**EPICS Project Delivery**

It is the goal of the EPICS program to improve our project delivery. There are several aspects of the project delivery that we would like to focus on. The first of being a **safe** project.

The second being a **quality** project. A project that has attention to detail and is well constructed will serve our project partners for many years of use.

The third being a **durable** or “hardened” project. Many of our projects must survive extreme conditions. Conditions that need to be considered is the environment that the project will be deployed in. Make sure to research the conditions that your final design will be installed in.

The last aspect for your project is to deliver it a **timely** manner. Remember that the project may not need to be finished and polished or “show ready” for your project partner. Through the research, design, and implementation process, you can make smaller portions of your project a delivery goal. Providing smaller deliverable potions or sections of your project, you can give your project partner a chance to “review and try” a feature or idea that your team is working on in the final design. This method can speed up delivery by allowing your team to develop a feature, test, and adjust any of the features/design as needed.

The EPICS (Engineering Projects in Community Service) program aims to enhance project delivery by focusing on several key aspects:

1. **Safety**: Ensuring that all projects are safe for users and the environment is paramount.

Safety is the foremost priority in the EPICS program’s project delivery. A well-designed project must prioritize the well-being of its users and the environment. To ensure the highest safety standards, consider the following elements:

1. **Risk Assessment**: Conduct a thorough risk assessment at the beginning of the project. Identify potential hazards associated with the design, construction, and use of the project. Consider all stages of the project lifecycle, including installation, operation, maintenance, and decommissioning.
2. **Compliance with Standards**: Ensure that your project complies with relevant safety standards and regulations. This includes local, national, and international standards that pertain to your specific project. Compliance not only guarantees safety but also enhances credibility and trust with your project partners.
3. **Material Selection**: Choose materials that are safe and appropriate for the intended use. Avoid materials that are toxic, flammable, or otherwise hazardous unless absolutely necessary, and ensure that appropriate safeguards are in place if they must be used.
4. **User-Centric Design**: Design with the end-user in mind. Consider ergonomics, ease of use, and potential misuse scenarios. Ensure that the project is intuitive and accessible, reducing the likelihood of user error that could lead to accidents.
5. **Protective Features**: Incorporate protective features such as guards, shields, and emergency shut-offs. These features can prevent accidents and protect users in case something goes wrong. For instance, if your project involves machinery, ensure that there are safety guards to prevent injuries.
6. **Testing and Validation**: Rigorously test your design under various conditions to identify and mitigate potential safety issues. Conduct both simulated and real-world testing to ensure that the project performs safely under all expected conditions. This might include stress tests, environmental tests, and user trials.
7. **Documentation and Training**: Provide comprehensive documentation and training for users and maintenance personnel. Clear instructions and safety guidelines can prevent accidents and ensure that the project is used correctly and safely. Include warning labels and safety signs where necessary.
8. **Regular Reviews and Updates**: Safety is an ongoing concern. Regularly review and update your project to address any new safety issues that arise. Stay informed about new safety standards and technologies that can be incorporated into your project.

By focusing on these safety elements, the EPICS program can deliver projects that protect users, comply with regulations, and maintain the highest standards of safety throughout their lifecycle.

1. **Quality**: Projects should exhibit attention to detail and be well-constructed to provide long-term service to project partners.

Quality is a critical aspect of the EPICS program’s project delivery. A high-quality project not only meets the needs of the project partners but also ensures long-term reliability and satisfaction. To achieve superior quality in your project design, consider the following elements:

1. **Attention to Detail**: Quality starts with meticulous attention to detail. Ensure that every aspect of your design is carefully considered and executed. This includes accurate measurements, precise calculations, and thorough documentation. Small details can have a significant impact on the overall quality and functionality of the project.
2. **High-Quality Materials**: Select materials that meet the highest standards of quality. The choice of materials affects the durability, performance, and aesthetic of the project. Use materials that are appropriate for the intended use and that will stand the test of time.
3. **Craftsmanship**: Emphasize skilled craftsmanship in the construction of your project. Whether it involves assembling components, welding, or programming, each task should be performed with precision and care. High-quality craftsmanship ensures that the project functions as intended and looks professional.
4. **Testing and Validation**: Rigorous testing is essential to ensure quality. Conduct comprehensive testing at every stage of the project to identify and address any issues. This includes functionality tests, performance tests, and stress tests. Validate that the project meets all specifications and requirements.
5. **Continuous Improvement**: Adopt a mindset of continuous improvement. Gather feedback from project partners, users, and team members to identify areas for enhancement. Use this feedback to refine and improve the project design, even after the initial delivery.
6. **Documentation and Standards**: Maintain detailed documentation throughout the project. This includes design specifications, test results, user manuals, and maintenance guides. Adhering to industry standards and best practices ensures that the project is built to a recognized level of quality and can be easily understood and maintained by others.
7. **Aesthetics and Usability**: Quality also encompasses the aesthetic and usability aspects of the project. A visually appealing and user-friendly design enhances the overall experience for users. Consider the project’s appearance, interface, and ease of use to create a product that is both functional and enjoyable.
8. **Reliability and Performance**: Ensure that the project performs reliably under all expected conditions. This involves designing for robustness and redundancy, so the project can handle unexpected stresses and continue to function correctly. High-quality projects consistently meet performance expectations without frequent failures or maintenance issues.
9. **Quality Control Processes**: Implement quality control processes at each stage of the project. This includes peer reviews, inspections, and formal quality assurance checks. Establishing these processes helps catch issues early and ensures that each phase of the project meets the required quality standards.
10. **Partner and Stakeholder Engagement**: Engage with project partners and stakeholders throughout the design and development process. Their insights and feedback are invaluable for ensuring that the project meets their needs and expectations. Regular communication helps align the project’s objectives with the desired outcomes and ensures a high level of satisfaction.

By focusing on these elements, the EPICS program can deliver projects that are not only safe and durable but also exhibit exceptional quality. This commitment to quality ensures that projects will serve their intended purposes effectively and provide lasting value to project partners.

1. **Durability**: Projects must be designed to withstand extreme conditions. It's important to research the specific environmental conditions where the project will be deployed to ensure its durability.

Durability is a key aspect of the EPICS program’s project delivery. A durable project is one that can withstand the test of time and continue to function under various conditions. To ensure the durability of your project design, consider the following elements:

1. **Material Selection**: Choose materials that are known for their strength and longevity. Consider factors such as corrosion resistance, fatigue strength, and wear resistance. Materials should be suitable for the specific environment in which the project will be deployed. For instance, projects exposed to harsh weather conditions should use materials that can withstand extreme temperatures, moisture, and UV exposure.
2. **Environmental Considerations**: Research and understand the environmental conditions where the project will be installed. This includes factors like temperature fluctuations, humidity levels, exposure to chemicals, and physical stress. Designing for these conditions ensures that the project can endure the environment without degrading prematurely.
3. **Robust Design Principles**: Apply robust design principles that enhance durability. This includes designing for redundancy, where critical components have backups to prevent total failure, and designing for simplicity, where fewer parts mean fewer points of failure. Consider stress distribution, load balancing, and fatigue limits in your design.
4. **Protective Coatings and Treatments**: Utilize protective coatings and treatments to enhance the durability of materials. For example, galvanization, anodizing, or powder coating can prevent corrosion and wear. Applying these treatments extends the lifespan of the project components.
5. **Modular Design**: Design the project with modularity in mind. Modular components can be easily replaced or upgraded without needing to overhaul the entire system. This approach not only extends the project’s lifespan but also makes maintenance and repairs more manageable.
6. **Thorough Testing**: Conduct extensive testing to ensure durability. This includes accelerated life testing, where the project is subjected to extreme conditions to simulate long-term use, and real-world testing, where the project is used in its intended environment to identify potential issues. Testing helps verify that the design can handle the stresses it will encounter over time.
7. **Quality Manufacturing Processes**: Ensure that the manufacturing processes used to build the project adhere to high-quality standards. This includes precision in fabrication, consistency in assembly, and adherence to specified tolerances. Quality manufacturing reduces the likelihood of defects that could compromise durability.
8. **Regular Maintenance and Inspection**: Design the project to facilitate easy maintenance and inspection. Provide clear guidelines for routine checks and upkeep. Regular maintenance can prevent minor issues from escalating into major problems, thereby extending the project’s lifespan.
9. **Failure Mode and Effects Analysis (FMEA)**: Perform a Failure Mode and Effects Analysis to anticipate potential points of failure and their impact on the project. By identifying and addressing these potential failures early in the design process, you can enhance the overall durability of the project.
10. **Feedback Loop**: Establish a feedback loop with users and stakeholders to gather information on the project’s performance over time. Use this feedback to make iterative improvements and address any emerging durability issues. Continuous improvement based on real-world use ensures that the project remains reliable and effective.
11. **Documentation and Training**: Provide detailed documentation and training for those who will use and maintain the project. Proper use and maintenance are critical to the longevity of the project. Ensure that users are aware of best practices and potential pitfalls to avoid misuse that could compromise durability.

