Instrument Development Guide Vol. II

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3 Introduction:

The instrument developer's guide version two is a revision of previous guidance for W. M. Keck Observatory's instrument life cycle process that set major milestones and gaiting reviews.
Through use of advanced instrumentation, WMKO's scientific community explores the frontiers of astronomy in ways that lead the astronomical community in the US and globally. The instrument suite provides WMKO's observers the tools to perform astronomical research and respond strategically to initiatives outlined in the US Decadal Surveys and those defined in WMKO strategic plan. Instrument developers engineer new technologies in response to the identified needs defined in the WMKO strategic plan and the US Decadal Survey as well as those identified by the WMKO community of astronomers.

Historically, instrument development at WMKO was based on military processes with strict review milestones that served as gates for key decision points. These reviews followed a development cycle from concept to commissioning, and the process successfully shepherded a few instruments to first light. Although, not explicitly stated, the process had flexibility based on the size of the project, but was focused on medium and large facility class instrumentation activities.

In 2020, WMKO recognized a need to revise the instrument development process in order to formalize flexibility and to better align the process US funding agencies. Instrument develop teams frequently submit to the National Science Foundation (NSF)and have historically submitted proposals to TSIP, ATI, MRI, MSIP, and MsRI grant programs. WMKO has also submitted project funding requests to NASA that has increasingly more opportunities available. Aligning the instrument life cycle process with both NSF and NASA will better position the WMKO community of PIs to both propose to the available grant programs and ease reporting to the NSF and NASA program officers. To this end, this revision has folded in processes, philosophies, deliverables, and, common language from the NSF Major Facilities Guide (NSF 19-68 Sept. 2019) that is used as guidelines for MSIP and MsRI programs. In addition, NASA's Space Flight Program and Project Management Handbook was reviewed to fold in life cycle best practices and for evaluating project size and scaling.

With larger telescopes being planned and instrument projects at WMKO partner institutions in design phases for those facilities, instrument teams and PIs are exposed to processes and rigor that may not be appropriate for WMKO projects. The complexity of the larger facility partnerships necessitate the overheads in both reporting and documentation, but those same needs don't apply for Keck work and this revised guide is also being updated so that the same teams designing for the larger facilities understand that WMKO's process is scaled appropriately for WMKO. NSF's major facility guide is designed for larger projects and thus scaling the guidance in that document for smaller Keck projects is appropriate.

WMKO leadership, the SSC, and the Board also recognize a need to better understand the project costs before proposing to the NSF and NASA grating opportunities. Guidance from both the NSF and our community of observers on the level of investment needed to appropriately assess full construction costs are included in this document, and the early design phases that are precursors to submitting a proposal to a private or public funding agency are designed such that our instrument teams and WMKO makes that investment. To this end, WMKO will be better at predicting the project costs over the full life cycle and demonstrate to NSF and NASA that we have the tools and programmatic structure to complete the project with the identified funds once the project starts.

3.1 Roles and responsibilities

Throughout the instrument life cycle, the project will report and make requests at gating milestones to observatory leadership that includes the Science Steering Committee (SSC), WMKO Director, WMKO Chief Scientist, and members of the WMKO Board. The responsibilities for the leadership positions help define the gating strategy for approval to subsequent stages as well as ensuring that the project

performance is meeting the expectations of stakeholders. The roles and responsibilities for these leadership positions are as follows:

WMKO Board: Evaluates recommendations on instrumentation provided by the SSC, WMKO Director, and WMKO Chief Scientist. The Board communicates directives for instrumentation projects to the WMKO Director and Director of the instrument development teams originating institution. The Board has ultimate authority whether a project may start a design phase and proceed with a proposal. The Board reviews high level instrumentation budget and gives directives on budget and schedule.

SSC: The SSC reviews all requests for starting the early design phases of the instrument. PIs make requests to start a design phase with the SSC typically in June or July. The SSC establishes the scientific priorities for the instrument in context with existing instrumentation and projects under development or consideration. The SSC reviews proposed instrument science drivers, sets strategic goals, assesses the high-level budgets and schedules, assess the instrument team capabilities, and weighs PI requests against others under consideration. The SSC sets the priorities keeping in mind national recommendations and the WMKO strategic plan. The SSC makes instrumentation recommendations to the WMKO Director and Board. The SSC includes representative membership from all observatory user groups.

WMKO Director: The Director receives recommendations for instrumentation from the SSC and Chief Scientist. The Director monitors and oversees the construction of the approved instruments and communicates status on budget, schedule, and capability to the Board. The Director takes direction from the Board on both budget and programmatic processes for instrument development and communicates these directives to the IPM.

WMKO Chief Scientist: The Chief Scientist provides an independent assessment of the instrument capabilities and helps the SSC establish the scientific priorities for the instrument in context with existing instrumentation and projects under development or consideration. The Chief Scientist leads the Scientific Strategic Planning process working with the SSC to identify the future instrumentation initiatives. The Chief Scientists provides recommendations to the Director and Board when requested and takes direction from the Director and Board. The Chief Scientist communicates directives to the IPM. The Chief Scientist communicates with and takes guidance from the NASA IRTF Keck Users Group ensuring that the national observing community's opinions are considered.

Director of originating institution: The Director provides project oversight and final budget authority at the primary institution. They receive status reports from the PI and PM. The Director receives the SSC recommendations communicated to the Board. In many circumstances, the director may be a member of the SSC and Board. The Director communicates Board and observatory recommendations and mandates to the instrument project leads. With input from the PI and PM, both technical and programmatic decisions may be made by the Director when they are not resolved at the project level.

PI: The instrument Principle Investigator is responsible for communicating project status to the SSC and Observatory leadership. The PI requests with the SSC approvals to move forward into the Design phases, and when funded, has the responsibility of delivering the instrument to the observatory. The PI keeps the Director of the home institution informed of project status by providing regular reports. The PI collaborates with the IPM on reports and leads the project through the established instrument life cycle process. Based on the scale and complexity of the project, the PI collaborates with the IPM to establish an agreed upon phased path of instrument milestones and reviews described later in this document.

IPM: WMKO Instrument Program Manager provides oversight external to the lead institution. The IPM collaborates with the PI and PM on reports to the Directors and the SSC and will provide independent updates to the SSC when requested with an emphasis on actual expenditures, schedule, and budgets. In consultation with the PI, the IPM organizes the independent review committees for major reviews. The timing of developmental project reviews and their organization will be overseen by the IPM in

consultation with the PI and PM with oversight from the SSC and Directors. The IPM provides all review reports to leadership.

PM: The project manager is responsible for the programmatic processes of the instrument managing technical scope, budgets, and scheduled in close partnership with the PI. The PM works with the PI and IPM in developing reports to leadership. The PM works with the IPM and PI on meeting review milestone goals and ensuring requirements are met.

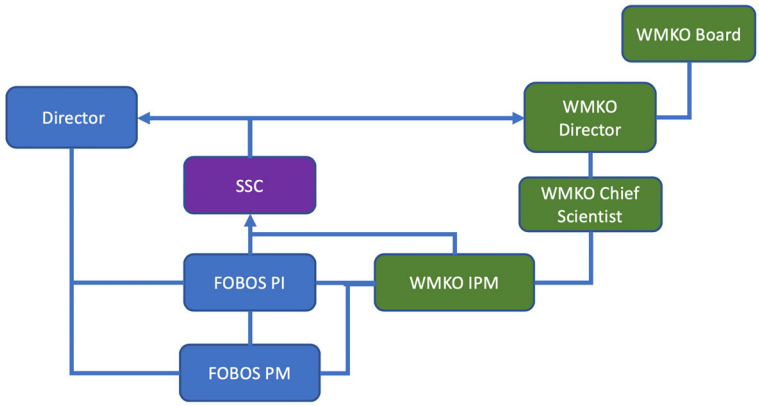


Figure 1: Leadership organizational structure for instrument development

4 Instrumentation Development Life Cycle

The instrumentation life cycle is broadly categorized by Design Formulation and Construction with the progressive steps under these categories that have reviews and key decision points before moving to the next stage of the project. Figure 2 identifies the phases in the instrumentation life cycle. Projects advance to the next phase on if recommended by the SSC and endorsed by the Board and is not guaranteed. Key decision points often follow a review that is designed to provide periodic assessments of technical and programmatic health. Reviews serve to assure stakeholders that the project is progressing and completing the work required. Written reports submitted by the PI to the SSC and major project review reports provided by independent review teams are inputs into decision points for recommending a project moves forward.

