Report of the JWST Grant Review Process Working Group

A Working Group (WG) was requested by the JWST Users Committee (JSTUC) to review the grant allocation process. The WG was constituted by the Space Telescope Science Institute Interim Director, Nancy Levenson, and began biweekly virtual meetings on January 24, 2024 culminating in this report which addresses each item in the Working Group's charge. The overall charge of the WG was to provide advice and recommendations on adopting a formulaic approach to allocate funding to JWST science programs.

The WG was chaired by Ata Sarajedini (Florida Atlantic University) and included Rupali Chandar (U. Toledo), Philip Choi (Pomona College), Tuan Do (UCLA), Rose Finn (Siena College), Jamie Kennea (Penn State, *Swift*), Dale Kocevski (Colby College), Lauranne Lanz (The College of New Jersey), Danny Milisavljevic (Purdue), Rodolfo Montez (*Chandra*), and Vice Chair Casey Papovich (Texas A&M) as members. Katey Alatalo (STScI JWST Science Mission Office), Susan Neff and Stefanie Milam (GSFC JWST Project Science Team) served as primary contacts and ex officio members. Neill Reid (STScI Science Mission Office) and Paula Sessa (STScI Grants Administration) also supported the work of the committee.

Below are the Working Group's responses:

1. Identify the key principles that should underlie JWST grant funding allocations for the US community:

The prime directive is to optimize the funding so as to maximize the scientific return, while minimizing the overall effort required to prepare, evaluate, and revise budgets, i.e. the so-called return on investment (ROI).

- **How much money has NASA allocated for total JWST grant funding?**

- **What is the minimum amount of useful funding per project?**
  - **– What is the "can't do the proposed science" line for the total budget?**
  - **– How to effectively gauge the Return On Investment (ROI) of accomplishing ALL of the science goals partially versus SOME of the science goals completely.**

- **For projects that involve international teams, how do we effectively interleave the efforts of the (NASA funded) US team members with the (non-NASA funded) international investigators?**

● How do we incorporate the complexity of the analysis and the level of effort that are required to yield the scientific return?

● How do we prioritize ancillary science benefits in the budget considerations, such as
  – the training and preparation of US undergraduate/graduate students in the reduction and analysis aspects of the project as a way to encourage and grow the next generation of scientists.
  – the legacy/archival/heritage benefits of larger-size projects

2. Codify the advantages and disadvantages of an FRC-style review and of a formulaic budget-allocation process

We outline below the pros and cons of three (3) review processes: the FRC-style review (the status quo): a purely formulaic allocation process (you get what you get); a hybrid process (formula+appeal; formula is used to provide target allocations for all proposals; only submitted budgets that exceed their target and "large" proposals are reviewed by an FRC.)

Advantages of an FRC-Style Review

● Provides optimum evaluation of projects that are especially challenging and unorthodox, since the reduction and analysis of some JWST observations is nuanced and not just a simple "by the hour" calculation.

● FRCs can maximize the budget; there's a collective consensus of how much money the ***community* needs to do the science.**

Disadvantages of an FRC-Style Review

● Significant amount of work effort among the investigators involved in writing and especially *revising* the FRC submitted budgets.

● Significant amount of work in the FRC review process can be extremely burdensome on the volunteer FRC members.

Advantages of a purely formulaic approach

● Given the size and complexity of the project, it gives investigators an idea of the "fair" amount of funding to request. This is a suggested amount not set in stone.

● Provides "peace of mind" for proposers, especially those in their early career stages and those at non-astro-focused departments, to know what to expect so

that they are assured of a level playing field in terms of funding for their projects in relation to others of similar size and complexity.

● The funding decision is returned to the proposers relatively quickly as compared with a FRC-style review process.

<u>Disadvantages of a purely formulaic approach</u>

● Could be very difficult to effectively implement given the complexity of JWST instrumentation and analysis requirements.

● A typical formulaic algorithm may be too rigid, overlooking regional variables such as differences in indirect cost rates (i.e., overheads), the cost of living, wages, and fringe benefit rates.

● May be prone to "gaming" meaning that more experienced proposers may try to use the system to enhance their budget allocation beyond what their program actually needs to deliver on their science.