By focusing on these elements, the EPICS program can deliver projects that are not only safe and of high quality but also robust and durable. This commitment to durability ensures that projects will serve their intended purposes effectively and withstand the challenges of their operating environments for many years.

1. **Timeliness**: Projects should be delivered in a timely manner. While the final project might not need to be fully polished for the project partner, providing smaller, incremental deliverables allows for ongoing review and feedback. This iterative approach can accelerate the overall delivery by allowing for continuous testing and adjustments along the design cycle.

Timeliness is a crucial aspect of the EPICS program’s project delivery. Delivering projects on time ensures that project partners can begin benefiting from the work as soon as possible and helps maintain a positive reputation for reliability. To achieve timeliness in your project design, consider the following elements:

1. **Project Planning**: Start with a detailed project plan that outlines all phases of the project, including research, design, development, testing, and delivery. Break down each phase into smaller tasks with specific deadlines. A well-structured plan helps keep the project on track and ensures that all team members are aware of their responsibilities and timelines.
2. **Realistic Scheduling**: Set realistic deadlines that account for potential obstacles and delays. Avoid overly optimistic timelines that do not allow for unforeseen issues. Factor in buffer times to handle unexpected problems without derailing the entire project schedule.
3. **Milestones and Checkpoints**: Establish clear milestones and checkpoints throughout the project. These intermediate goals help monitor progress and ensure that the project is advancing as planned. Regularly review and adjust the schedule as needed based on milestone achievements and any encountered challenges.
4. **Prioritization**: Prioritize tasks based on their importance and urgency. Focus on critical path activities that directly impact the project’s timeline. Ensure that essential tasks are completed on time to prevent bottlenecks and delays in subsequent phases.
5. **Agile Methodology**: Consider using agile methodologies to enhance flexibility and responsiveness. Agile involves iterative cycles of planning, execution, and review, allowing for continuous feedback and adjustments. This approach helps in delivering smaller, functional portions of the project incrementally, which can be particularly useful for early user testing and feedback.
6. **Effective Communication**: Maintain open and consistent communication among all team members and stakeholders. Regular updates, meetings, and progress reports ensure that everyone is aligned and informed about the project’s status. Effective communication helps in promptly addressing any issues or changes that may arise.
7. **Resource Management**: Efficiently manage resources, including personnel, materials, and finances. Ensure that the team has the necessary tools and support to complete tasks on time. Proper resource allocation prevents bottlenecks and enables smooth progression through project phases.
8. **Risk Management**: Identify potential risks that could affect the project timeline and develop mitigation strategies. This includes anticipating technical challenges, supply chain issues, and other factors that could cause delays. Proactive risk management helps in minimizing disruptions and maintaining the project schedule.
9. **Progress Monitoring**: Continuously monitor the project’s progress against the plan. Use project management tools and software to track task completion, resource usage, and timelines. Regular monitoring allows for early detection of deviations from the schedule and enables timely corrective actions.
10. **Iterative Delivery**: Deliver the project in smaller, manageable portions or phases. This iterative approach allows for early testing, feedback, and adjustments, which can streamline the overall process. Smaller deliverables provide project partners with tangible results sooner and enable them to review and provide input, ensuring that the final product meets their expectations.
11. **Feedback and Adjustment**: Incorporate feedback from stakeholders and team members to refine the project as it progresses. Timely feedback helps in making necessary adjustments without causing significant delays. Adaptability and willingness to make changes based on feedback contribute to a more efficient and timely delivery.
12. **Documentation and Handover**: Prepare all necessary documentation and ensure a smooth handover to the project partners. Comprehensive documentation, including user manuals, maintenance guides, and final reports, facilitates a seamless transition and reduces the time required for the project partners to start using the deliverables effectively.

By focusing on these elements, the EPICS program can ensure that projects are delivered in a timely manner without compromising on quality, safety, durability, and delivered efficiently. This commitment to timeliness helps build trust with project partners and enhances the overall impact of the projects.

