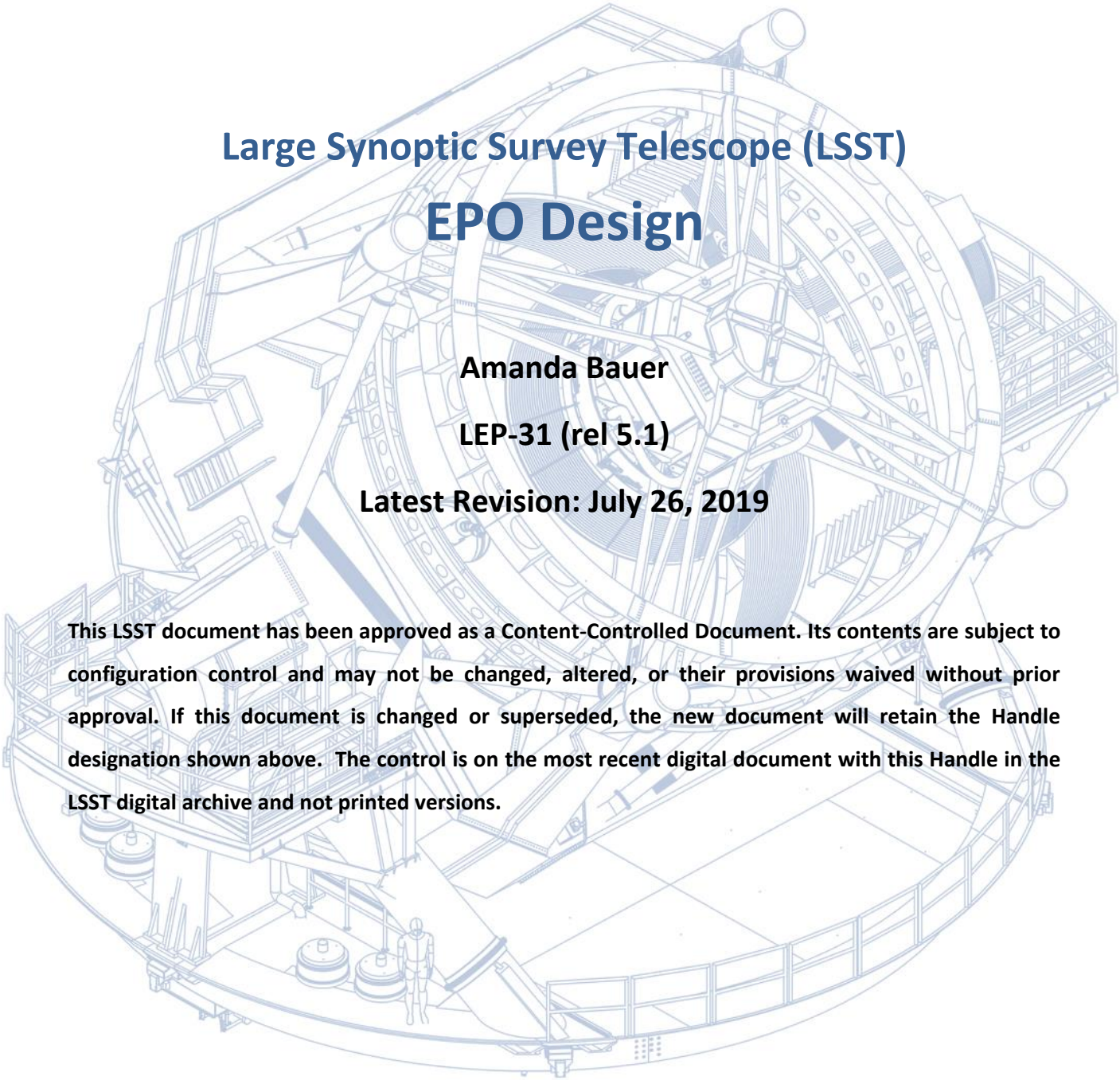
LARGE SYNOPTIC SURVEY TELESCOPE



Large Synoptic Survey Telescope (LSST)

EPO Design

Amanda Bauer

LEP-31 (rel 5.1)

Latest Revision: July 26, 2019

Change Record

Release	Date	Description	Owner Name
2.0	10/7/2018	FDR version of EPO Baseline Design, D-12079	S. Jacoby
3.0	10/2016	Refreshed based on updated EPO Requirements (LSE-89) and planning subsequent to FDT	B. Emmons
4.0	07/18/2017	Refreshed based on Operations Planning	A. Bauer, B. Emmons, E. Bechtol
4.1	09/05/2017	Major updates for EPO Review	E. Bechtol, A. Bauer, B. Emmons
5.0	07/2018	Content updated after EPO team growth	A. Bauer
5.1	2019-07-26	Content updated after EPO team growth	A. Bauer

Table of Contents

The LSST EPO Design

Executive Summary

This document provides an overview of the Education and Public Outreach (EPO) program for the Large Synoptic Survey Telescope (LSST). It defines specific EPO program elements that shape the cost, schedule, and scope detailed in the LSST Project Management Control System (PMCS) - WBS 5.0 for the construction of the LSST EPO program, to be delivered at the start of LSST Operations.