Design Formulation starts with the initial concept and brings it to a full Preliminary Design. Under the Design Formulation, there are four phases that include:

- **Concept** phase to determine feasibility and an initial science case;
- **Phase A system** design phase during which designs for the instrument are matured on the most important aspects of the instrument as well as maturing the budget and schedule;
- **Proposal Development** phase for soliciting funding from private and public granting agencies;
- **Preliminary design** when all technical subsystems are designed and matured while programmatic processed are introduced and refined relative to the proposal phase.

During these phases, no major purchases are made. At the end of each one of these phases, the SSC recommends to the Board whether the project should continue. Preliminary Design usually does not formally begin until major project funding is secured. The start of the Preliminary Design phase is considered the formal project start date.

Funding internal to WMKO is available for the early phases of development through Proposal Development. Instrument development teams may seek other sources of funding for these early phases. PIs are encouraged to present to and gain endorsement from the SSC even if external funds are used.

Construction begins when the project passes a Preliminary Design Review and the SSC and Board endorses the project to continue through a full build. Construction has two primary phases

- **Implementation phase** is when the instrument detailed designs are finished and the build of the instrument is completed for all subsystems. Before delivery to the summit a review is held;
- **Commissioning** includes integration of the instrument at the observatory and night time engineering activities to commissioning the instrument for routine operations. The project completes with a hand over to operations at the end of this phase.

At the start of the Implementation Phase, major purchases may be made while fabrication designs are being finalized. WMKO recognizes that small instrument teams spread over multiple campuses and sometimes managing independent sub systems cannot afford marching army costs for staff while waiting for the critical path subsystems to complete design ahead of a review gate that triggers purchases and fabrication. Instead, the Implementation phase allows subsystems to transition into full scale development and continue momentum with build activities before other subsystems complete designs. A project major programmatic review is held at an appropriate time during the Implementation phase to assess project programmatic status only as by this time all major technical decisions have been made. Please see the Implementation section for details.

Instead of an Implementation phase, both NSF and NASA guidelines divide this work into two distinct phases, a Detailed Design phase gated by a review before transitioning into a Full-Scale Development Phase. This is the language and process used in past instrument development projects with WMKO. However, the scale and budgets of both NSF major facilities and NASA projects is significantly larger (refs) than the majority of WMKO instrument projects, and therefore, WMKO is adopting a streamlined Implementation phase. For significantly large projects, WMKO may require a detailed design review before major purchases may be made if observatory and project leadership deems this necessary. In this way, WMKO will maintain flexibility, and at the start of the Preliminary Design, the PI and instrument team will agree to the review, gating, and development process tailored to their instrument.

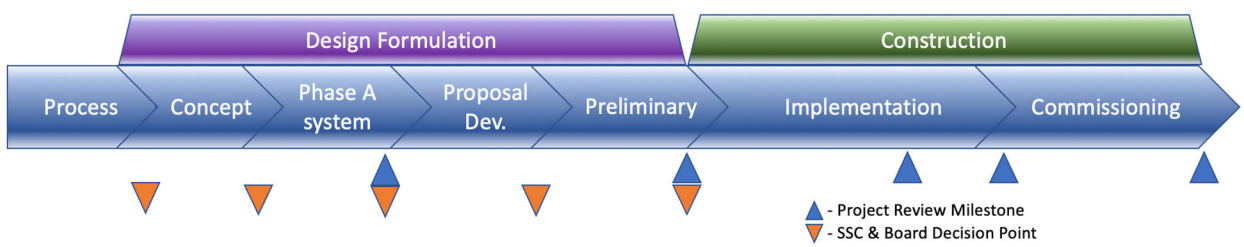


Figure 2: Instrumentation Life Cycle for WMKO projects

4.1 Project sizes

Projects are broadly categorized as large, medium, and small based primarily on project cost.

- Large 6-30M
- Medium 1.5-6M
- Small < 1.5 M

The scale of the project sets the level of rigor and formality for the project life cycle of development and is agreed to at the start of the project defined when significant funding is provided to kick off the preliminary design phase. Minor upgrades are likely small and we use the example. Major instrument overhauls and instruments with a specific science niches may be considered medium depending on technical complexity. Facility class instruments are often larger in scope and cost. These roughly coincide with NSF funding boundaries for programs like the ATI, MRI, MSIP, and MsRI that PIs will likely

submit proposal to. Examples of projects in the Small, Medium, and Large categories are the LRIS red detector upgrade 2020 that replaced the detector and controller electronics, the HISPEC instrument or the NIRSPEC upgrade which replaced the two detectors, electronics, and all the IR guider opto-mechanical model, and the Keck Planet Finder instrument. There is flexibility in the review system as for example a the KCRM $8M upgrade although large in costs obtained full funding before preliminary design.

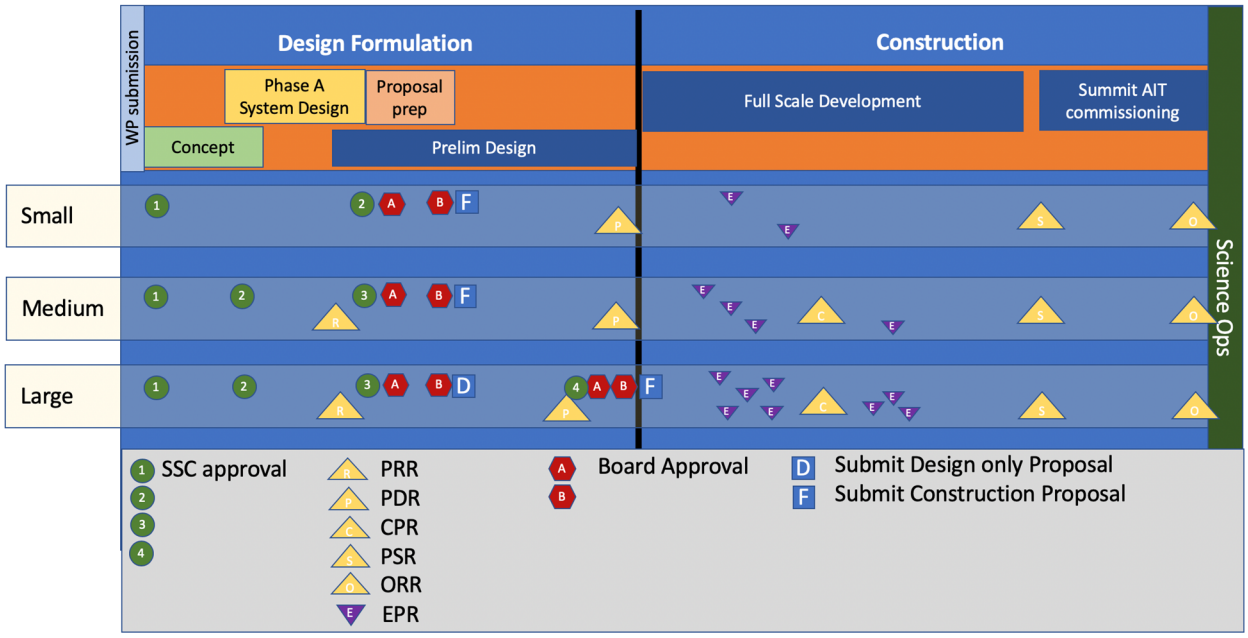
4.2 Life Cycle Reviews General information

Project reviews provide the development team an opportunity to demonstrate that it has completed the work of the previous phase and provides institutional leadership with an independent assessment on the projects technical and programmatic health. In general, the review serve to evaluate whether the

- Science goals, science impact, and alignment with the WMKO strategic plan,
- Technical assessment and approach: flow down of science requirements, instrument architecture and design, operational concepts and modes, and data handling.
- Project management approach, partnerships, organization, staffing resources and institutional resources.
- Cost, Schedule, and Budget with what are the possible control plans like descopes or upscopes, as well as contingency. Includes funding plan and profile.
- Risk management plan, approaches, assessments, and actions and resources to mitigate.

At different times in the project lifecycle, emphasis on these five major themes will vary. Influencing the emphasis will be variables such as current in-hand funding, what phase the project is in, risks involved, and project size.

- Emphasize with the teams what is most important. PIs and project managers should know this is what the SSC and Board are thinking.
    - In the early phases of project development Scientific and technical scope is most important as the project aligns with strategic needs.
    - As the project moves forward with a proposal Budget and Scope are balanced.
    - Once full project funds are secured, Budget and project schedule costs have a greater emphasis than Science Scope and schedule deliver milestones.