### Team: EPICS India

### Sub-team name: Bullock-Driven Tractor

### Project: Bullock-Driven Tractor Digital Delivery

### Project Partner (organization name): IIT Delhi

### Project Partner (contact person): Davinder Pal Singh (keeratiit@gmail.com)

### Design Lead: Elizabeth Kanemitsu and Shubha Vijayaraj

### Team Members: Aruna Acharya, Naomi Patel, Shyam Kumar, Archit Srivastava, Avigyat Painuly, Prajeeth Jillellamudi, Deven Parasnis, and Manas Doshi

### Advisor: Jorge Martinez

### Date delivered: May 2025

### Delivery Process: The Project Manager oversees the review and delivery process for each project. They are responsible for collecting initials for each category from the team’s advisor, project partner, and an EPICS Administration representative. Before submitting the project for delivery, the Project Manager should initial each category themselves. Additionally, they are tasked with obtaining initials for the two-week follow-up check.

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| **Delivery Checklist** | Design Lead | Advisor | EPICS Admin |
| 1. The key components have been reviewed by the team advisor and/or external reviewers.   List the key components here:  1. User Manual  2. Manufacturing Document  3. Drawing and CAD models  4. Delivery Document |  |  | N/A |
| 1. The project partner’s requirements have been addressed by the project.   List the project requirements in detail here:   1. Affordability: should be affordable for a rural farmer making minimum wages ($350 or Rs. 25,000) 2. Lifting Mechanism: Key component that is being modified. Needs to lock securely into place at predefined positions. Should also be able to carry 60-70Kg. 3. User Ease: Should function without need for trained or highly educated individual. 4. Versatility: Ability to farm multiple crop types, namely wheat and rice. Adjustable plowing depth to ~1” and 2” for wheat and rice respectively. | EK |  |  |
| 1. The project or system has been completely tested in the delivery configuration.   Identify the tests that were performed:   1. Conducted FEA static and dynamic stress and fatigue analysis on Fusion 360 (Fall 2022, Spring 2023, and Spring 2025). 2. Static Safety and Ergonomics conducted in basement of ARMS as key components of physical prototype was being manufactured (Fall 2023 – Spring 2025).    1. Verified structural integrity without motion    2. Proper functionality of individual components    3. Established baseline measurements 3. Driven Farm Tests (Fall 2024 and mainly Spring 2025).    1. Validated real-world performance    2. Identified failure modes and weak points    3. Collected quantitative data about drag force and loads while in motion    4. Tests included:       1. Time to assemble and disassemble design       2. Force required to pull tractor with plow spikes engaged 1” and 2” into soil          1. Find drag force       3. Farmer ergonomics and safety          1. Body fatigue, discomfort          2. Simulated sudden stops caused by either bulls or by tractor hitting debris          3. Simulated extreme testing by going 6 mph       4. Checking for disruption caused by debris or dirt accumulation       5. Checking for deflection or issues with tolerances/clearances with dynamic components | EK |  | N/A |
| 1. The project has EPICS branding (sticker, sign, etc.) applied to the project.   Digital delivery; a logo will be applied in documentation. |  |  |  |
| 1. The team has completed the “Design Document” in TEAMS. | EK |  |  |
| 1. The quality and the appearance of the project is acceptable for delivery.   Digital Documents | EK |  |  |
| 1. Safety issues identified in design reviews have been addressed.   Mitigated on CAD files and shown in drawings. | EK |  |  |
| 1. User manual is complete and delivered to project partner. | EK |  |  |
| 1. Troubleshooting guide is complete and delivered to project partner. | EK |  |  |
| 1. Maintenance and upkeep roles for EPICS team and project partner have been clearly identified. A list of all maintenance items will be included in User Manual and Design Document. | EK |  |  |
| 1. EPICS team has taken a photograph of the project to include in “Design Document” project summary. | EK |  |  |
| 1. EPICS team has taken a photograph of the project to post using team social media accounts. | EK |  |  |
| 1. Customer satisfaction questionnaire has been provided to community partner. | EK | N/A |  |
| 1. Preliminary copy of the delivery checklist delivered to the program coordinator (Haley Cutler). | EK | N/A |  |
| **\*Post-delivery Check - Two-week after the delivery of your project, your team need to review the items below. If your team is delivering the project in the last two weeks of the semester, a follow up date needs to be identified for the Team in the following semester to complete these items and included in the Team Transition Document and also in the transition section of the project Design Document.** | | | |
| 1. Follow up with Project Partner and review performance of the deployed project. Is the project working and satisfactory for the partner? List the due date of the follow-up appointment here:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |  |  |
| 1. Customer satisfaction questionnaire has been completed and returned to EPICS by community partner. |  |  |  |
| 1. Project is working and should remain deployed at the project partner. |  |  |  |

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