Operations Science Use Scenario

Phil Puxley

Introduction

This document presents an example scenario of the operational use of the Gemini facility following an astronomer from her initial idea for a science program through planning and execution of the program by Gemini staff. The intent is to illustrate the procedures for use of time on the Gemini telescope and highlight the software tools required at the various stages. It is assumed that both Gemini telescopes are in a 'steady-state' operational phase.

This scenario is an expansion upon examples given in the Gemini Science Operations Plan (currently in version Draft 1.2) and instrument-use scenarios (GSCG.sbw.008/01).

Scenario

1. Pre-application

1.1 Astronomer (the future PI) has an idea (yes, another one!) : "a search for Positronium recombination line emission from the Galactic centre". (Actually, they copy the idea from Puxley & Skinner, Proc. ESO/CTIO Conference on the Galactic Centre, 1996 !!). Astronomer calculates expected wavelength and estimates line flux.

1.2 Astronomer searches mirrored Web site in own country to find Gemini schedule information, facility and instrument status to see if a suitable instrument will be on the telescope at the appropriate time of year.
[s/w used : (1) WWW, search tools; (2) partners need mirror sites]

[status : existing s/w]

1.3 Astronomer has a query about a specific detail of the instrument configuration and e-mails the query to the local contact in the national office. (If it had been a different instrument, this could have been a contact in a different country's office, which had more expertise in that subject area). Receives prompt reply.

1.4 Astronomer examines expected distribution of observing conditions and decides what conditions are required for the program.

1.5 Astronomer uses an integration time estimator on the Web site for the instrument of choice to decide if the observation is feasible. In this instance, the input parameters are wavelength, line flux and line width and desired S/N ratio. Astronomer selects the appropriate instrument configuration from menu options. Output parameter is integration time.
Astronomer decides a longer time would be better, enters this new value into the time estimator, re-calculates and is presented with the predicted S/N ratio.
[s/w used : integration time estimator]

[status :instrument groups to provide basic algorithms (?), augmented by Gemini; need WWW interface]

1.6 Astronomer enters object co-ordinates into guide-star selection tool on Web site to determine if suitable guide stars are available for desired image quality. The tool uses its knowledge of the wavefront sensor FOVs and perfomance of the telescope as a function of guide star brightness, relative position etc. to present the optimum guide stars. Several selections are presented in case of problems with the optimum choice. The astronomer is also presented with a graph of the predicted image quality as a function of natural seeing appropriate for the object declination.
[s/w used : (1) Guide star catalogue search; (2) image quality predictor]

[status : (1) GSCII interface via HTML needed, modelled on ESO skycat - OCS/DHS workpackages; (2) need IQ prediction algorithms and s/w]

1.7 Astronomer discovers that the predicted image quality at the low elevation of the Galactic centre from Mauna Kea is poorer than they had expected and decides that the spectrometer slit will have to be wider to accept more flux. (In this example, no equivalent instrument is available on Cerro Pachon which is better suited to Galactic centre observations). The astronomer iterates back to the last-but-one step to determine the new integration time and S/N. The astronomer prints out a summary of integration time details.

1.8 Having concluded that the observation is feasible, Astronomer decides to submit an application to her national time allocation committee.

2. Application Phase I

2.1 Astronomer follows Web link and reads instructions for proposals appropriate for her particular country.

2.2 Astronomer writes scientific justification using favourite text editor, in this case MS Word and produces an RTF file, one of the formats acceptable to her TAC.
[s/w used : 'commercial' text editors (partner preference but best to have formats common to Gemini Phase II input)]

[status : existing s/w]

2.3 Astronomer enters basic information into form e.g. contact details, object position, required conditions, instrument configuration, observing mode, integration time. (*Format is partner preference, but best to have compatible with Gemini Phase II and scheduling tools*). Web-based version constrains entry of several parameters (e.g. choice of image quality bin, dark or bright time, spectrometer grating) but allows comments to be entered where appropriate. Astronomer attaches output file produced by guide star selection page, scientific and technical justification files and a previous spectrum as a postscript image. Web form and attached files ("the proposal") is submitted electronically.
[s/w used : (1) Web applications forms; (2) FTP]

[status : (1) Need to define form and information required for Phase I; commercial forms software exists. Could be common to all partners]

2.4 National support office for TAC (could be the national office depending on partner preference) receives proposal and replies to PI with a reference number.