Life cycle reviews

- PRR: Proposal Readiness Review assesses the projects maturity in advance of submitting a proposal for major project funding.
- PDR: Preliminary Design Review assess the projects status and gates moving into the construction phase with a focus on technical designs, project costs, and schedule with contingencies for the remaining project work.
- EPR: Engineering Peer Reviews assess technical aspects of project subsystems and interfaces to maintain technical momentum. These should be technical deep dives. Review summaries for reviews held before CPR are included as supporting documentation at CPR.
- CPR: Construction Programmatic Review assess the projects budget and schedule for the current and remainder of the work and is not focused on technical analysis.
- PSR: Pre-ship Review assesses project readiness to integrate and commission at WMKO
- ORR: Operational Readiness review follows commissioning and assesses project deployment and documentation status for long term support of the instrument at the observatory.

PRR, PDR, PSR, and ORR are a one-step review that assess technical and programmatic status during a one or two day review.

EPRs and CPR form a two-step review process with the EPRs designed to assess technical progress with deeper dives into each subsystem and the CPR focused on the programmatic positions, budget, and schedule for the remainder of the construction phase. This enables the teams to maintain technical progress and provide project management with guidance for maintaining scope, schedule, and budget.

Special reviews:

- Delta reviews: Any of the reviews may be subject to a delta review to address aspects flagged as critical before moving to the next phase of the project. These are reviews triggered by observatory and institutional directors after review of the committee reports
- Detailed Design Review: may be defined as needed at the outset of the project planning to refine preliminary designs before long-lead items may be purchased. The PI, PM, and IPM agree to hold this review and put it into the project execution plan with a budget and schedule to support it.
- Cost Reviews may be triggered by IPM in consultation with project leadership to control project costs.
- Termination reviews may be triggered by the IPM in consultation with the project leadership, SSC, and Board when minimum project requirements may not be met.

Review committee panels range between 3 and 6 panel members. The project leadership encourages the Chair of the committee to have touchstones on the project throughout the development to provide the Chair with more in-depth insight. The review Chair is encouraged to remain Chair for the life cycle of the project. Continuity of panel members across the reviews is also encouraged.

Following all reviews, the WMKO director provides a decision memorandum that provides direction to the instrument development team. The direction is provided following review of the review committee report and is communicated to the PI as well as SSC co-chairs and the Board if deemed appropriate. This memorandum becomes part of the instrumentation documentation.

5 Design Formulation Phases

The early Design Formulation phases of the instrument development life cycle are to incubate instrument concepts to a mature enough level to seek funding. These early design phases are the Concept, Phase

A/system, and Proposal Development phases. At the end of the proposal development phase, the PI and PM have developed a mature project plan, schedule, and budget that has been vetted by a review team and endorsed by the SSC and Board. The instrument project then works to secure funding. Once funding is secured, the project officially starts the Preliminary Design phase kicking off the start of the project.

During Design Formulation phases the project explores a full range of implementation and scope options and develops project costs while defining what an affordable project concept will be that will meet scientific goals. This is an iterative process that matures the project plan with each successive phase.

The instrument development community, SSC, Board, and WMKO instrumentation leadership recognize the need to mature instrument designs to a level of confidence that a project could be completed with the proposed needed funding identified by the PI. NSF guidance provided in the Major Facilities Guide suggests that the Design Formulation phases could range in cost from 5-25% of the expected total cost of the instrument, and average 10%. For the NSF, this investment includes the Preliminary design phase. Instrumentation projects are significantly less than major facilities, yet, the sentiment from the WMKO community is that we should to invest 5-10% of the expected total instrument costs in order to vet the critical technical design aspects as well as the budget and schedule.

This investment would pay for some level of involvement of an instrument scientist, system engineer, optical engineer, mechanical engineer, electrical engineer, and a detector expert. The level of involvement from the engineering staff depends critically on the technical risks that are present in the project and not all of the listed engineers need to be involved for all projects. The most essential and difficult to fund part of pre-proposal work is the support of these engineers to flesh out the optical/mechanical design with enough specificity to have a believable budget and performance numbers. Software is usually not directly addressed in the proposal development stage unless there is some unique application.

Below is guidance based on community input and the WMKO internal budging that is available for the Concept, Phase A, and Proposal development phases. This estimated encompasses all costs leading up to the start of the Preliminary Design Phase. The estimates assume 5-10% of the total instrument budget is spent before seeking funding for the full instrument.

- Minor improvements at <$1M: <$100k available annually via WMKO internal funds
- Instrument upgrades at $1-3M: $50-$300k available annually via WMKO internal funds
- Brand new instrument $3-30M
    - $3-6M => $150-600k : WMKO internal funds over 2.5 years
    - $6-$15M => 300-1.5M : WMKO internal funds over 2.5-3.5 years
    - $15-30M => 750K-3M : WMKO internal funds over 2.5-3.5 years requiring external supplemental funding

The primary goal is to mature the proposed plan to a point where leadership has confidence that a project may be completed using the proposed funding. Once awarded, the project becomes a fixed-price contract with little availability for gaining additional funding beyond funded work.

PIs are encouraged to participate in the early formulation phases via an Instrument Development Call to the community soliciting:

- Instrument **concept studies** and **Phase A design** studies for both new instruments and upgrades to existing instruments
- **Mini grants** for efforts and equipment costs for either new tools and techniques to improve the observatory scientific productivity or minor hardware capability enhancements
- **Proposal development** efforts to draft and submit proposals to funding agencies

Mini grants for instrument work are considered too small and handled outside of the instrument lifecycle development processes described in this document. The Concept studies, Phase A design, and Proposal

Development are funded through this call to the community. The call is made annually with notionally each phase lasting one year.

Figure 3 shows the notional trajectory for the early design formulation phases laid out on a calendar year. The notional trajectory is driven by both WMKO fiscal year constraints and planning that starts 1 Oct annually as well as anticipated NSF grant submission deadlines that are in the winter months. The latest SSC meeting that lines up with the FY and NSF funding time frames is the summer SSC meeting, and it is at that meeting when instrument development initiatives are evaluated. WMKO's instrument development trajectory begins with a call to the community that is released in either April or May following an SSC meeting during which the call is approved for distribution. The community composes and submits white papers for concepts, phase A/system design, proposal development activities, and mini grants. All white papers are evaluated by the SSC in June or July during the summer SSC meeting. Projects are recommended to move forward at the summer SSC meeting, and PIs are provided feedback and funding instructions if funds are awarded. There is a second SSC evaluation period in November if further review is requested by the SSC. The November period is intended for proposal development extended review.

The spiral progression assumes a one-year duration for each phase, but the schedule and process are flexible. As an example, instruments that have completed a conceptual design prior to approaching the SSC for approval, may a present their conceptual design seeking funding and approval to move into the Phase A/system design phase. Smaller upgrade projects may request moving to a proposal development phase and skip the Phase A/system design phase because the scope of the project does not merit that level of planning. Larger projects or teams with limited time could request two years of Phase A/System design work to properly mature the designs.

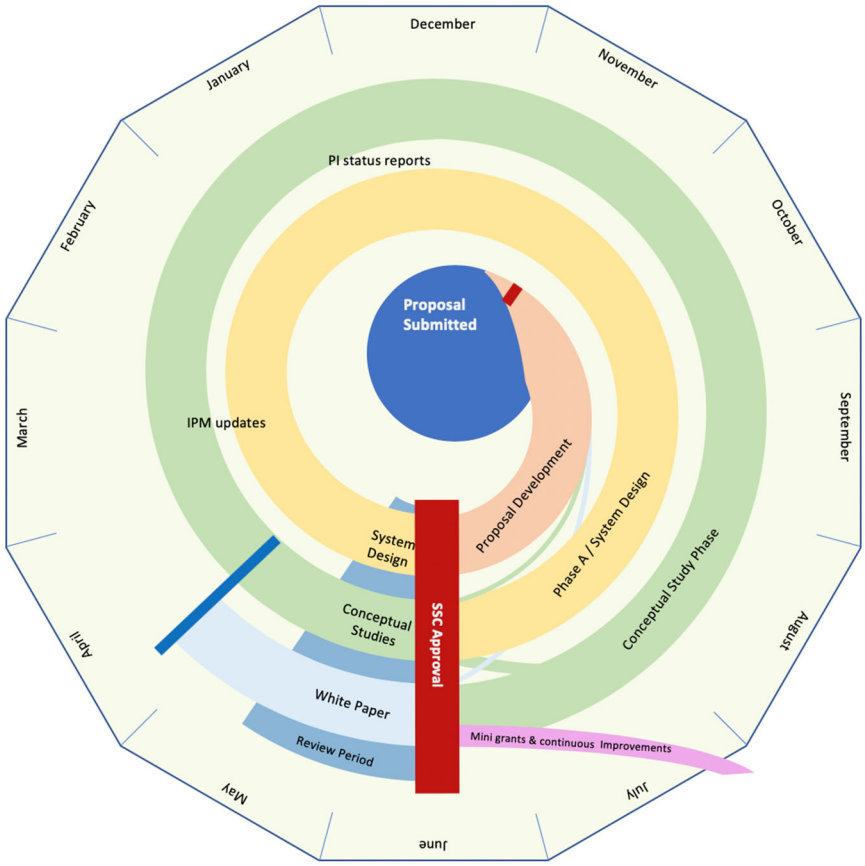


Figure 3: Early Design Formulation Phases

PIs may propose what funding track to pursue, but the SSC will approve and recommend the track for the project and may suggest a different track than what the PI proposed. At any step, the SSC may recommend that a project not proceed to the next phase. It is important to understand that previous SSC approvals at any phase are not a green light to seek project funding for the build of the instrument ,and it is anticipated that funding and proposal requests be approved by the SSC in the proposal phase of development.