The mission of LSST EPO is to offer accessible and engaging online experiences that provide non-specialists access to, and context for, LSST data so anyone can explore the Universe and be part of the discovery process. The subset of LSST data to be made world public immediately will be referred to as the *EPO data set* in this document. Key objectives driving the EPO program are guided by requirements for user-centered learning tools that meet the needs of specific audiences with different levels of knowledge, experience, and skill.

LSST EPO will serve four main categories of users, with a focus on people in the United States and Chile:

(1) General public (with an emphasis on science-interested teens and adults),

(2) Formal educators teaching astronomy content at the advanced middle school, high school, and undergraduate college levels,

(3) Principal investigators with LSST data rights leading citizen science projects, and

(4) Content developers at informal science centers.

For these audiences, EPO's vision is to facilitate a variety of engagement options by creating accessible online astronomy activities for non-specialists, from exploration of astronomical imagery and information to more complex interaction with LSST data. To achieve this, EPO is creating a website featuring a multimedia gallery, interactive visualizations, opportunities to participate in citizen science projects that use LSST data, and a suite of online investigations for classroom use. Products will be optimized for viewing on mobile devices or tablets and sharing via social media, to align with current trends in digital literacy and the modern era of social interaction. Where possible, EPO products will be available in both English and Spanish.

Visitors to the website will find articles about LSST discoveries, features on people involved with the LSST Project, introductory videos about LSST, and opportunities to explore the latest astronomical imagery.

Formal educators will have access to online, easily adoptable classroom investigations that integrate LSST data into web-based activities. Investigations will be aligned with the Next-Generation Science Standards (NGSS)[1] in the USA and the Curriculum Nacional in Chile, and will follow best practices for

[1] https://www.nextgenscience.org/

college level students. LSST EPO will also provide the professional development training and instructional materials necessary for educators to successfully engage their students in each investigation.

The EPO Team will work with Zooniverse[2] to add LSST data compatibility to their Project Builder tool, allowing scientists with data access to easily create citizen science projects that help them accomplish their research goals and engage with a global community. EPO anticipates that the number of citizen science projects in the astronomy field will increase dramatically when LSST is operational, giving a new generation of citizen scientists the opportunity to deepen their engagement with astronomy using real data from LSST.

LSST EPO will provide free multimedia visualizations for use by museums, science centers, and planetariums around the world, offering maximum flexibility for content developers to adapt the materials to their specific needs. These visualizations, associated metadata, and distribution methods will follow industry standards and best practices.

Underlying all EPO programing is critical infrastructure that responds quickly to varying levels of demand. Therefore, a foundational component of LSST EPO is the cloud-based EPO Data Center (EDC) which allows for scalable, on-demand computing best suited to EPO audiences.

Another critical priority during construction is building prototypes and performing user testing, which continually improve the user experience, usability of interfaces, and lowers the risk of not achieving our main objectives.

Finally, LSST will engage the science community in developing and distributing its products, fulfilling the NSF's Broader Impact requirements and strengthening the link between LSST scientists and EPO audiences.

[2] https://www.zooniverse.org/

The LSST EPO Design

1 Requirements

At the highest level, the need for an EPO program is established in the LSST System Requirements Document (LSE-29) and flows down to the LSST Observatory System Specifications (LSE-30). From there, full implementation requirements are detailed in EPO Subsystem Requirements (LSE-89) and DM/EPO Interface (LSE-131). Details related to EPO Commissioning are included in the LSST Commissioning Plan (LSE-79) and details for EPO Operations are included in the LSST Operations Plan (LPM-181).

This technical system-level documentation is under Change Control within the LSST Project and the work within is subject to Compliance and Verification Procedures (LSE-160) as defined by the LSST Systems Engineering Team.

Reference Documents:

- LSST System Requirements (LSE-29)
- Observatory System Specifications (LSE-30)
- EPO Subsystem Requirements (LSE-89)
- DM/EPO ICD (LSE-131)
- LSST Commissioning Plan (LSE-79)

2 Objectives

These objectives describe specific aims that drive the overall scope of LSST EPO and support achieving the requirements of the program:

- Provide non-specialists access to the LSST EPO data set through online tools and interfaces.
- Enable and promote citizen science projects that use LSST data.
- Support STEM education and training by engaging with educators to enable use of real LSST data in classrooms.
- Develop multimedia resources for content developers at informal science centers.
- Build relationships with institutions and organizations serving underrepresented groups in STEM and proactively engage with diverse audiences.
- Engage with the Chilean community by providing culturally responsive EPO products in Spanish.
- Remain agile and relevant during the full lifetime of LSST Operations by adjusting to technology trends and changes in educational priorities.
- Provide evidence-based evaluation of the LSST EPO program and publicly report findings.