2.5 National support scientist decides on appropriate technical and scientific referees and forwards proposal.

2.6 At (or shortly before ?) national TAC meeting, scientifically-ranked lists of classical and queue observing programs produced. National support staff analyses ranked lists using nominal partner share of time and expected distributions of observing conditions to determine balance amongst conditions. National TAC revises lists to redress approximate balance if necessary.
[s/w used : Scheduling simulator (for time accounting)]

[status : non-existent; must be portable for use at TAC meetings. Can be common to all partners.]

2.7 Ranked lists and proposals sent by each national TAC to Gemini. If necessary, national support offices convert proposals into one of the Gemini accepted text formats and translate into english.
[s/w used : (1) ftp; (2) Web-based form; may need text conversion s/w]

[status : 'commercial' conversion s/w exists; forms definition as in (2.3)]

2.8 Gemini scheduler at one of the telescopes merges classically-scheduled programs from partners using the merging sequence and relevant information accessed from proposals, for both telescopes. (These 'top-level' scheduling tasks are better carried out by a single individual at one site, rather than in parallel at both sites, to ensure common operation and time usage distributions across the two facilities). Draft classical observing calendars produced for both telescopes consistent, to the maximum extent possible, with the blocked schedule of instrument availability and proposal requests. Nominal queue allocations to partners adjusted as a result of the draft classical allocations.
[s/w used : (1) Classical merging and scheduling tool; (2) Time accounting s/w]

[status : (1) non-existent (but see other telescopes); (2) trivial (spreadsheet)]

2.9 Gemini scheduler determines partner usage of the different types of observing conditions over the previous 2 semesters and adjusts nominal entries in queue merging sequence if historically inequitable.
[s/w used : Time usage accounting s/w]

[status : OCS tracks time usage; need output, say to spreadsheet ?]

2.10 Gemini scheduler merges queue-scheduled programs from partners using merging sequence and expected distribution of conditions using software tools to ensure that each category of observing conditions is overallocated by some predetermined fraction.
[s/w used : Queue merging and loading tool]

[status : non-existinet; can define functional requirements now]

2.11 Gemini scheduler does several runs of an execution simulator to determine if (i) the pool of proposals is sufficient for reasonable variance in the expected distribution of conditions, (ii) the likely distribution of partner usage of different conditions is equitable.
[s/w used : Queue execution simulator]

[status : non-existent; can define function requirements soon (s/w must be portable - see 2.13)]

2.12 Gemini scheduler communicates draft classical schedule and queue to national TAC (or support office depending on partner preference), flagging any conflicts in time requests or usage e.g. programs which could not be scheduled, inequalities in time usage.

2.13 At international TAC meeting, ITAC and Gemini scheduler resolve conflicts by making modifications to the draft schedule and queue.
[s/w used : classical merging and scheduling; queue merging and loading; queue execution simulator]

[status : see 2.8 & 2.11; software must be portable for use at ITAC mtg]

2.14 Gemini Director approves draft schedule and queue. These are communicated to national TACs and/or support offices and posted on Gemini Web site. National TACs or support offices immediately notify PIs of proposal acceptance or rejection.
[s/w used : Web; e-mail]

[status : existing s/w]

2.15 The first version of the "observation likelihood" table is published on the Web site giving the likelihood of execution of observations in the semester based on the results from the execution simulation.
[s/w used : execution likelihood predictor (output from execution simulator)]

[status : see 2.11]

3. Application Phase II

3.1 Our astronomer, a successul queue PI, studies pre-defined examples of recommended observing modes (data acquisition and on-line processing) in the spectrometer user guide on the Web to see if any are relevant. The one which describes a deep integration by repeating a simple nod pattern is suitable but the astronomer realises that they will also need a broadband IR image to identify a suitable off-position for the nod cycle. (Remarkably, no suitable image of this rather well-studied region exists in the literature...). An example of the acquisition image mode is contained in the manual.
[s/w used : Web-based manual]

[status : existing s/w]