In any year, the funding requested may be more than what is available, and the SSC will recommend not funding projects in order to fund higher priority projects. Even though funding may not be awarded, the SSC may recommend continued pursuit of a concept, and thus, encourage PIs to find other resources to develop concepts further. Some project may have to temporarily halt work if funding is not provided. Although this is unfortunate, PIs are encouraged to address SSC concerns as best they can and re-propose the following year.

The following subsections explain the project activities for each phase of a project. In practice, this document recognizes that the activities and deliverables may not always be carried out exclusively in that phase due to schedule requirements, staffing, complexity, and budget limitations. This may result in deltas in the review process or agreements on paths forward towards completing those deliverables in the next phase. It is more fluid in the earliest phases of the project. However, PDR and CPR are major project gatings, and as such, all deliverables are expected.

Notes for the next sections:

For each phase below want to see sections on

1. How to enter this phase: Proposal for this Phase
    a. Required predecessors
2. Purpose and goals of the phase:
    a. What to consider
3. To that end, the deliverables of the phase:
    a. Outputs of the phase
4. Activities during this phase
5. Schedule and budgetary constraints.
6. Roles and Responsibilities in this phase:
    a. Transmitting results within the team and to the next phase
    b. Data architecture and repository (documentation for this stuff).
7. Reviews of the phase
    a. Give insights into review criteria/charters
        i. Set the stage for the format and timing.

Simplify this

- Process
    - This goes with costs
    - How will you manage changes for the next phase.
    - How will people communicate/rhythm across institutions.
        - Case example for
- People
- Tools
    - Where store data
    - How you are managing data/schedule/costs/risks

- Product

5.1 Concept studies

In response to the white paper Instrument Development Call, proponents of an instrument concept will provide the SSC with a concept proposal that describes in general terms the essential characteristics that define the instrument and that also presents an initial case necessitating development of an instrument or upgrade. The purpose of the Conceptual Design phase is for the team to identify a promising instrument concept and design that is feasible for the observatory. At the end of the phase, the conceptual designs should clearly articulate how it meets research initiatives that are defined in developed science cases. A feasible concept is one that is probably achievable technically and must demonstrate that it will meet the needs of the scientific community.

For concept studies, the SSC is the reviewing body that recommends whether a project moves to the next phase, and the SSC will review both the technical feasibility as well as the scientific merit of the project. This is an exploratory exercise and may result in an instrument concept that is not feasible to move forward at that time.

5.1.1 Purpose and process

PIs should provide SSC with a concept proposal white paper in response to the Instrument Development call. The concept proposal should briefly describe the instrument and present both scientific and technical justification that would necessitate its development. It is assumed that the project is in its infancy.

The PI will propose to the SSC a Concept study with a small budget sufficient to refine the science and technical case for the instrument as well as assess feasibility at the observatory. The PI will provide a written report and present to the SCC at the summer SSC meeting. The report, presentation, and next phase request will be part of the evaluation package for the SSC.

These initial proposals identify what is known at that point in project development, as well as what tasks remain to be accomplished in order for NSF to consider a project for eventual funding. In the near term, they also define what work should be done to develop the project to the Conceptual Design level of maturity.

The list below describes the activities that a project needs to accomplish to demonstrate a sound concept that provides the SSC the necessary information to evaluate the proposed instrument concept.

Science and Technical

- Develop a science case backed by community support
- Build a science team
- Develop a feasible instrument concept(s);
- Identify scope and future upgrade options
- Identify preliminary key technologies
- Develop preliminary high-level driving requirements
- Assess observatory interfaces
- Identify future key trade studies
- Assess heritage components and reuse of equipment

Programmatic

- Estimate cost schedule of full instrument build
- Estimate costs and schedule for scope and upgrade options
- Develop a budget, schedule, and scope of Phase A activities
- Identify preliminary risks and possible future mitigation effort
- Provide a preliminary organization chart with key staff and partnerships
- Determine staffing for Phase A and assess availability
- Provide a written report for the SSC for review; this may take the form of a Phase A proposal
- Provide a presentation to the SSC

5.1.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that Phase A funding is paying for effort for a small team of individuals.

- Principle investigator
- Instrument scientist as the main instrument architect
- Mechanical Engineer(s) who will mature mechanical designs
- Optical engineer who will further develop the opto-mechanical model

For observatory activities, the following people will be involved with helping assist with observatory planning and defining interfaces. Requests for engineering assistance will be coordinated via the IPM and do not need to be specified in a proposal. The IPM will request engineering assistance from WMKO staff for a limited number of hours.

- IPM who assists the project as requested managing limited resources and is the main point of contact in the conceptual phase

5.1.3 SSC reporting process:

At the end of the conceptual phase, the PI will submit a written report to the SSC for review. This report may take the form of a summary report or may be folded into the Phase A proposal which is a continuing request with the SSC to pursue the instrument design. A presentation at the summer SSC meeting combined with the written report serve as the deliverables for the project.

5.1.4 Concept Phase Exit

Formal exit from the Concept Phase follows an endorsement from the SSC to move forward to the Phase A design efforts. The PI will make a brief presentation to the SSC providing the team with an opportunity to summarize the project and provide a response to the SSC questions and concerns. The SSC will consider the project and re-review the science cases in context with WMKO's ongoing initiatives. The SSC will vet the maturity of the project and provide recommendations to the Board and WMKO whether the project is achievable and should continue. The SSC may recommend terminating an instrument study or request that PIs continue their conceptual study for an additional year instead of moving to the Phase A design efforts.

For projects that have received previous development and design funding from other sources, a project may skip the concept stage and propose a Phase A study to the SSCl. This request should be coordinated with the IPM. Project looking to the next phase will be required to present at the SSC.

5.2 Phase A Design

During Phase A design, the team further develops a conceptual instrument design and architecture that is credible and responsive to the science drivers defined by the science team, SSC, and WMKO strategic

plan. The project plan will demonstrate that it is striving to meet science requirements and also requirements due to demands of staffing, schedule, and potential funding resources. The project team is formed and expanded to develop the instrument concept and begin or assume responsibility for technical development as the WBS is defined. The project explores a range of implementation options and defines an affordable project concept that can address the science requirements. A key outcome of this phase is a robust vetted estimate of the project costs and schedule for the preliminary design phase through commissioning.

For Phase A Studies, the SSC will continue to vet the science case of the instrument and a review will be held at the end of the phase. The review is a milestone in project development and is a gate before projects may seek construction funding.

5.2.1 Purpose and process

The project team will propose to the SSC Phase A work with a budget and staffing request sufficient to mature the project so that the project is ready to propose for major construction funding. The WMKO IPM will hold a Proposal Readiness Review of the project in advance of the summer SSC meeting. The review findings will be part of the evaluation package presented to the SSC as an independent assessment of the project. It is expected that during this phase the project will make both technical and programmatic progress as described below:

Science and technical work:

- Bolster the science case and establish science requirements
- Flow science requirements to primary technical requirements
- Develop initial designs for critical components and overall instrument packaging, layouts, location, and key interfaces
- Risks detailed
- Identify technical risk mitigation plans.
- Identify long lead items and major milestones
- Start high level trade studies
- Identify key technologies and requirements of those technologies
- Assess early prototyping and models needs
- Provide technical scoping options

Project management, planning, and control tasks

- Refine the full project budget, schedule, and scope for the instrument.
- Develop an initial project plan
- Develop an instrument funding plan and approach
- Create a technical, cost, and schedule risk matrix
- Identify initial programmatic risk mitigation plans
- Define WBS elements with partnership and vendor responsibilities
- Baseline a project execution plan at the appropriate level for the size of the project
- Provide an. organization chart with key staff and partnerships
- Provide report to the SSC and written request to seek a proposal if desired

The project at this time should be collecting and developing documentation. Depending on the scale of the project, tools the team may employ to help manage the project include:

- Documentation repository (Google Docs, Atlassian, …) accessible by all staff at participating partner institutions
- Team communication tools like email distribution lists and communication team software (e.g. Slack, Microsoft Teams, Zoom, Bluejeans,…)

- Project plan with a level of sophistication appropriate for the size of the project to assess the budget and schedule.
- Requirements document
- Risk matrix for managing risks
- CAD mechanical and optical models

For a summary of the documentation see Appendix …

5.2.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that Phase A funding is paying for effort from all or some subset of these individuals.

