997, the help desk received 2178 questions, with 934 related to the Space Telescope Science Data Analysis System (STSDAS), 553 concerning individual instruments and their calibration and data reduction, 79 specific to Phase II (this does not count questions sent directly to the PCs), 32 concerning Phase I, and 580 general questions.

## 5.4. CONSIDERATIONS FOR DOCUMENTATION, TOOLS AND SOFTWARE

We provide tools and documentation to assist the observers in the creation of a well-designed and schedulable program. All the documentation is currently available both as paper and on the WWW (usually as html and postscript). Further, we attempt to make the documents as uniform as possible so that our users are comfortable with the consistent look and feel of our many diverse documents.

The same considerations apply to the software that we provide on the web: tools to aid the computation of exposure time and to provide information on target coordinates, an orientation tool, and proposal preparation software. The popularity of exposure time calculators in the past year shows that such utilities are perceived by the community as valuable and important for proposal preparation. For the simple tools which are not CPU intensive, putting them on the WWW assures easy access and removes concerns about portability between computing platforms.

## 6. SUMMARY AND RECOMENDATIONS

Lessons learned from the HST experience are the following.

1. User support is essential to attain the basic goals of efficiency and high scientific output.
2. User support is required at every stage of an active observing program and beyond if an observatory has an archive.
3. The single point of contact and “cradle-to-grave” support provided by the CS and PC are critical to the success of HST user support.
4. The wholistic approach combines CS/PC support with documentation, software and tools, and the help desk to create an efficient and powerful support structure for observers.
5. The most important aspects of user support are:
  - interaction with observatory users
  - routine instrument calibration
  - documentation
  - software tools
  - development of new techniques/capabilities
  - maintainance and updates of documentations and tools
  - maintaining the history of the instruments capabilities for the archive user.

We have found CS/PC support in the context of a larger, wholistic approach to be the best balance between demand on staff time, efficiency, and user support. In the second decade of HST, we will continue to optimize and streamline our user support, making use of new emerging software and communications technologies. Emerging communications technologies will be used to reduce the time/personnel spent on routine questions and hand holding, so that the necessary personnel can be used to maintain highly calibrated instruments capable of observing at the limits of the instrumentation’s abilities and producing cutting-edge scientific research.

## 7. APPENDIX A. GLOSSARY

CS (Contact Scientist) - The instrument scientist assigned to support a particular observing program.

Confirmation Chart - A confirmation chart is an image of the sky taken from a guide star survey plate with cross hairs superimposed on the pointing specified. They are used to confirm that the specified pointing is what the PI intended.

DA (Data Analyst)

ETC (Exposure Time Calculator)

GO (General Observer) - A scientist who is awarded telescope time through the TAC process.

GTO (Guaranteed Time Observer) - A scientist who was part of one of the instrument definition teams and has therefore earned guaranteed time on the telescope.

HOPR (HST Observation Problem Report) - A HOPR provides a mechanism for observers to inform STScI when a problem has occurred with the implementation, scheduling, execution, or data processing of their observations. It is also the means by which the PI makes a request for failed observations to be repeated.  
<http://www.stsci.edu/public/hopr-request.html>

IS (Instrument Scientist) - The scientists at STScI who specialize in a particular instrument (FOC, FGS, NICMOS, STIS, and WFPC2) and work to calibrate and characterize it.

LRP (Long Range Plan) - The LRP is an execution plan for a large pool of observations over a long period of time.

Phase I - Phase I is the annual process of accepting and reviewing the roughly thousand of applications (called Phase I proposals) for time on HST.

Phase II - If a Phase I proposal is approved it becomes a Phase II program. The Phase II program is contains the observer's detailed specification of the parameters of the observations and is written using the RPS2 software.

PC (Program Coordinator) - This person is one of two primary contacts for a PI with a Phase II proposal. (The other is the CS.) The PC will help the PI throughout the observing program preparation process. The PC will also run the software to implement the program after it has been submitted by the PI.

PRESTO (Project to Re-Engineer Space Telescope Observing)

PI (Principle Investigator) - The lead scientist for a program is called the PI.

RPS2 (Remote Proposal System 2) - This is the software package used by the PI to construct a Phase II observing program.

STScI (Space Telescope Science Institute) <http://www.stsci.edu/>

STSDAS (Space Telescope Science Data Analysis System)

TAC (Telescope Allocation Committee) - This committee which meets about once a year to peer review Phase I proposals and choose proposals to recommend to the STScI Director for telescope time.

USCC (User Support Coordinating Committee) - During the first two years of the CS/PC program this group set up policies and procedures for user support and coordinated the efforts of the two divisions directly supporting observers. The committee contained representatives from all the Instrument Groups as well as the PCs and other PRESTO personel.

## 8. ACKNOWLEDGMENTS

We are grateful to Glenn Miller and Danny Golombek for comments on the manuscript. The Space Telescope Science Institute is operated for NASA by the Association of Universities for Research in Astronomy, Inc. (AURA). CPO thanks Scott Adams for inspiration.