To achieve these objectives, the LSST EPO team will engage with our identified audiences to create and test powerful and easy-to-use digital tools for exploring the rich EPO data set, enabling users of any background to engage with the Universe like never before.

3 EPO Program

In developing accessible online resources for the general public to engage with LSST data and discoveries, EPO will capitalize on upward trends in digital literacy, use of mobile devices, and use of social media to share discoveries. This section starts by identifying audiences and estimating reach, highlighting features of the website, and then details some of the major EPO program components: multimedia gallery, formal education, and citizen science (see Figure 1).

3.1 Audiences

Four primary audiences for LSST EPO are listed below with estimates of the number of users in each group and the relevant deliverables. We have analyzed user behavior by audience group and learned from related projects to determine the anticipated number of users for LSST. Note that EPO will reach some participants directly and others indirectly, for example, "content creators" at informal science centers; products they create will then indirectly reach very large audiences.

1. General Public (with an emphasis on science-interested teens and adults)

   Users will engage with the project through social media outlets and the EPO website. We estimate 1 million visitors to the website and 5 million reached through social media. LSST currently has accounts on facebook, twitter, and Instagram.

2. Formal educators teaching astronomy content at the advanced middle school, high school, and undergraduate college levels

   We estimate 1000 users a day will log into the educational resource part of the website to use online investigations to enable authentic research projects. It is also possible students will explore independently.

3. Principal Investigators with LSST data rights leading citizen science projects

   We estimate that 100-200 Citizen Science projects using LSST data will be launched by researchers over the 10 years of Operations. We estimate up to 10,000 LSST Citizen Science users based on the history of Zooniverse users.

4. Content developers at informal science centers.

   In addition to content developers at planetariums and science centers who receive very large numbers of in-person visitors to their locations, major hardware and software vendors are an audience for our multimedia products. We anticipate 12 vendors receiving annual updates of LSST content and 100 content providers using multimedia products to integrate into their live, ongoing, or new programs.

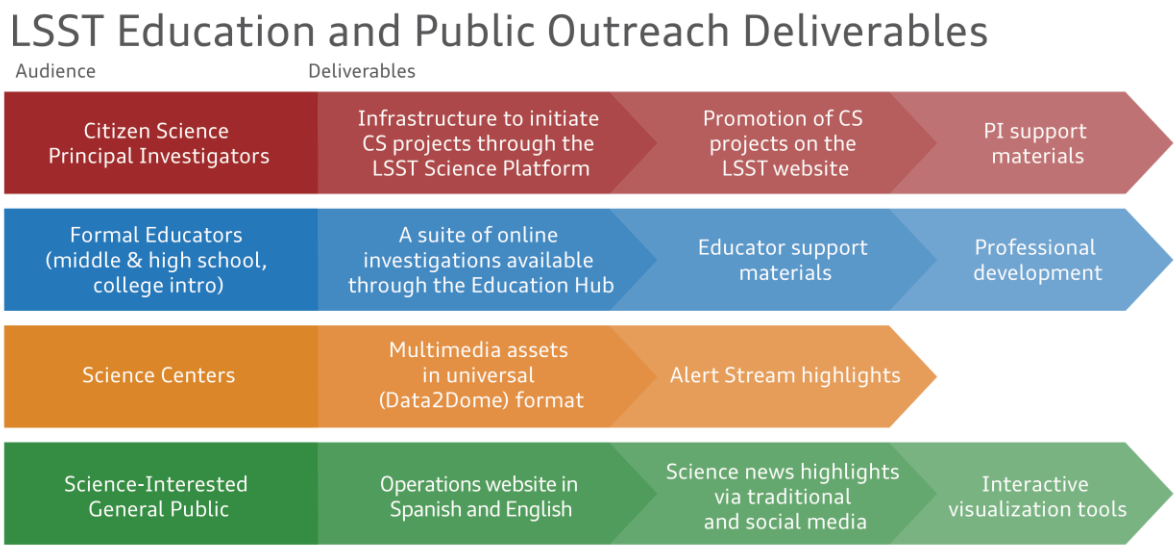


Figure 1: The audiences and deliverables of the LSST EPO program

3.2 Website

The website home page is intended to be the main landing page for visitors to the public LSST webpages during Operations. The home page could feature media, such as a promotional video and astronomical images, news from the Project, formal education highlights, featured citizen science projects, and highlights of recent discoveries with LSST data.

Throughout the website, users will find articles about LSST discoveries and people involved in the Project (e.g. scientists, engineers, developers, etc.); features on LSST science results; and videos that introduce the general public to LSST, its science goals, and general astronomy concepts. Information about the facility design and construction will also be available.

The website will also share what is happening at the telescope site -- the current weather, information from the previous night's observing, etc. EPO will use status information from summit sensors, cameras, and the Engineering Facilities Database to populate this page.