- Principle investigator to relieve them from other institutional responsibilities if needed. The PI may perform any of the activities below listed for other staff members
- Instrument scientist who is the main architect of the instrument and will mature designs in all areas
- Project Scientist who is leading the science team and developing the science cases
- Mechanical Engineer(s) who will mature mechanical designs
- Optical engineer who will further develop the opto-mechanical model
- Software Engineer(s) to define software high level software plans

For observatory activities, the following people will be involved with helping assist with observatory planning and defining interfaces. Requests for engineering assistance with a specified number of hours should be part of the Phase A proposal to the SSC. The IPM and PM do not need to have hours requested.

- IPM who assists the project as requested managing limited resources
- PM who will help the IPM develop a project plan for observatory activities
- Mechanical Engineer provide technical planning for observatory interfaces and WBS
- Staff Astronomer who will provide both technical and scientific guidance and information.
- Other engineers as the need is identified

5.2.3 Proposal Readiness Review Process:

A Proposal Readiness Review will be held at the end of the Phase A design phase at an appropriate time the project determines that it is mature enough to request major project funding. A PRR is a mandatory review milestone and is often timed to be one month ahead of the SSC meeting in June. This review may be held up to 6 months in advance. Review dates after the summer SSC meeting are difficult to accommodate gaining approval by all governing bodies identified in Section 3.1. An example charter for the review is provided in the appendix.

At this point, it is expected that the Phase A baseline plan will have cost and schedule uncertainties. The full detailed scope may not yet be defined but major systems have been evaluated, staffing resources considered, technical risk identified and initial plans for mitigation discussed. Unknowns and uncertainties may remain to be addressed in more advanced stages of planning and development, and are identified as key tasks when kicking off the Preliminary Design phase. The Phase A design, top level requirements, supporting budget estimates, risk analysis, and institutional partnerships should be detailed enough for reviewers and the SSC to decide whether the project status mature enough to start preparing a proposal for major funding.

5.3 Phase A Exit

Formal exit from the Phase A Design Phase follows a successful PRR reviewed by a committee of at least three members and attended by interested SSC members and board representatives. The review committee will vet the maturity of the project and provide a recommendation to the SSC, Board, and WMKO

whether the project is achievable at the proposed costs. The PI will make a brief presentation to the SSC providing the team with an opportunity to summarize the project and provide a response to the review recommendations. The SSC will consider the recommendations and re-review the science cases in context with WMKO's ongoing initiatives as well as national directions before making a funding recommendation to the Board. The SSC may recommend terminating an instrument study or request that PIs continue their Phase A study for an additional year instead of moving forward with a proposal.

The Board will review the SSC recommendation and input from WMKO and give permission to seek future funding. WMKO IPM will then work with the PI and team to develop a proposal in the next phase of development.

During the PRR, the review committee will be reviewing materials defined in the charter. An example charter is provided in Appendix ?###?

For medium and large-scale projects that have received previous development and design funding from other sources, a project may skip the Phase A work stages and immediately request a PRR to vet current designs for moving forward with a proposal. This request should be coordinated with the IPM. PIs may not bypass the PRR as this is a mandatory gate.

5.4 Proposal Development

During proposal development, the instrument design team is focused on developing the content necessary for submitting a proposal. This is primarily a documentation development phase, although, engineering assistance may also be needed to address critical recommendations from the Phase A review team or SSC.

Instrument teams that have completed phase A activities either internal or external to the WMKO instrument development call may request permission and support of minor cost efforts to develop a proposal for a public grant program or a philanthropic opportunity. Awards are contingent upon a successful review by a Phase A committee prior to submitting a funding request and contingent upon a favorable SSC recommendation.

5.4.1 Purpose and process

Following the SSC favorably recommending a project seek construction funding, the development team begins preparing the necessary documentation needed for the identified funding opportunities. Funds provided by WMKO are specifically intended to develop and deliver a proposal for submission. If following an NSF grant cycle this requires a proposal being completed in Nov – Jan before deadlines like the ATI, MRI, MsIP, and MsRI. The previous phases of development, deliverables, and documentation identified in this phase are part of the needed documentation for a successful NSF proposal.

It is recommended that the PI requests a red team to review the proposal before submission. This activity, however, is not mandated nor funded by WMKO.

Budgets and institutional agreements are finalized during this phase, and must be approved by the board in advance of final submission. The IPM will coordinate communication of the budget, schedule, and agreed upon responsibilities to the SSC, Board, and WMKO Directorate.

The request in response to the white paper Instrument Development Call should include for this phase of work:

- Request to submit a funding proposal with the program(s) identified
- Budget for proposal development
- It should highlight and address findings presented in the report summary from the PRR

PIs may not solicit major funding from private or public funding agencies without having an endorsement from the SSC and approval from the Board.

Science and technical work:

- Finalize the science cases and driving requirements
- Finalize initial instrument designs
- Address SSC and reviewer recommendations
- Write a science and technical proposal

Project management, planning, and control tasks

- Finalize the full project budget, schedule, and scope for the instrument.
- Baseline a project plan
- Finalize a technical, cost, and schedule risk matrix
- Finalize programmatic risk mitigation plans
- Complete definitions of WBS elements with partnership and vendor responsibilities
- Complete a project execution plan at the appropriate level for the size of the project
- Finalize an organization chart with key staff and partnerships
- Work with sponsored program officers to coordinate a proposal submission
- Coordinate proposal supporting documentation for institutions and co-investigators
- Obtain institution agreements (SOW, IAL)

5.5 Preliminary Design

Plan should be developed with refined scoping options with milestones defined for triggering those scoping options.

NSF: Preliminary Design Phase: This phase further advances the project baseline definition and the Project Execution Plan. It produces a bottom-up scope, cost, schedule, and risk analysis of sufficient maturity to allow determination of the Project Total Cost and overall duration for a given Fiscal Year start and to establish the budget request to Congress. The Preliminary Design Phase ends with a thorough review of the design, the Preliminary Design Review (PDR), and NSF approval to continue on to development of a final design.

Results of this development are reflected in a revised and updated PEP or associated files scaled appropriately for the size of the project.

A revision to the project plan now includes the controls for scoping options. The plan must now idenfity the minimum mission success criteria associated with the instrument requirements so that the PM has scoping & schedule options for controlling cost. If the minimum requirements can not be met, the PM must communicate this to the PI and IPM which may trigger a special review if unresoved.

Need a communication and documentation plan: Atlasian, teamup, whatever, drawings management, email aliases,

Updated components might include

- Update of the project development plan budget and timeline, with major anticipated risks in the completion of design and development activities;
- Refinement of the research objectives and priorities of the proposed facility;
- Update of the description of the required infrastructure, site-specific design, and definition of interconnections of all major subsystems;
- Bottom-up budget and contingency estimates for construction, presented using a Work Breakdown Structure (WBS) structure and supported by a WBS dictionary defining the scope of individual elements;
- Scope management plans that include de-scoping options and scope opportunities that can be implemented depending upon available contingency levels.
- Updated construction schedule with contingency estimate;
- Updated risk analysis, including regulatory issues affecting construction or operation, and time-dependent factors such as inflation indices, price volatility of commodities, etc. (The preliminary design budget estimate will be the basis for a future NSF budget request to Congress if the project successfully emerges from the Preliminary Design phase. Costs and risks should be projected forward to the anticipated award date for construction funds.)
- Demonstration that key technologies are feasible and can be industrialized if required;
- Plans for management of the project during construction, including preliminary partnership arrangements and international participation, oversight of major subawards and contracts, organizational structure and management of change control;[2] and
- Updated estimates for future operating costs, anticipated future upgrades, or possible decommissioning costs of the facility at the end of its operating life.
-

Projects may be removed from the Preliminary Design Phase by the NSF Director due to:

- Insufficient priority over the long term;
- Failure to satisfy milestones or other

  criteria defined in the IMP/PEP;

- Eclipse by other projects;
- Collapse of major external agreements;
- Extensive estimated or actual cost

  increases;

- Significant changes in schedule for design

  readiness or eventual construction;

- Unexpected technical challenges;
- Changes in the research community that

  indicate eroding support for the project;

- Any other reason that the Director deems

  sufficiently well-founded.

