



ACORN GUI Strategy at Fermilab

Madelyn Polzin UX Engineer

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In partnership with:



Outline

- ACORN overview
- Current control system ACNET
- Modernization strategy for ACORN
- Next steps



Accelerator Controls Operations Research Network (ACORN)

- The ACORN Project will modernize Fermilab's accelerator control system and replace endof-life accelerator power supplies
- ACORN Mission Need (CD-0) was approved August 28, 2020
 - Fermilab's power systems and ACNET control system need to be modernized or replaced to meet the future needs of LBNF/DUNE and PIP-II
- Project Completion (CD-4): 2031
- \$211M total project cost



ACORN Project Goals

- Replace end-of-life Booster, Main Injector, and Muon Campus accelerator power systems
- Replace the antiquated ACNET control system with EPICS for the accelerator complex
 - Improve the human-system interfaces & software development applications of the accelerator control system
- Implement an architecture that promotes a highly reliable and resilient control system
- Support the development and deployment of AI/ML capabilities for accelerator operations





Accelerator Controls Operations Research Network (ACORN)





Fermilab's Control System

- ACNET
 - 40+ year history at Fermilab
 - Unified system for the entire complex
 - All accelerators, all machine and technical equipment
 - Common console manager can launch any application
 - Users connect to a LinuxVM via SSH
 - Applications are served to desktop via X11
 - Most applications written in C/C++
 - FORTRAN still exists
 - Handful of applications written in Java

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Fermilab's Control System - Synoptic

- Built with Java APIs
- "No-code" Display Builder
- SVG for rendering displays
- Displays can be launched in a dedicated viewer or browser
- Still supported but development has stalled
- 1,600 Synoptic displays
- Synoptic \rightarrow Phoebus





- Our GUI strategy is to embrace web and cloud computing technologies as the future for control system applications and services
 - Move from mostly text-based applications to modern graphical web applications
- Currently in the alternatives analysis phase that will develop the next generation platform for control system GUIs at Fermilab
- Incorporating User Experience and Human Factors into the development of our applications from the beginning





- Currently 629 active applications
- ACORN's Scope
 - Core Applications (13)
 - Essential for day-to-day Main Control Room Operations
 - Discussions with Operations Department
 - Critical Applications (58)
 - Essential for mission-critical operations
 - Discussions with the Accelerator Directorate on how they use the control system to accomplish their responsibilities



- Process (iterative)
 - Design
 - Test
 - Implement
 - Deploy
- User inclusion throughout





- Applications to work with ACNET and EPICS while giving the user the same experience
- Web Applications
 - Widely available and understood
 - Cross-platform
 - Accessible
 - Widget oriented
- Moving business logic from applications
 - Using existing APIs gives us flexibility for our GUI framework
 - Decoupling and moving into backend services tier
 - Web applications become thin clients that interact with the service tier



Architecture (Simplified)



Application Framework

- Flutter for framework (Dart)
 - Investigated various popular application frameworks Flutter was preferred
 - Flutter allows for progressive web applications that can be adaptive to screen sizes
 - Uses Material (Google) so there is no need to create components from scratch

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Telephone Index Application using React and Flutter



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ACORN User Experience and Human Factors

- Identifying end-user tasks and objectives
- Identify functional objectives of the system
- User research and usability testing
- UX design
 - Design philosophy UX/HF principles and standards
 - Design style guide
 - Application GUI design
- Lab tour
 - Valuable to learn from others as we modernize our control system
 - Collaborative efforts & fostering an exchange of knowledge

Fermi National Accelerator Laboratory	
HUMAN-SYST GUIDE FOR A SYSTEM	EM INTERFACE STYLE CORN DIGITAL CONTROL
Accelerator Controls	Operations Research Network
August 2023	
Rachael Hill, Madelyr Kovesdi, and Dr Katy	Polzin, Zachary Spielman, Casey a Le Blanc
ACORN-doc-1475 FERMILAB-TM-2812-AD	
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Prototyping and Design

- Figma
 - Design tool used to create, share, and test designs for websites, mobile apps, and other digital products and experiences
 - Rapid prototyping to workshop designs
 - Not heavy UI design upfront
 - Iterative process
 - Opportunity for user input
 - Widget and style library
 - Ability to generate code in Figma





Widget and Style Library

- Library of common components to streamline the development process
 - Cards, fonts, colors, etc. styles
- Material Design 3 (Google) as a starting point
 - Application "scaffolds" (title bars, navigation bars, etc.)
 - Graphing and chart elements



Fermilab

Next Steps

- Requirements for core and critical applications
- Prototyping and GUI design development
 - Templates
 - Widget & style library
- Continued user input/interaction throughout our development process
- Synoptic to Phoebus conversion

Thank you!



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acorn.fnal.gov

Madelyn Polzin | UX Engineer

mpolzin@fnal.gov



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