Ultimately, LSST has the unique opportunity to combine the beautiful astronomical images the public has come to expect with the excitement of new discovery as embodied by the nightly alert stream. The main LSST website will take advantage of this opportunity by providing interactive visualizations demonstrating the sheer number of objects observed and highlighting discovery images and stories we expect to be the most intriguing. Linking the process of discovery of moving and flashing objects to more traditional thinking of astronomy is a goal of the website overall.

In order for the public to navigate the full breadth of LSST data and the process of discovery, we will guide the general user towards specific learning goals and objectives. The website will provide pathways of discovery through the content to avoid the user feeling overwhelmed or unsure of where to go next. For example, if a user is brought to the webpage through a social media post or news article, related

content will be suggested to them to encourage them to continue their exploration through the site. Some options include creating listicles featuring interesting discoveries such as "The Top 10 closest asteroids detected by LSST" or "The most distant objects in our Solar System found by LSST to date." Such features are quickly consumable, relevant, and dynamic – a perfect fit for sharing on social media and encouraging repeat site visits by the public.

Where possible, features throughout the website will be shareable via social media; the entire website will be designed to be mobile-friendly to support this.

EPO will also host a forum to promote communication with and between its users. During Construction, the forum will be an avenue for user testing, feedback, and building a network of users for when we are ready to launch into Operations. During Operations, the forum will become an avenue for communicating with all the primary EPO audiences.

The rest of this section is dedicated to describing EPO Program components intended for specific audiences that will be hosted on the general website: multimedia, citizen science projects using LSST data, and formal education resources.

3.3 Multimedia

LSST EPO is developing a library of digital multimedia assets (See Table 1) during Construction to be used in Operations on the LSST website as well as at science centers, planetariums, and media outlets. Assets include:

- Visualizations of astronomical phenomena related to LSST science
- Images and videos of progress on the construction of telescope components, including the camera assembly, the mount structure, the dome and telescope facility on Cerro Pachón
- Video interview footage of the broad range of people involved in the Project, from those who brainstormed its early design to the scientists, engineers, and other experts making LSST a reality
- A virtual tour of the telescope facility

EPO will contract with external multimedia specialists, video production firms, and visual effects consultants to develop multimedia assets over time. We will not be developing a full-length planetarium show, and will instead deliver short video clips ranging from 30-90 seconds in addition to some short introductory films on the Project up to a few minutes in length.

LSST EPO will provide multimedia in accepted standards for formatting. Planetarium fulldome video footage will include Domemaster frames to maximize compatibility with various dome styles, projection systems, and software products. Image assets and flat-projection video footage (such as panoramas, sunset/sunrise, day/night time lapse, and aerial drone) will support the *Astronomy Visualization Metadata (AVM)*[3] standard for images to facilitate easy searching, cataloging, and distribution via LSST's

[3] https://www.virtualastronomy.org/avm_metadata.php

digital asset management system and the International Planetarium Society's *Data2Dome*[4] standard.

Throughout Construction, EPO is collecting video footage of various hardware delivery milestones and interviews of members of staff and the science collaborations. Some footage is collected by our team during the annual Project and Community Workshops at voluntary "StoryTime Domain" sessions. In 2018, we conducted 20-minute video interviews of 21 people involved in the Project. Most were in English and 6 were recorded in Spanish. These sessions will continue each year!

Table 1: Library of digital multimedia assets

Deliverable	Format	Milestone	Completion	Length
Planetarium videos (20)	Fulldome 4K	Start 2017	March 2019	30-90 sec
LSST Promo video	YouTube	Start 2017	August 2019	120 sec
Virtual tour	Web / 360	Prototype 2019	July 2022	
Construction Footage			ongoing	

3.4 Citizen Science

Citizen science is research made possible by volunteers from around the world assisting professional scientists with projects that would otherwise be impractical or not possible. Because of the size of the LSST dataset, some research projects may be too big or complex for individual researchers and their teams to handle, even with the assistance of machine learning technologies - computers simply cannot perform certain tasks required of astronomical data. The goal of LSST EPO's citizen science program is to enable anyone with LSST data rights and access to build citizen science projects using LSST data through a seamless process.

LSST citizen science will be delivered in partnership with Zooniverse.org, a popular online platform with tools that allow scientists to create and run such projects. So far almost 100 peer reviewed articles have been published using data derived from Zooniverse-approved projects over Zooniverse's 10 year lifetime. We envision that hundreds of projects and even more publications could be achieved as the result of using LSST data for citizen science projects.

As a result of the integration between LSST and the Zooniverse, professional researchers will be able to create and run citizen science projects themselves, which enables far more projects than EPO could run by itself. Additionally, EPO has supported Zooniverse to offer language translation within individual projects so there is now the capacity to create a new project or translate an existing project to Spanish.

LSST Users interested in starting a citizen science project with LSST data will access the LSST Science Platform and use the tools available there to define and create their citizen science data set. The researcher then uses an EPO-developed package to transfer suitable data to the Zooniverse Project Builder tool, where they go to build and test projects.