For each phase below want to see sections on

1. How to enter this phase: Proposal for this Phase
2. Purpose and goals of the phase:
    a. What to consider
3. To that end, the deliverables of the phase:
4. Roles and Responsibilities in this phase:
5. Reviews of the phase:
    a. Goals
        i. assess the robustness of the technical design and completeness of the budget and construction planning.
        ii. the IPM has overall responsibility for organizing the review, and throughout the review process acts as the interface between the NSF and the Recipient. The PO authors the review charge and organizes the review panel.
        iii. Following the review, the PO and the LFO Liaison will each independently assess the review, confer on areas of concern, share their views, and report their observations through their respective supervisory chains
        iv. The review scrutinizes the effectiveness of project management through this phase of development, as well as plans for completion of final design and eventual construction and operation.
        v. firms to evaluate proposed plans and budgets as described in the Project Execution Plan (PEP)
        vi. The PDR also examines the management structure and credentials of key staff to assure NSF that an appropriately skilled management organization is ready to complete final design activities and execute the construction phase of the project.

6. Exiting the phase (I like having a clear definition of exiting from the various phases. Need a clause here that says that we will continue along the plan until the final WMKO Director recommendation is provided.)

Formal exit from the Phase A Design Phase :

7. The review team makes a recommendation that project is ready to move to the construction phase.
8. SSC and WMKO recommends to the Board the project should advance to the construction phase
9. The Board approves moving forward with a proposal
10. Reviewer and WMKO recommendations are provided to the PI and development team with further directive to advance to the construction phase.
11. The PI, PM, and IPM update the update the PEP if necessary to respond to required recommendations on scope, budget and schedule necessary to bring the project to completion

WMKO approval is given if WMKO leadership determines that:

- The project has a sound financial plan for supporting the remaining construction activities and that the project has the needed funds for executing the plan.
- WMKO believes that the panal of experts have done due diligence in assessing the project
- WMKO supports the organizational structure and governance of the project
- WMKO understands the level of risk inherent in the project and has evidence that the primary institution understands and accepts the level of risk.
-

5.6 Design Formulation Summary

Figure 2.1.4-1 Summary Timeline for Major Facility Projects (Development and Design)

	Development	Conceptual Design Phase	Preliminary Design Phase	Final Design Phase
Budget evolution	Preconstruction Planning Funded via R&RA and EHR funds			
		Develop construction budget based on conceptual design Develop budget requirements for advanced planning Estimate operations costs	Expend ~5-25% of construction cost on planning & design activities Construction estimate based on preliminary design Update operations cost estimate	Final design over approximately 2 years Construction-ready budget & contingency estimates Update operations cost estimate
Project evolution	Initial ideas emerge Broad science community consensus built for potential long-term needs, priorities, and general requirements High level concept developed	Formulate science goals: define requirements, prioritize, review Develop conceptual design identify critical technologies, high risk items Formulate initial risk assessment Develop top-down parametric cost and contingency estimates Initial proposal submission to NSF Initial Project Execution Plan (PEP)	Proponents development strategy defined in Project Development Plan Develop site-specific preliminary design, environmental assessments/ impacts (NEPA) Develop enabling technologies Bottom-up cost and contingency estimates, updated risk analysis Develop Project Management Control System Develop preliminary operations cost estimate Update PEP	Develop final construction-ready design & PEP Verify key technologies are ready for production or detailed production design Refine bottom-up cost and contingency estimates Finalize Risk Assessment & Mitigation, Management Plans Complete key staff recruitment
	NSF oversight defined in Internal Management Plan (IMP) updated at each development phase.			
Program oversight	Interface with the research community to nurture concepts for development Recommends to the NSF Director that a project advance to Conceptual Design	Integrated Project Team (IPT) organized Develop Internal Management Plan (IMP), estimate PD costs, timeline Establish interim review plan and competition milestones Forecast international and interagency participation, issues Initial analysis of NSF opportunities, risks **Conceptual Design Review (CDR)** – external panel review and internal review CDR Cost Analysis Merit review, apply 1st and 2nd ranking criteria	NSF Director approves PD phase Approve Project Development Plan (PDP) & budget Forecast external partner decision milestones **Preliminary Design Review (PDR)** – external panel review and internal review Establish target total project cost (TPC) PDR Cost Analysis Project Definition established – cost, scope, schedule, plans, risks, & contingency	NSF approves submission to NSB OMB/Congress negotiations on proposed project and budget profile Evaluate design costs, schedules; and operations cost estimate. Semi-annual assessment of baseline and projected operations budget for projects not in construction Finalization of interagency and international requirements, agreements **Final Design Review (FDR)** - external panel review and internal review FDR Cost Analysis - informed by an Independent Cost Estimate (ICE) if not done earlier EVMS Acceptance Establish project construction baseline
FRP, DRB, OD & NSB	Internal review regarding advancement to design stage. NSF Director approval to start Conceptual Design	Apply 3rd ranking criteria Facilities Readiness Panel Review NSF Director approval for advancement to Preliminary Design	Facilities Readiness Panel Review DRB Review NSF Director requests NSB approval for MREFC request & approves advancement to Final Design NSB authorization for inclusion in MREFC Budget Request and to proceed with final design	Facilities Readiness Panel Review DRB Review NSF Director approves advancement to construction stage NSB authorizes NSF Director to make a construction award

Nice summary diagram should include something like this for the phases

6 Implementation Phases

NSF text: The construction stage begins when funds are obligated for the acquisition and/or construction of the research infrastructure in accordance with the terms and conditions set forth in an award instrument between NSF and the Recipient(s). Depending on the technical nature and scale of the infrastructure or major facility, construction typically lasts 2-6 years and costs range from $70M to $800M, or possibly more. This stage has the most stringent requirements for overseeing Recipient performance in managing the scope, cost and schedule against plan, for reporting progress, and for formality of oversight and assurance by NSF. Progress is reported against the approved Performance Measurement Baseline (PMB) in the Recipient's Project Execution Plan (PEP). The project status is reviewed periodically to assess whether the project is capable of finishing within budget and schedule and what corrective actions (if any) might need to be taken. The Construction Stage normally includes activities to transition the facility to operations. Construction ends after final delivery and acceptance of the defined scope of work and an assessment facility performance per the terms of the award instrument.

6.1 Implementation

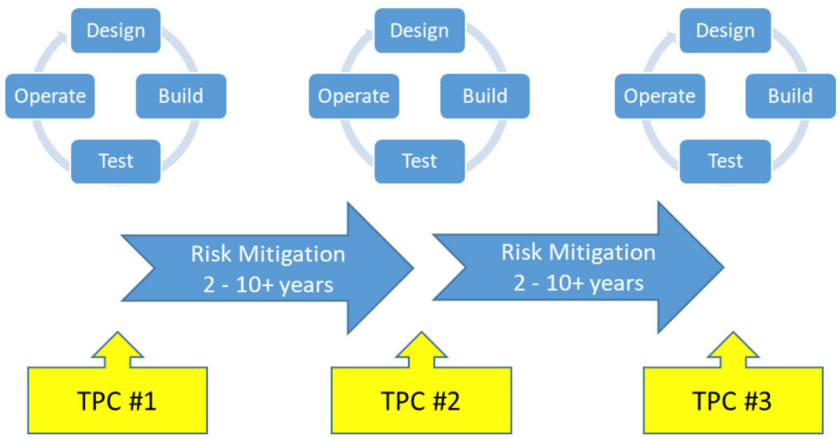
Describe the two-stage review approach as called out in NASA book that you liked.

Prototyping spiral development NSF guidelines for non-waterfall approaches.

piral development refers to the process of designing, building, testing and using a technology to increase understanding and reduce risk; and then repeating the process again. Although, almost all facilities use spiral development for various components and sub-systems during development, design and, at times, construction, the process described here is intentionally planned for and executed at the macro scale, with each spiral having a discrete total project cost (TPC). Figure 2.1.4-4 illustrates this concept of one project leading into follow-on projects.

The duration of the spirals can be relatively short (2 years) or quite long (a decade or more) depending on technical maturity and the rate of technological change. Risk is reduced following the completion of each spiral to improve confidence in the ability to meet the technical objectives of the next spiral within budget. A spiral development approach is generally imbedded within the Operations Stage and may combine aspects of the Design and Construction Stages. NSF oversight is based on the TPC and associated authorization thresholds.

Figure 2.1.4-4 Spiral Development Process



The approach used should be identified early in either the project Development or Design Stages and documented as part of the managing organization's proposal and eventually the Project Execution Plan (PEP), as well as NSF's Internal Management Plan (IMP).