3.2 After a quick phone call to the national support office for clarification of a query, the PI generates a detailed description of the required observations using the Observing Tool to modify the examples identified in the spectrometer user manual. The PI makes a note in the "additional information" section of the form, for the Gemini staff observer/operator team who will be carrying out these observations, that the nod offset is notional and should be updated after examining the acquisition image. (Really would like a conditional flag here so that spectroscopy can't be executed before the imaging.)
[s/w used : Observing tool]

[status : OCS work package]

3.3 From the information provided by her pre-application use of the integration time calculator, the PI enters in the form the conditions under which the observation should be terminated. As she has great confidence in her line flux estimate she checks the box which sets a limit derived from

the sky noise level in the on-line processed data frame. If this level is achieved in less that the requested integration time then the observation will terminate (cleanly, at the end of a nod cycle). (In practice the integration may be extended by the Gemini observer/operator team who have the standing authority from the Director to increase the integration time by 30% beyond that allocated by the TAC if necessary). The requested observation descriptions and associated information are automatically submitted to the "pending" queue observation database.
[s/w used : (1) Phase II 'form'; (2) observing database management]

[status : (1) need to define Phase II info requirements;
(2) OCS workpackage]

3.4 The PI interrogates the queue observation database to confirm that her program has been entered (but is restricted from examining sensitive information on other programs).
[s/w used : observing database management s/w]

[status : OCS w/package ?]

3.5 A Gemini scientist routinely examines the "pending" database and finds that a new program has been entered. They check that the program of observations is (i) consistent with the time allocation by the TAC and (ii) reasonable given the scientific aims in the case and instrument performance (using the integration time estimator and image quality predictor for the selected guide stars). The scientist notes the need for an IR acquisition image. (In another instance they might e-mail the PI to say that, given the complexity of the starfield and great sensitivity required by the spectroscopic observations, it might be better for the PI to be involved in the selection of the nod offset and that they could be sent the acquisition image. The spectroscopy observations would be put "on hold" until the offset had been defined).
[s/w used : database management s/w; integration time estimator; image quality predictor]

[status : see 1.5 & 1.6]

3.6 The Gemini scientist approves the program as entered by the PI and transfers it to the "active" queue observation database.
[s/w used : observing database management s/w]

[status : OCS w/package ?]

4 Program Execution (...some time later)

4.1 For the weekly queue observing preparation meeting, the execution simulation tool is run for various distributions of expected conditions and using a long term weather forecast as a guide. The Web-based table of observation likelihood is updated. Gemini scientist and operator teams scheduled to be observing in the forthcoming week familiarise themselves with the observations most likely to be executed and identify any special requirements e.g. non-standard filters to be installed, common calibrations.
[s/w used : execution simulator, database management s/w (to study likely proposals)]

[status : see 2.11]

4.2 The daytime scientist/operator team, co-ordinating with daytime engineering work, execute instrument checks and calibration observations appropriate for science observations likely to be carried out that night on the basis of the short-term weather forecast. An 'engineering' observation is executed on the spectrometer to check basic instrument performance, read noise, dark current and throughput using the calibration unit. An on-line data processing script reduces

the data according to a standard procedure. The scientist/operator team are notified that the performance is nominal (e.g. read noise within some limits) and a note to this effect is automatically appended to the current narrative observing log.
[s/w used : Gemini prinicpal (and sub-) systems (e.g. TCS, ICS, DHS) via OCS]

[status : existing workpackages;
scripts needed to automate procedures e.g. to check performance]

4.3 A series of dark frames and flat-fields are taken for our PI's program, reduced by the standard on-line processing scripts and verified by the scientist/operator team monitoring the standard quick-look display streams.
[s/w used : as 4.2]

[status : existing workpackages]

4.4 The daytime scientist/operator team set the primary and facility conditioning parameters (e.g. mirror temperature and rate, facility AC) appropriate for the forecast night-time temperature.
[s/w used : (1) weather forecasting; (2) OCS and Gemini sub-systems (e.g. PCS, ECS)]

[status : (1) non-existent; (2) existing workpackages]

4.5 The daytime team handover to the night-time team. The night-time team review the observing log and the daytime team's comments and the calibrations already taken.