[4] http://www.data2dome.org/

LSST EPO will design and create templates for LSST citizen science projects that principal investigators will be encouraged to use to maintain an identifiable and consistent look and feel of LSST projects.

To boost public participation in citizen science projects, EPO will promote current LSST-related projects hosted on Zooniverse, throughout the website, encouraging site visitors to participate in projects they find interesting.

To assess the effectiveness of the LSST citizen science infrastructure, EPO will work with two researchers to initiate and run two citizen science projects during LSST Commissioning. The principal investigators will be asked to document their project-building processes during Commissioning, and provide EPO with feedback which will be used to make improvements.

To assess the success of the citizen science program, we will use feedback forms and analytics collected by Zooniverse on the participation rates and demographics of citizen scientists over time.

3.5 Formal Education

The EPO team will produce online, data-driven classroom investigations for students in advanced middle school through college. The topics cover commonly-taught principles in astronomy and physics, and each investigation is designed for use with Next Generation Science Standards (NGSS) in the United States and the Curriculum Nacional in Chile.

The LSST education program takes advantage of opportunities that exist within the modern web ecosystem, recognizes the necessity for mobile-friendly interfaces, offers a clear path toward learning outcomes, and uniquely develops activities that require no software to install or data to download in order for educators to introduce these activities into their classrooms. These characteristics combine to lower the barrier to access these state-of-the-art classroom activities and increase inclusivity within the growing number of schools that have internet connectivity. In 2018, 98% of K-12 schools in the US, urban and rural, had the broadband infrastructure and internet access they needed for digital learning[5].

EPO will develop investigations around six themes (see Figure 2), merging the main LSST science pillars and the most commonly taught topics in astronomy in the US and Chile. Each investigation will feature authentic LSST data accessed through interactive online widgets that are intuitive to use.

Investigations will be designed to implement effective classroom teaching practices that support student's critical thinking, data analysis skills, and complex problem-solving abilities. Investigations will include a Teacher Guide, introductory videos, and assessment materials. All investigations will be available in English and Spanish.

[5] https://s3-us-west-1.amazonaws.com/esh-sots-pdfs/2018%20State%20of%20the%20States.pdf