6.1.1 Engineering Peer Reviews description

An EPR is a focused, in-depth technical review of a subsystem, lower level assembly, or component. The goal is the EPR adds value and reduces risk through expert knowledge infusion, confirmation of approach, and specific recommendations. A key distinction of an EPR is that the review panel is selected by the project team and not by the IPM. It is composed largely of team members with expertise from outside the team pulled in when additional expertise is requested. The PM and technical lead under review will agree on the committee members.

A summary of the EPRs is presented at the CPR to mark technical progress and status.

6.1.2 Programmatic DDR

6.1.3 Local AIT

6.1.4 Summit AIT

7 Commissioning

8 Document Summary for Review Milestones

Table showing review documentation what state it is expected to be in and what we will review.

9 Appendix

9.1 Notional major review sequencing and timing.

Review page 127 of the NASA handbook to provide guidance. Put together a graphical flow chart with descriptions of the events.

9.2 Concept actions and deliverables

9.2.1 Purpose and process:

Science and Technical

- Develop a science case with community support that leads to initial main driving science requirements; science case should dovetail with WMKO strategic plan or demonstrate an unidentified need
- Build a science team
- Develop at least one feasible instrument concept, architectures, and operational modes; identify alternative concepts, scope options, and operational modes; assess future upgrade options

- Perform initial identification and assessment of key technologies (optics, mechanisms, detectors, etc.,) and state how technologies meet main science drivers.
- Develop initial list of the high-level requirements (the top 10 or less)
- Assess possible locations at the observatory and key observatory interfaces
- Identify high level trade studies
- Assess heritage components and reuse of retired equipment
- Develop technical recommendations for the instrument

Programmatic

- Estimate total cost and schedule of full instrument build for the feasible concept proposed; if scope options, upgrades, and operational modes are given, cost estimates for these alternatives should be included.
- Develop a budget, schedule, and scope of Phase A activities.
- Identify the highest-level risks and options for mitigation or exploration for the full project and specifically what would be addressed in the next phase of development
- Provide an initial organization chart with key staff and partnerships
- Identify key staffing needs for the next phase of work and obtain agreements for availability
- Identify the key partnerships (partner institutions, vendors) and their possible scope of work; alternatives may be identified
- Provide a written report for the SSC for review and a seperate Phase A project proposal for future work if desired

9.3 Phase A actions and deliverables

9.3.1 Purpose and process:

The project team will propose to the SSC Phase A work with a budget and staffing request sufficient to mature the project to a funding proposal ready level. The WMKO IPM will hold a Proposal Readiness Review of the project in advance of the summer SSC meeting. The review findings will be part of the evaluation package presented to the SSC as an independent assessment of the project. It is expected that during this phase the project will make both technical and programmatic progress as described below:

Science and technical work:

- Further **develop and refine** the **science case** and level one **science requirements** to meet the observing community's science objectives; science case should dovetail with WMKO strategic plan or strengthen the case for a previously unidentified need
- **Flow** the **top-level science requirements** into the main **technical requirements** for the instrument; requirements must be verifiable
- Develop **initial designs** for the primary and **critical** aspects of the instrument and show the **overall packaging**, **layout** of the instrument, its **location** and **key interfaces** at the observatory, and the critical sub-system interfaces.
- **Risks updated** from conceptual phase
    - ID risks in engineering development
    - Id risks in the use of heritage hardware and software
    - Risks with vendors or supply chains

    - Initial risk analysis and mitigation strategy for construction, identifying enabling technologies, high-risk or long-lead items, and research and development (R&D) needed to reduce project risk to acceptable levels;
- **Identify** plans for **in-house** work versus **procurements** for major proposed procurements and sub-systems with an initial estimate of a no-later than **date** for **long lead items**
- **Identify technical risk mitigation plans.**
- **Start high level trade studies** to assess maturity level of potential technology under consideration and develop a plan for inclusion of that technology with schedule milestones.
- Complete **identification** of **key technologies** (optics, mechanisms, detectors, etc.,) and initially assess the **technology requirements**, developing initial strategies to achieve them.
- Assess needs for early prototyping and models for higher risk components and assemblies that have not been previously built; these may carry higher risk until prototyping is complete
- **Provide technical scoping options** that may be triggered to increase or decrease scope. Provide descriptions of the descope and impact on the level one science requirements.

Project management, planning, and control tasks

- **Refine the full project budget, schedule, and scope for the instrument.** Include basis of estimates for costs for justification (ROMs, past experience, actuals for similar components, …);
- **Develop** an **initial project plan** with staffing resources identified, an initial equipment and procurements list included, and key milestones and reviews identified
- **Develop** an **instrument funding plan and approach** with observatory guidance and contingency requirements
- **Create a technical, cost, and schedule risk matrix** that included risks for technology development, engineering development, procurements with vendors, heritage hardware and software, reuse of equipment, and scope changes, and identify which risks will drive the project's cost and schedule.
- **Identify programmatic risk mitigation plans** for schedule, budget, and scope in the preliminary design phase
- **Develop** plans for the **partnerships** with partner institutions and with vendors; Define an initial **WBS** with **partnership and vendor responsibilities**
- **Baseline** : Begin addressing aspects of a **project execution plan** at the appropriate level for the size of the project; **PEPs are required by funding agencies for large scale projects.**
- Detail an **organization chart** with key staff and partnerships
- Define all staffing requirements for the remaining phases of the project and assess availability
- **Provide** a written **report** for the **SSC** for review and a written request to seek for proposal development funding project proposal for future work if desired

9.3.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that Phase A funding is paying for effort from all or some subset of these individuals.

- Principle investigator to relieve them from other institutional responsibilities if needed. The PI may perform any of the activities below listed for other staff members
- Instrument scientist who is the main architect of the instrument and will mature designs in all areas
- Project Scientist who is leading the science team and developing the science cases
- Mechanical Engineer(s) who will mature mechanical designs
- Optical engineer who will further develop the opto-mechanical model
- Software Engineer(s) to define software high level software plans

For observatory activities, the following people will be involved with helping assist with observatory planning and defining interfaces. Requests for engineering assistance with a specified number of hours should be part of the Phase A proposal to the SSC. The IPM and PM do not need to have hours requested.

- Instrument program manager who assists the project as requested managing limited resources during Phase A.
- Project Manager who will together with the IPM develop the project plan for observatory activities in support of the instrument
- Mechanical Engineer provide technical planning for observatory interfaces and WBS if assigned.
- Staff Astronomer to provide both technical and scientific guidance and information. This is critically important for AO instrumentation.
- Other engineers the need is identified

The project at this time should be collecting and developing documentation. Future projects may be able to take advantage of WMKO provided documentation services and are encourage to inquire about them. Tools the team should be employing to help manage the project include:

- A team **documentation repository** for storing data (Google Docs, Atlassian, …) that is accessible by all staff at participating partner institutions
- **Team communication tools** that may include: an email distribution list, communication team software (Slack, Microsoft Teams, Zoom, Bluejeans,…)
- **A project plan** with a level of sophistication appropriate for the size of the project to assess the budget and schedule. For medium and large projects, MS project plan or equivalent with resources identified.
- **An initial requirements document** with the level one science drivers defined and initial flow down to critical technologies
- **A risk matrix for managing risks** and identifying the high priority risks to the project.
- **CAD mechanical and optical models** to begin capturing the overall instrument design and for now these may be stored as local copies at the primary institution.

9.4 Proposal Readiness Review Charter

Criteria for the PRR

- The project's science (research) program addresses one or more science objectives, clearly demonstrating a compelling need for the project;
- The project's PRR documentation indicates that:

1. the engineering design and construction plans are appropriately defined at the conceptual design level of project maturity and that the management plans and budget estimates for further planning and development, as well as constructing and operating the facility are reasonable;
2. the sponsoring Directorate endorses the IMP and Project Development Plan[1] (PDP) for further development to the Preliminary Design Phase;
3. the technology to create the facility exists or can exist shortly, and can be used without excessive risk;
4. other risks to development are satisfactorily defined and minimized or otherwise addressed in the IMP, and
5. there are no better alternatives to the facility (i.e., with a better mix of cost and quality) that would address the science objectives in a timely manner. (this is really an SSC question)

Proposal Readiness Review Process and Charter

Date

10 Introduction

The University of California at San Diego (UCSD) and Los Angeles (UCLA) is collaborating with the W. M. Keck Observatory (WMKO) in the development of the Liger: A wide-field AO-fed integral field spectrograph and imager for WMKO that will be a second generation instrument that will superseed the OH-Suppressing Infra-Red Imaging Spectrograph (OSIRIS) on the Keck I telescope. Liger was originally proposed to the WMKO Science Steering Committee as a merger of the InfraRed Imaging Spectrograph (IRIS) designs and the hardware for the OSIRIS imager. The SSC wants to preseve OSIRIS, and instead, encouraged the Liger team to design a complete new instrument for WMKO. Liger significantly leverages IRIS designs that have already passed design reviews, but there are modifications to the IRIS concept that are necessary for Liger at WMKO.

