Program management of the HST Advanced Camera for Surveys: a new approach

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ABSTRACT

The Advanced Camera for Surveys (ACS), which will be installed on-orbit in HST during the 1999 Servicing Mission, is being developed jointly by the Johns Hopkins University (JHU), Ball Aerospace \& Technologies Corporation, and NASA Goddard Space Flight Center (GSFC). On ACS, GSFC has contracted separately to JHU for the Principal Investigator (PI) and his science team and to Ball for development and fabrication of the instrument. In addition, GSFC is providing significant amounts of flight hardware. Led jointly by the PI, the Ball Program Manager, and the GSFC Technical Officer, an integrated product team approach has been implemented that includes members from all three organizations, ensuring an integrated approach to meeting the instrument objectives. An innovative, performance-based contracting structure has been implemented that reflects the dual objectives of meeting the science requirements within the cost and schedule constraints.

Keywords: HST, ACS, management

1. INTRODUCTION

The Advanced Camera for Surveys (ACS) was competitively selected in 1994 and awarded to the Principal Investigator (PI) in 1995 for on-orbit installation in the Hubble Space Telescope during the third servicing mission in 1999. ACS is the first HST instrument whose selection criteria weighted cost and schedule equally with science.

ACS (Figure 1) is truly an advanced camera. It contains three, high-performance channels: 1) a Wide Field Channel (WFC), with a large format (4K x 4K) charge coupled device (CCD) detector optimized for the I-Band and an order of magnitude higher discovery efficiency than currently available with HST; 2) a High Resolution Channel (HRC), with a 1K x 1K CCD optimized for the visible/ultraviolet and a coronographic capability; and 3) a Solar Blind Channel (SBC), with a 1K x 1K multi-anode, microchannel array (MAMA) detector containing a cesium iodide photocathode.

The challenge for ACS is to build this instrument for less than half the cost of previous HST instruments on a significantly shorter schedule while maintaining all of the scientific goals. This requires an innovative approach to the design, management, contracting structure, and performance of the effort.

2. BACKGROUND

HST science instruments are selected through the NASA Headquarters Announcement of Opportunity process. Historically, the instruments are of a unique design, and contracts are awarded to the selected Principal Investigator's institution, which in turn contracts with the instrument contractor and other supporting organizations. In order to meet the stringent cost and schedule requirements of the 1994 AO, several innovative approaches were proposed by the ACS PI and his team.
First, the ACS technical approach makes large, deliberate use of HST heritage designs from existing instruments, especially the Space Telescope Imaging Spectrograph (STIS) and the Near Infrared Camera and Multiobject Spectrometer (NICMOS). This not only enables re-use of hardware and software designs and drawings, but also enables the direct use of spare flight, non-flight, and ground support hardware.

Second, the PI offered NASA the option of performing selected portions of the work in house when this would benefit development of the hardware. An example is in the design, development, procurement, and test of the suite of thirty-eight types of filters and other optical elements. The proximity of the Goddard Space Flight Center (GSFC) to the PI institution and key science team members facilitates the ability to perform the correct trades to produce the best science filters for the lowest cost on an appropriate schedule.

Finally, the PI offered NASA the option to directly contract with the instrument contractor. This approach was an outgrowth of the successful HST Corrective Optics Space Telescope Axial Replacement (COSTAR) effort, conducted under a similar contracting structure. This option carries significant cost savings and has, as will be shown in the following sections, accrued major benefits in facilitating a team structure on ACS.

3. ACS CONTRACTING STRUCTURE

The ACS contracting structure has three components: 1) a contract with Johns Hopkins University (JHU), the PI institution; 2) a contract with Ball Aerospace and Technologies Corporation, the instrument contractor; and 3) internal GSFC non-contractual efforts and support contractor tasks. Each of these will be discussed in turn.
The contract with JHU is science driven, focusing on the PI, his team, and the eventual observational use of ACS. The contract is written to specifically ensure that the PI is an integral part of the instrument development, just as though the instrument itself were being contracted through him and his institution. All science-related deliverables (e.g., design reference missions, calibration, etc.) are his lead responsibility. In addition, parallel advanced CCD development activities that are not currently, but could be, baselined are conducted under the auspices of this contract to avoid defocus of the main effort at the instrument contractor.

The contract with Ball is a research and development, performance-based contract. It is instrument performance driven, focusing on the development, fabrication, integration, and test of the science instrument. The cost and schedule challenges of ACS, however, as well as performance-based contracting require that the exact nature of the instrument contract reflect the equal emphasis placed on those parameters by the AO. To that end, a contract was formulated that carries incentive fee provisions reflecting cost, schedule, and performance goals. One-half of the total fee pool is set aside for incentives. Within that incentive pool, one-half is allocated against science performance; the other half is allocated to cost and schedule. A series of eight, very specific cost, schedule, and performance milestones and criteria (Figure 2) were established at contract initiation.