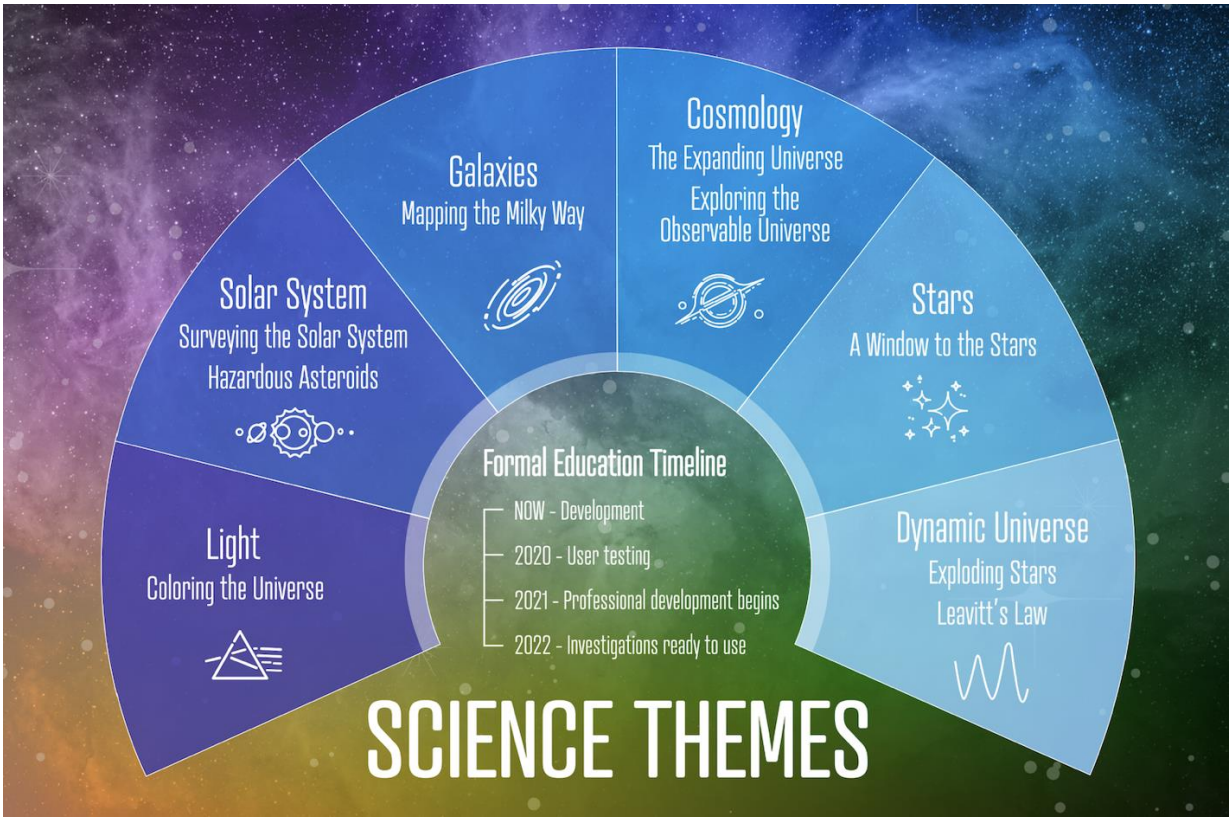


Figure 2: Science Themes of LSST EPO Formal Education Investigations

All investigations will use LSST data as it becomes available. Extensive field testing with a diverse range of educators will be conducted throughout Construction using simulated data, pre-cursor data sets, and LSST commissioning data (as it becomes available). Field testing is important as it allows us to iteratively improve the design of the online investigations and support materials, as well as improve the ease of use for instructors and accessibility for different types of classrooms.

To increase adoption and encourage sustained use of EPO investigations in classrooms, EPO will offer professional development and support options for educators. Professional development options to be evaluated include holding workshops at professional society meetings and educator conferences, providing training materials online, and facilitating sessions at strategically-selected regional venues.

4 LSST Science Community

EPO will provide opportunities for members of the LSST Science Community to participate in education and outreach. These opportunities, while aligned with NSF Broader Impacts[6] criterion, will be available for the entire LSST Science Community. Examples include:

[6] https://www.nsf.gov/pubs/2007/nsf07046/nsf07046.jsp

- Contribute to online investigation development
- Contribute to interactive widget design and development
- Create investigations on relevant science topics
- Assist with the assembly of precursor data for user testing during Construction
- Expand EPO's network at strategic conferences/events
- Provide scientific input for EPO deliverables
- Prototype citizen science projects with LSST, pre-cursor, or simulated data
- Prototype EPO's professional development program

5 Diversity

EPO is committed to engaging with diverse audiences, in particular those traditionally underrepresented in STEM fields. EPO is undertaking a multi-faceted approach to reaching diverse individuals. Within each part of the EPO Program, design decisions are made that incorporate diversity, inclusion, and accessibility. For example, care has been taken in designing diverse animated characters in educational videos; diverse scientists will be highlighted on the website; citizen science projects will be available in Spanish; and multimedia will be available in standards such that smaller planetariums can easily use them. Evidence-based design decisions around diversity and inclusion will be documented in EPO evaluation reports.

We will also build websites and online interactives that meet the Web Content Accessibility Guidelines[7] (WCAG) through the World Wide Web Consortium (W3C) process[8]. These guidelines have been created to help make the web accessible to people with disabilities. To achieve this, we carefully choose attributes such as text size, color contrast, screen-reader text, interactive element sizes, etc. that follow the WCAG. To ensure success, we are incorporating tests into our development process that alert us to infractions related to those guidelines. In addition, we are taking care to employ semantic HTML, utilizing technologies that perform consistently across most modern browsers and devices, observing best practices of Universal Design, and we are actively innovating data visualization strategies for screen readers.

6 EPO Data Center (EDC)

All parts of the EPO program described above depend on making data available in a way that is responsive to requests and easy for non-specialists to use. Therefore, a foundational component of the EPO program is a scalable data center tuned to unique EPO audience needs.

User load and usage varies significantly throughout each day and during different parts of the year.

[7] https://www.w3.org/WAI/standards-guidelines/wcag/

[8] https://www.w3.org/2019/Process-20190301/

Spikes in web traffic will follow references to LSST in media, science results, media references to citizen science projects, and social media references by popular individuals or organizations to a feature of the website.

To accommodate these patterns, the EDC will follow best practices popularized by cloud computing: leveraging containers, infrastructure-as-code, and scalable architecture.

The EPO data set will not exceed 10% of the full LSST data set, will be obtained from the Data Access Center (DAC) at NCSA, and will be transferred to the EDC as defined in the interface requirements document (LSE-131).

By designing an agile, scalable infrastructure, EPO can meet the challenging and unique needs of our audiences while efficiently minimizing cost. As we develop these creative solutions, we anticipate that our contributions and insights can benefit future EPO programs associated with big data astronomy projects like the *Square Kilometre Array* (SKA) and thirty-meter class telescopes as well as the open-source community.

7 Evaluation

During Construction, EPO will engage in iterative prototype testing and evaluation to improve Program design.[9] As individual components of the EPO Program are developed, we will recruit people to interact with, test, and provide feedback. Testing may be moderated, where EPO or contractors engage with participants in real time, or unmoderated, where they interact with programs online. Feedback from user testing sessions will be incorporated into ongoing development and design, adding improvements to the user experience and EPO deliverables. By regularly testing with representatives of our main audiences, including our Spanish-speaking Chilean audience, we can ensure the goals and outcomes of the EPO program are more likely to be achieved when Operations begins.