● Some proposals will get "overfunded" compared to what they might have otherwise budgeted.

<u>Advantages of a hybrid approach</u>

● Has all of the advantages of the purely formulaic review.

● Mitigates, to some degree, the disadvantages of the purely formulaic review.

● Provides optimum evaluation of "large" projects.

● Allows for nuanced evaluation of some projects that are especially challenging and unorthodox.

<u>Disadvantages of a hybrid approach</u>

● Not fully immune to the disadvantages of the purely formulaic approach.

● Funding would be required (in reserve) to accommodate requests for funding above the formulaic amount that may come out of the appeals process.

● Major extra administrative effort on how to keep funding in reserve for the appeals process.

3. Identify the impacts (positive and negative) to equity of the current process, and of a formulaic approach, across community demographics, including career stage, type of institution, and DEIA categories

The FRC process (positives for DEIA):

- **Categories of the various funding request types (e.g. salary, travel, publications, etc.) are mostly transparent.**
- **Defining "work effort needed" as opposed to "dollar amount requested" can be tailored on a case by case basis to different regional locales and institutions with a range of costs of living, overhead rates (IDC), fringe rates, etc.**

The FRC process (negatives for DEIA):

- **While the allowable and unallowable categories of funding that can be requested are transparent, the amount of funding that can/should be is not clear.**
- **Anecdotally, this means that 1) early-career researchers, 2) those at institutions with few astronomers, and 3) senior researchers seem to ask for less funding.**
- **The amount of time required to draft a budget and its justification is more onerous on smaller institutions without large grants and sponsored project offices.**

Possible suggested improvements to the FRC process

- **Providing investigators with guidance and examples of budgets and justifications based on actual projects approved by the FRC.**
- **These examples would preferably be designed to address as many specialized project types as possible, including examples of work effort and reasonable costs for each type of project.**
- **Proposers could be asked to check a box when they submit their budgets if they are willing to have their fully anonymized budgets shared with others as examples.**

Formulaic approach (positives for DEIA):

- **Beneficial for early-career investigators new to the process and institutions that are not research-heavy.**

● Significant time savings in cases where the submitted budget is approved without a first round of revisions.

<u>Formulaic approach (negatives for DEIA):</u>

● Regional and institutional variations in individual costs (salaries, cost of living, overheads, fringe rates, etc) will lead to complications in devising a robust dollar figure allocation for each project.

4. Determining what factors could be included within a formulaic approach, including the possibility of an appeal

We have used a machine learning based model trained on the Cycle 2 and Cycle 3 General Observer (GO) funding data to estimate what percentage of the funding manifold can be accounted for by the various fitting parameters. See the Appendix for more details, but to summarize, we find the following as the most important fitting parameters in ranked order:

1. **Prime instrument observing hours (64% of variation)**
2. **US Principal Investigator (13% of variation)**
3. **Primary observing instrument (9% of variation)**

Other factors that the WG deems could be important to consider in such a formulaic approach are:

● Total amount of funding available for cycle from NASA

● Floor level of funding (minimum needed to do the proposed science)

● Complexity of the analysis
- **Instrument(s) + mode(s) of the proposed observations**
- **Judged by the investigators**
- **Judged by the TAC**
- **Given by the investigators and then evaluated by the TAC**

● Ratio Number of total investigators / US investigators

● non-US Principal Investigator

<u>Tertiary Factors</u>

● "Seniority" of the funded investigators [(under)graduate students, postdoctoral researchers, tenure track faculty, soft money faculty, staff, etc.]