4.6 The night-time team study the updating site monitoring data for seeing parameters, water vapour content, cloud cover images, transparency etc. They run the queue execution tool which compares the current and short-term forecast conditions with the queue database of active programs and are presented with a suggested list of observations which could currently be executed. The list is ordered from highest to lowest weight on the basis of scientific ranking, match to conditions, sky position, program completion status etc.
[s/w used : (1) site monitoring; (2) weather forecasting; (3) queue execution]

[status : (1) currently defining requierements; (2) non-existent;
(3) OCS workpackage]

4.7 The scientist/operator team select our PI's observation from the top of the suggested list and the required telescope and instrument information are transferred from the observation database. The team note the requirement for an acquisition image to set up the nod offset.
[s/w used : OCS etc.]

[status : existing w/package]

4.8 The team note that the basic instrument calibration frames have already been taken by the daytime team and proceed to slew the telescope to the requested co-ordinates. During the slew the instrument is configured to the correct grating, filter, camera combination and the on-instrument and peripheral wavefront sensors (PWFS) are moved to the expected guide star positions. A clock starts counting from the start of the slew.
[s/w used : OCS etc (include. time accouting)]

[status : existing w/package]

4.9 At the end of the slew the operator attempts to close the loop on the first guide star but the PWFS1 status display indicates poor lock. Remembering an earlier request from the WFS engineer for examples of poor lock, the operator captures 5s of WFS status data (using an engineering "science program" from the OCS database) and stores the accumulated data in the engineering archive. (On closer inspection this star is actually a close binary and not suitable for

accurate guiding). A ‘reserve’ guide star from the program in the observation database is selected and the PWFS1 moved to the new position. The operator notes the failure of the first guide star acquisition in the log and flags the errant star in the guide star database.
[s/w used : ‘engineering’ status displays; OCS etc.]

[status : basic status in existing workpackages; need to identify most useful displays and information during commissioning]

4.10 The operator successfully closes the loop with the two guide stars as indicated by the image quality status display. The operator notes from the status displays that the contribution of the primary mirror to the error budget at this low elevation target is significantly larger than expected although the overall predicted image quality is within the requirement for the observation. The operator makes a note in the narrative observing log, copies it to a fault report as a possible indication of a problem with the mirror cell supports but continues to execute the acquisition imaging observation.
[s/w used : (1) image quality estimator; (2) OCS]

[status : (1) Could be same as image quality predictor ? (see 1.6)]

4.11 The acqusition image, a simple object-sky frame, is taken and the result displayed by a quick-look stream attached to the on-line processing script for this observation. The scientist/operator team uses the GUI to identify the location of a suitable nod position and the new offset is entered into the spectroscopic observation description using the Observing Tool. The team save the acquisition image into the science program archive.
[s/w used : OCS, DHS etc.]

[status : existing w/package]

4.12 The spectroscopic observation is selected and proceeds to execute a long series of nodded integrations. Watching one of the quick look display streams attached to the on-line processing, the scientist/operator team notice thhe possible presence of a weak line one arcsec from the expected position. They make a note in the observing log and attach another quick look stream to display this spectrum from further along the slit.
[s/w used : OCS etc.]

[status : existing w/package]

4.13 The scientist/operator team continue to monitor the observing conditions and periodically run the queue execution tool to update the suggested list of new observations.
[s/w used : OCS etc]

[status : existing w/package]

4.14 Monitoring the steadily reducing sky noise in the processed data as more integrations are accumulated, the scientist decides that the noise is sufficient and terminates the observation slightly ahead of schedule. Using the GUI, the last stage in the processing and several different display aspects (the 2D frame, the spectrum at the nominal position and the spectrum at the position of the interesting feature) are saved to the science program archive.
[s/w used : OCS etc]

[status : existing w/package]

4.15 The scientist selects the next observation from the updated list of suggestions (something about a brown dwarf search in the Pleiades) and the operator initiates the slew. The clock stops counting on our PI’s observation and the time accounting database is updated.
[s/w used : OCS etc]

[status : existing w/package]

4.16 During the slew to the next object, the scientist/operator team flag the observation as completed which sends an automatic e-mail notification to the PI. The raw data, selected processed data, acquisition image and observing log for the relevant time period are automatically copied to a temporary ftp archive.
[s/w used : OCS, DHS]

[status : existing w/package]

4.17 The PI receives an e-mail with instructions on the location of her data and retrieves it.
[s/w used : ftp; other media ?]

[status : existing s/w; what media ?]