Evaluation during LSST Construction will focus on answering questions such as:

- To what extent do users find deliverables intuitive and relevant?
- To what extent are deliverables and the website accessible to our core audiences?
- To what extent are audience needs being met?
- What are short-term user outcomes as a result of using EPO deliverables?
- To what extent are activities sustainable through Operations?
- How can we improve deliverables to be more appropriate, efficient, effective, and sustainable?

User feedback and iterative testing during Construction offers an opportunity to test and refine evaluation questions for use during Operations.

Analytic tracking will be built into technical components of the program during Construction. For example, the website will use an analytic tracking system to determine user dwell time and click paths. These data will be delivered to an external evaluator who will be contracted to evaluate the impact of

[9] This process, known as formative evaluation, occurs during program development.

the EPO Program on our core audiences during Operations.

Outcomes for the main program components are being defined during Construction and are detailed in Table 2. Evaluation will be organized and performed at the program component-level on the premise that if each component is successful, then EPO has successfully fulfilled its mission. Planning for evaluation in Operations is an ongoing process throughout the LSST Construction and Commissioning periods.

Table 2: Outcomes and associated evaluation methods for the main components of the LSST EPO Program

Program Component	Audience	Desired Outcomes	Evaluation Methods
Website	Science-interested teens and adults	• Awareness of LSST • Increased awareness of having access to LSST data • Awareness of the diversity of people working on LSST • Awareness of the main science themes of LSST • Awareness of scientific research methods	-Web surveys -Web analytics -Focus groups -Interviews
Multimedia	Content creators at informal science centers	• Awareness of LSST and its multimedia offerings • Perception that LSST multimedia resources are easy to adopt • Perception that LSST multimedia assets are useful for programming	-Web analytics -Surveys -Focus groups -Login requests -Data2Dome-Gallery exchange
Formal Education	Educators in advanced middle school, high school, and undergraduate college classrooms	• Awareness of LSST and its educational offerings, particularly among underrepresented groups • Increased confidence using online science investigations with students • Use one or more formal education investigations over multiple years • Use of professional development opportunities	-Surveys -Focus groups -Login requests -Documentation of feedback from EPO team -Pre/post professional development surveys -Online feedback form -Forum monitoring

Citizen Science	Principal investigators of citizen science projects using LSST data	• Awareness by the LSST Science Community of the opportunity to build citizen science projects using LSST data via the LSST Science Platform • Awareness by the LSST Science Community that they can use citizen science as a tool to achieve their science goals • Increased skills by citizen science principal investigators in developing citizen science projects	-Surveys -Focus groups -Online feedback form -Project Builder analytics -Documentation of feedback from science community

Needs assessments, focus groups, interviews, and prototype testing sessions have and will continue to have concentrated effort around recruiting for diverse individuals and viewpoints. Through this work, EPO will create deliverables that are interesting, accessible, engaging, and relevant to as many people as possible and learn about the diverse ways people engage with astronomy.

Periodic summaries of evaluation findings will be made publicly available. This could be through published journal articles, presented talks at conferences or the LSST Project and Community Workshops, and/or publicly posted reports.

8 Communications and Marketing

During Construction, Communications is encompassed within the Project Office. As the Project transitions from pre-Operations (2021) into full Operations, Communications will start to transition to operating within EPO. In 2019, EPO will start developing the Operations Communication Plan. This plan will address topics such as the buildup of marketing activities before the start of Operations, the process for supporting and issuing press releases, social media strategy, and internal communication procedures.

9 Construction Staffing

To achieve these goals during LSST Construction, EPO will be staffed with content specialists, scientists, educators, and developers. Most team members will be based in Tucson at LSST Headquarters and led by the Head of EPO. The Chile EPO Coordinator will be located in Santiago or La Serena, Chile. LSST EPO will also work with EPO groups within the AURA Observatory group and others in Chile to incorporate effective practices and maximize efficiency.

The education and outreach focused members of the EPO team will develop structured online LSST data-based classroom activities that reflect national education priorities and are engaging for a diverse

audience of educators and students. Members of this group will represent LSST at events like AAS and the IAU, document project progress as archival footage for use in LSST Operations, and work closely with the Head of EPO to build and maintain relationships with organizations serving underrepresented groups in STEM.

The technical members of the team are responsible for architecting, developing, and maintaining the EPO Data Center. They also maintain EPO website features like the online investigation infrastructure, widget development, interactive features, and multimedia gallery, taking advantage of modern web technologies. They will coordinate with the LSST Science Platform development group, the LSST Data Facility (NCSA), and key technology partners to ensure data integrity, seamless integration, scalability, and fast performance.

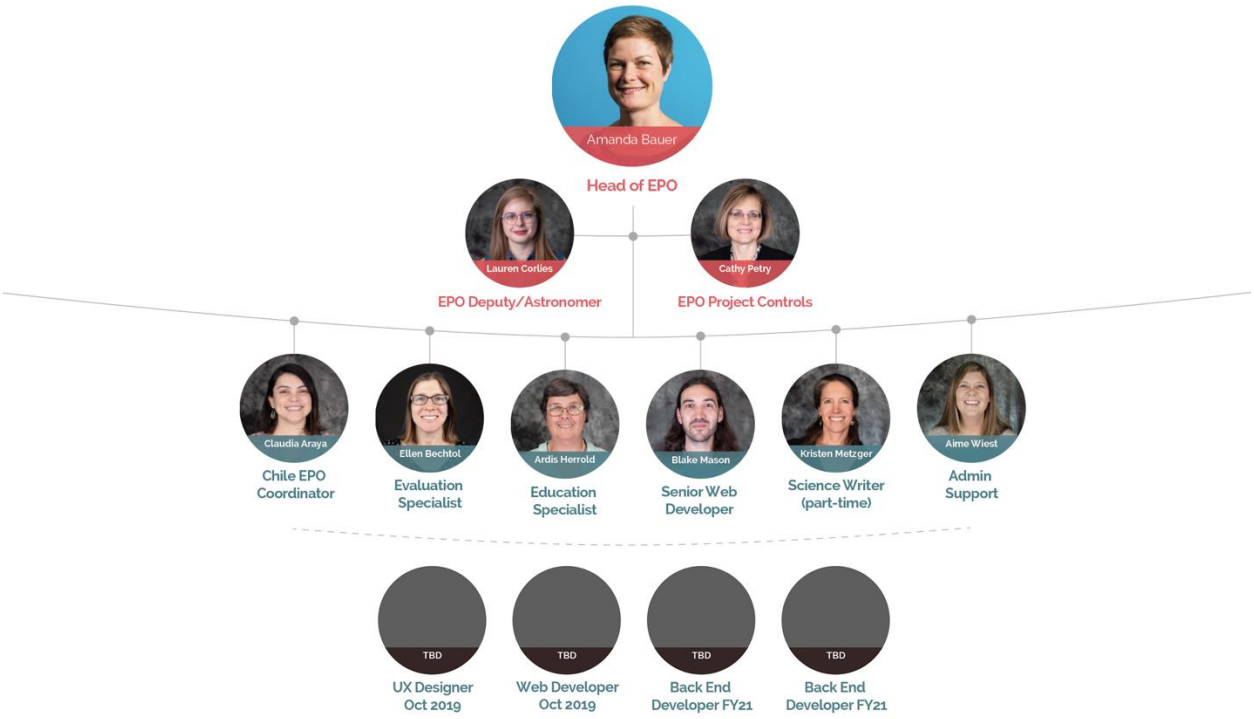


Figure 3: LSST EPO Org Chart (July 2019)

Note: Operations staffing is described in the LSST Operations Plan (LPM-181).

10 Operations Readiness

There are three major phases of EPO:

1. Construction: EPO will use simulated and precursor astronomy data sets to develop and perform testing of website features before Commissioning data from LSST becomes available

2. Pre-Operations and Commissioning: EPO will use LSST ComCam data, simulated data, precursor alert stream data, and then LSST Cam commissioning data to further build out and test website features
3. Operations: EPO will launch the public site. Note that commissioning data and precursor data will be used during the first year of telescope Operations prior to Data Release 1 and the beginning of Alert Stream production.

Commissioning tasks are defined in the LSST Commissioning Plan (LSE-79). We include some EPO highlights here for reference:

i. Test network bandwidth and load between NCSA and EDC
ii. Test loading the public subset of annual catalog data (the EPO Data set) into the EDC database
iii. Test loading the color co-add images from NCSA into the EDC and converting to image tiles for interactive web display
iv. Test robustness of educational investigations using EDC data
v. Test education investigations and supporting professional development materials with educators
vi. Test integration of Zooniverse Project Builder with LSST data sources
vii. Test website at full load using simulated users
viii. Verify Data2Dome-compliant software at informal science centers can access EPO multimedia
ix. Validate key use cases with small groups of actual users:
    - Usability testing of graphical user interfaces
    - Citizen science using two prototype projects
    - Classroom investigations
    - Professional development for educators
    - Data2Dome multimedia search and fulldome display
x. Review cybersecurity as defined in the EPO security plan (LEP-21, LEP-22)

LSST EPO will be declared ready for Operations at the successful completion of an EPO Operational Readiness Review, signalling the formal end of Construction for EPO.

11 Document History

Version 3.0 (November 2016) – the first version updated after Ben Emmons joined EPO Team

- Incorporated refreshed EPO Requirements (LSE-89)
- Replaced full text of LSE-29 and LSE-30 requirements with reference
- Added support section and removed telescope status reference
- Updated Operational Readiness section

- Updated authorship

Version 4.0 (September 2017) – major updates before September 2017 EPO Review

- Operations planning updates included
- Reorganized document structure and added introductory text
- Updated EDC derivative data sources
- Added evaluation information to each section and added own section
- Long term scope added
- Included community involvement and Broader Impacts
- Altered scope related to animated images