- **Type of project: (Legacy, Archival, General Observer, Medium or Large)**
- **High level data products / return on investment to the community**
- **Number of deliverables/outcomes**
- **Whether data reduction/analysis pipelines already exist among members of the group or they need to be written from scratch**
- **Minimizing the ways in which investigators can "game" the system so that they are allocated more funding than they would otherwise get (e.g., requesting funding for science not approved in phase I)**

Factors for Appeal:

- **Highly complex reduction and analysis not taken into account by the formula.**
- **Regional and local variations in personnel costs especially cost of living differences.**
- **Unusually high or burdensome institutional indirect cost (IDC) and/or fringe rates.**
- **Fraction of U.S. and/or international investigators**

Application of the formulaic process (and appeal for the hybrid approach):

- **Recommended funding amount yielded by the formula - including the application of a funding floor.**
    - **Proposers will then be given the opportunity to appeal this number with appeals being considered by an FRC-style review. This FRC would also evaluate funding requests for Archival and Theory projects.**
- **Proposers need to be informed that they are free to appeal the formulaic funding level allocation, but given the limited resources, their ultimate funding level may be LESS THAN the value yielded by the formula.**

5. Developing specific examples of formulae

- **Derive a first-order formula based on General Observer programs in Cycles 2 and 3 to model the total dollar allocation for each program. See the Appendix for an example.**

- **In cases where the number of hours requested is less than (for example) 1 hour, apply a minimum funding allocation to those programs - exact dollar amount TBD.**
- **Provide a target maximum allocation to each proposer and ask them to submit a budget requesting and justifying the dollar amount as given by the formula. The budget proposal submitted needs to be within the scope of the science they were approved to do in phase I.**
- **Any proposing group that submits a budget asking for more than this formulaic amount (say by 1% or 2%), will then have their budget proposal evaluated by the FRC.**
- **The FRC will automatically evaluate the large programs requesting more than say $400K.**
- **The FRC could also be asked to evaluate programs with an overwhelming majority of non-US investigators.**
- **The FRC will also evaluate budgets submitted for Archival and Theory programs.**
- **If designed properly with little additional logistical burden on STScI/GSFC staff, this approach could be implemented in Cycle 4.**

6. Identifying improvements that could be made to the current FRC process, if STScI decides to keep it:

- **If the FRC is a standing committee, then ask them to dissect the current budget narrative form and provide feedback on revising it. They are the ones in the best position to critique this form and suggest improvements.**
- **Way to reduce the workload on teams writing the budget**
- **Template for the budget justification/narrative so that the FRC knows where to look for certain information ?**
- **Design template so that the information is easier to dissect.**
- **Worked examples of budget narrative forms.**
- **More detail requested for continuing programs**
- **Offering guidance to proposers on what they should ask for**

7. Providing a consensus recommendation on the preferred grant-allocation process

> **We recommend implementing a hybrid (formula+appeals) approach for JWST funding. The details of the formula should be kept internal and should be allowed to evolve from cycle-to-cycle. The primary factors upon which the formula should be based and its implementation are outlined above (#4 & #5). The possible evolution of this funding approach from cycle to cycle should be assessed by this Working Group or another one convened by STScI as more data are gathered to refine the process. We recommend that there be overlap in the membership of the working groups so as to maintain some level of institutional memory each time the group is reconvened.**

The Working Group will have access to the results of the JWST Cycle 2 and Cycle 3 FRC budget reviews and appropriate support from STScI staff. Any recommendations must be consistent with federal law on grant funding.

The Working Group comprises 8-10 members of the astronomical community selected by the STScI in consultation with the GSFC JWST Project Science team and the JSTUC. The Chair of the Working Group will organize the meetings of the Working Group, and STScI will provide logistical (travel, meeting, telecon, etc.) support as needed.

The committee will present a preliminary report to the JSTUC at their Spring, 2024, meeting. The final report will be due by June 30, 2024, to enable proposed changes to be implemented in the JWST Cycle 4 Call for Proposals.

Katey Alatalo (STScI JWST Science Mission Office) and Susan Neff (GSFC JWST Project Science Team) will serve as the primary contacts for the Working Group. They will be ex officio members of the WG. STScI Grants Administration will also support the Working Group. STScI and GSFC may supply observers to the committee.