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Figure 2: The eight ACS incentive fee milestones

At each milestone, a predetermined portion of the incentive fee pool for cost, schedule, or performance can be provisionally collected if the criteria are met or held aside if not met. Provisional is the operative word, however, in ensuring that the ultimate goals are met. The contract provides for the return of provisional fees if ultimately the cost, schedule, or performance of the instrument do not meet the requirements. Conversely, full fee can be eventually obtained if, despite problems along the way, the instrument eventually is completed on cost and schedule and performs as required. It should be
noted that a single, clear performance metric is identified for each of the three ACS channels: a specific discovery efficiency, defined as the product of field of view and throughput. The overall fee structure concept is depicted in Figure 3.

Figure 3: The overall ACS schedule, cost, and performance incentive fee structure.

Internal GSFC efforts, such as the filters cited above, are not contractual in nature. However, formal statements of work, deliverables, budgets, and schedules are agreed to and documented. Tasks with GSFC support contractors; e.g., fabrication and qualification of two flight shutter mechanisms, are specified and implemented per standard contract task procedures.

The keys to the success of this type of multi-organizational structure are four-fold: 1) a single Technical Officer/Instrument Manager or equivalent for all efforts to coordinate and ensure continuity and consistency; 2) a shared leadership responsibility between the GSFC Technical Officer, the Ball Program Manager, and the PI; 3) development of a team atmosphere with clear charters, roles, and responsibilities defined; and 4) early development and release of science requirement specifications, instrument performance specifications, and a design reference mission.

4. ACS TEAM STRUCTURE

The ACS top-level team structure and lead responsibilities are shown in Figure 4. To reiterate, the GSFC Technical Officer is responsible for the technical, cost, and schedule performance of both the PI and instrument contractor, as well as in-house
efforts. With this also comes the responsibility to ensure that interfaces are well defined, that the proper individuals from all organizations are represented in each activity, and that the interest of HST as a national science resource for all observers is preserved.

![Diagram](image)

**Figure 4: ACS top-level team structure and lead responsibilities.**

Note that while the Technical Officer is, contractually, the common element of the structure, in reality and practice that leadership role is filled by a team comprised of the Technical Officer at GSFC, the PI at JHU, and the Program Manager at Ball. The close, continual interaction between these three individuals ensures that science performance, hardware development, cost, and schedule factors are represented in day-to-day resolution of issues and decisions. This enables performance of cost/risk/benefit trades in an effective and timely manner and clear decisions communicated to all.

The entire ACS effort is comprised of Integrated Product Teams (IPTs). Each major element or subsystem has a lead organization, with an IPT lead for that activity; however, the team itself contains members not only from the lead organization but other key organizations as well. For example, the CCD Detector Subsystem is the responsibility of Ball. While the team is led by Ball and populated with all of their appropriate subsystem support functions (e.g., mechanical, electrical, thermal, production, etc.), science team members have been integrally involved with the design, development, test, and selection of the devices, including on-site stints at the vendor and at Ball to work issues, perform selection, and gain run time experience on the devices. Similarly, the filter team is led by GSFC; however, the specifications and interfaces were jointly developed with Ball team members, design and selection have been iterated continually with the science team members, and the daily work is performed by the GSFC staff and on-site contractors. Joint vendor visits to work issues have included members from all three organizations. Finally, the calibration and Space Telescope Science Institute operations development is led by the PI; these IPTs maintain a close working relationship with the software and operations staff at Ball and with the Operations and Ground Systems staff at GSFC.
With each of these IPTs, the top-level requirements, interfaces, roles, and responsibilities are well understood. The day-to-day roles and responsibilities emerge naturally through the "badgeless" IPT interactions that occur: involve members of the IPT, agree to what makes sense, then get it done.

5. CONCLUSION

At the time of this writing, all ACS flight subsystems are complete or in final build, and integration of the optical bench is well underway with delivery to GSFC in less than one year. Contractual cost and schedule agreements are being met, and performance is predicted to meet the requirements. As is usual with advanced space science instruments, technical, cost and schedule difficulties have been encountered along the way. However, the ACS team environment has made resolution of those challenges easier and more collegial while the contractual structure has kept cost and schedule in clear focus along with the performance objectives.

6. ACKNOWLEDGEMENTS

The authors express their appreciation to the entire ACS team for their support in implementing the IPT approach and for their dedication to producing a scientifically excellent camera for use by the science community, within cost and schedule guidelines.

7. REFERENCES