The Liger project is currently preparing concepts in advance of seeking funding opportunities and this document describes a Proposal Readiness Review (PRR) process, the success criteria and the charter for the review committee.

11 Proposal Readiness review

11.1 Process

In the instrument's advanced conceptual phase, science goals are identified and an initial set of requirements are available for review within a broader context of the curent scientific landscape. The science goals address needs identified in the WMKO strategic plan, and thus, the desires of the

observatory's community. The science requirements drive the advanced conceptual design and operational concepts that results in sufficient detail and risk identification for all instrument sub-system components for both hardware and software. All designs are proposed with sufficient detail to establish that they are feasibile, that costs and the uncertainties in those costs are known or understood, and that the instrument is likely to meet its performance requirements. The project plans demonstrate that the budget and schedule are realistic through commissioning, having adaquate contingency costs in both budget and schedule. Through this demonstration, the instrument developent team establishes that they are prepared to submit funding requests.

11.2 Success Criteria

Success for this review means that the review committee considers conceptual designs and associated specifications presented to be mature and realistic because the

- Science cases are robust and are supported by the observing comminity
- Conceptual designs meet the science requirements for the instrument
- Schedule and management plan demonstrate that the work to complete the project can be accomplished by the development team
- Budget captures all development costs with acceptable contingency for identified risks, and there is a funding plan to support the instrument through commissioning

12 Review Process

12.1

12.2 Deliverables and Documentation:

The format of the review documentation will be defined by the review team. The team is encouraged to provide a conceptual design document that would be the base for future design documents that would be deliverables for later development phases. Alternatively, the team may provide a collection of primary technical notes and project files for review. A slide deck may also serve as the review documents, but if it is the primary source of reviewer material, the slides must be provided by the documentation deadline for reviewer feedback. The content for the above documentation is provided below and assumes a primary single document is used. The primary documentation will be clearly identified for the review committee at the time of release. It is not expected that these documents are complete at a level of preliminary design but they should demonstrate an acceptable level of detail for this early phase that would allow the team to request an appropriate amount of funding.

Documentation:

1. Concept design document
    - Exec summary
    - Science Case
    - Instrument design
    - Management Plan
        - Team makeup and availability
        - Work break down structure

        - Outlined management plan
    - Observatroy interfaces
    - Risk assessement
    - Cost breakdown
    - Schedule
2. Science traceability matrix for major system components
3. Models: These could be links in the primary documentation
    - Optical Model
    - 3D mechanical concept CAD model
4. MS Project file or similar documentation
5. Funding profile/ funding plan(s) (usually slides only)
    - Identify the source(s) for funding
    - Identify cost sharing when applicable
    - Contingency

12.3 PRR Charter example

The committee will use the review documenation as the basis for its evaluation, which will take place in a one-day meeting at UCSD. The committee will consist of three reviewers external to the project, one of whom is the chair of the review committee. The reviewers will have backgrounds in instrumentation, project management, mechanical enginneering, or other specific discipline required to assess the project. In addition, WMKO staff members not directly involved in the project and SSC members will be present and may ask questions of the development team.

12.3.1 Purpose and Objectives

The purpose of the PRR is to provide an external peer review of the current conceptual designs, schedule, costs, risks, and science cases and to provide recommendations to WMKO, the SSC, and the instrument project team on those plans in advance of seeking funding opportunities.
The review committee's charge is to determine if the project meets the success criteria and to recommend one of three courses of action:

1. Proceed as planned with proposal preparations and funding requests

2. Proceed with proposal and funding requests but address specific issues identified by the review committee as critical to the success of the project.

3. Do not proceed with funding requests at this time and instead further develop the conceptual design for the next opportunity that will address and strengthen specific issues raised by the committee.

In carrying out the review we specifically request that the review committee evaluate and consider the following questions:

1. Conceptual Designs

a. Does the instrument concept address a compelling science case and will the instrument design meet the needs of the community?
b. Are the technical requirements for the instrument clear, complete and well defined?
c. Are the concepts sufficient to establish the
    i. feasibility of the proposed design?
    ii. budget of the development process?
    iii. risks involved with the development of the instrument?
d. What is the probability that this instrument will be finished as it is currently proposed?
e. Based on the reviewer's knowledge and experience are the proposed designs based on sound scientific principles and best engineering practices?
f. Are the interfaces between the facility and the instrument well identified?
g. Are the key interfaces between internal instrument subsystems well identified?
h. Have risks been defined and approriately assessed?
i. Are there additional risks that should be considered?
j. Are the risk mitigation efforts and future plans likely to result in retirement of all critical risks?
k. Does the composition of the development team have the expertise to build the instrument or are there areas that need additional assistance?
l. Does the development team have the bandwidth to complete the project?

2. Documents and Reports
    a. Are the plans for completion of the project, including schedule and budget, sufficiently detailed and complete?
    b. Is the proposed schedule and budget to completion realistic and honest?
    c. Are cost differences with comperable existing or planned similar instruemntation at Keck or other facilities adaquately explained and realistic?
    d. Is there an appropriate funding model through commissioning of the instrument?
    e. Is there adaquate contingency and descope options available to stay within the cost cap bedget?
    f. Are the conceptual designs clear and sufficiently detailed?
    g. Is there a clear flow down established from the science requirements to the technical requirements?

12.3.2 Guidelines

In order to make the review as effective as possible we have established three guidelines for the process:

1. The review documentation should include all materials that the development team believes are appropriate to address the questions in the charter for the review committee. No additional materials should be presented at the review except for those needed to answer questions raised by the review committee prior to the review meeting.

2. The review agenda will include time for presentations that summarizes the documentation, but it will be assumed that all of the attendees have reviewed the documentation in some detail prior to the meeting.

12.3.3 Schedule

The following timetable is proposed for this review process:

Date	Description
May 27, 2019	Documentation released to the reveiw committee
June 3, 2019	Review committee members submit questions
June 4, 2019	Instrument team prepares responses to questions
June 7, 2019	Review meeting
June 13, 2019	Review summary recommendations released
June 26, 2019	Final report released

12.4 Committee Charter

The review committee charter is as follows:

1. Each member of the review committee should read the review materials prior to the review meeting.

2. Each member of the review committee should submit questions to the project team prior to the review meeting to obtain clarification or further information. The WMKO instrument program manager and the Principle Investigator will serve as the points of contact for the submission of questions.

3. Each member of the review committee should consider the answers to any questions asked in item 2.

4. The committee will hold a one-day meeting with the project team instrument design and the specific areas covered by the questions listed in the purpose and objectives sub-section of the Review Process section of this document.

5. The committee will hold one or more "executive sessions" during the meeting to develop the committee's report and recommendations.

6. The committee will use three tiers of recommendations for its findings.
    - Tier 1 recommendations must be resolved successfully before the review can be considered successfully completed.
    - Tier 2 recommendations must be resolved before seeking funding.
    - Tier 3 recommendations are offered by the committee for consideration by the development team but are not considered binding.

7. At the conclusion of the reveiw, the committee will provide a brief summary of the review outcomes to the WMKO instrument program manager and the instrument project team.

8. The chairperson of the review committee will lead the drafting of a written report. A preliminary or summary report will be issued within 2 days of the meeting and the final report

will be issued within 14 days of the review meeting. This report should summarize the important issues discussed at the review meeting and present the committee's findings.

9. The preliminary and final reports of the committee will be delivered to the SSC co-chairs and the Observatory Director.

12.5 Preliminary Design Review Charter

12.6 FRR/MRR Technical Review Charter

12.7 Programmatic DD Review Charter

12.8 Preship Review Charter

Project execution plan items:

- Describe how the project will report status to WMKO and other stakeholders; this can be a collaborative agreement with the IPM
- How will the project support a rebaseline review or cost exersize.
- How is the technical authority implemented
- How will EVM be used to track progress
    - What will be the baseline (typically cost to go at PDR for large projects)
    - Definitions or templates for what is required from the partner institutions
    - How will cost/schedule data be obtained from the partners to complete EVM
    - Examples of EVM for instrumentation
- What will be the process for controlling the IMS.
    - Methods for monitoring the critical path items.
- How will the project use both technical and schedule margins to stay under costs which is most critical to the observatory.
- How will the project report, schedule, technical, and cost status to the IPM and other folks
- What is the way of requesting waivers on requirements.
- Document the project scope options for descopes/upscopes with key decision dates, savings in the cost and schedule and how the descopes are related to the project level one requirements.

- How will SE be completed
    - Requirements tracking, verifications, change control, …
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