Appendix

In this portion of the report, we summarize the formulaic modeling work that one of us (Dale Kocevski) performed in investigating the validity of such an approach to the allocation of JWST funding. A polynomial regression model was trained on an increasing number of parameters to determine the relative importance of each parameter. The parameter sets were as follows for each model:

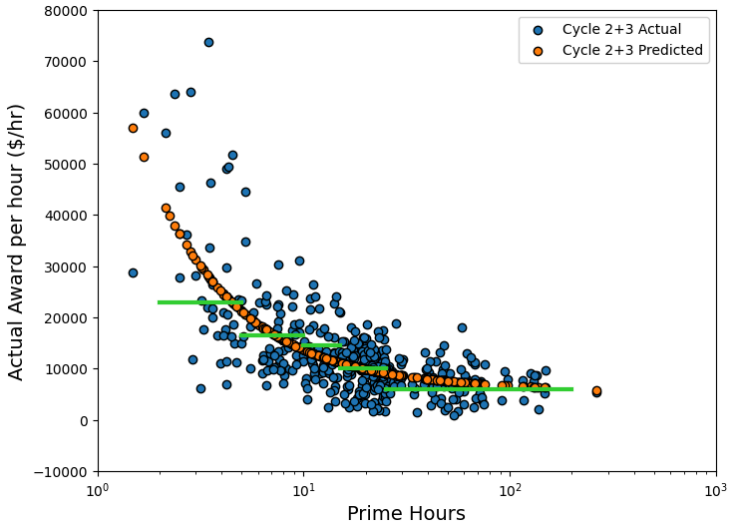
1) Prime instrument observing hours
2) Prime hours and US Principal Investigator status
3) Prime hours, US PI status,, and primary instrument
4) Prime hours, US PI status, and instrument mode.

As noted above, we find the following as the most important fitting parameters in ranked order:

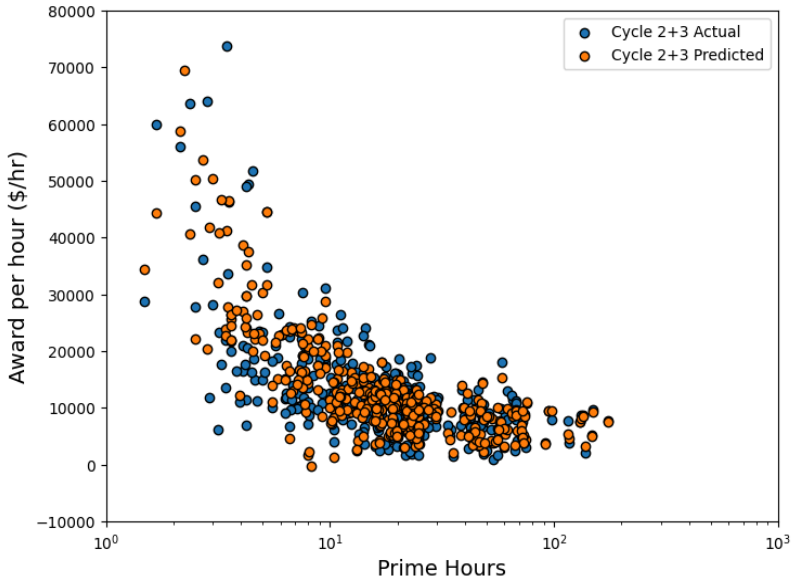
1. Prime instrument observing hours (64% of variation)
2. US Principal Investigator (13% of variation)
3. Primary observing instrument (9% of variation)

For reference, JWST Cycle 3 FRC advocated for a simple formula - looking at Cycle 3 results, the average $/hour is $23K for <5 hours, $16.5K for 5 to 9.9 hours, $14.5K for 10 to 14.9 hours, and $10K for 15 to 24.9 hours. We will refer to these as the "JWST reference allocations."

Here is the plot of actual awards $/hour as a function of the prime instrument observing hours for Cycle 2 and 3 (blue points). The orange points represent the polynomial fit for model #1 noted above. The green horizontal lines are the "JWST reference allocations" from the Cycle 3 FRC just mentioned.



Training on prime instrument observing hours **and** PI status reduced the scatter by 12% over the JWST reference allocations. Adding information on the instrument mode used reduces the scatter by an additional 17%. The predicted awards returned by model #4, compared to the actual awards can be seen in the following plot.



Overall the model with all the information has a scatter that is 27% smaller than the JWST reference allocations (over all program sizes), as seen in these two plots: