

Lean Prototyping for Early Hardware–UI Interaction Validation

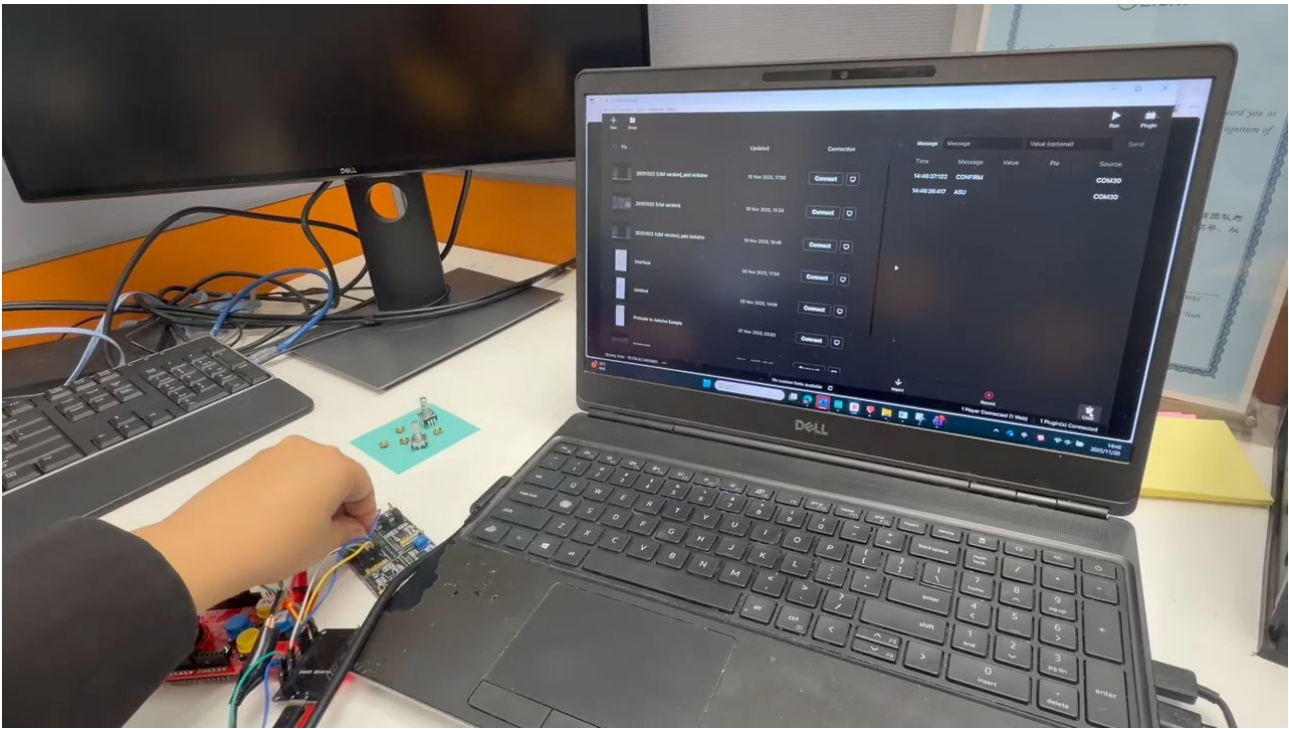
By Foley Kwok, Zhao Yang • May 2026

Introduction

Hardware program development and usability evaluation are often limited by the availability of integrated, fully functional engineering prototypes during early testing. As a result, usability and workflow validation may rely on shared test setups that are sometimes reallocated, unavailable, or occupied by other teams within Elekta.

Supplier-built functional prototypes also introduce significant constraints. They are costly, slow to manufacture, and difficult to modify. When prototypes are non-functional or only partially representative, early-stage usability testing cannot reliably reflect real interaction, tactile feedback, or ergonomics.

Because of these constraints, UX and design teams experience delays and increased risk when validating interaction concepts before formal engineering prototypes are ready. To address this, I collaborated with a colleague at Elekta to develop “lean prototyping” methods that enable fast, cost-effective evaluation of interactions between user, hardware, and software. This document presents one such method.



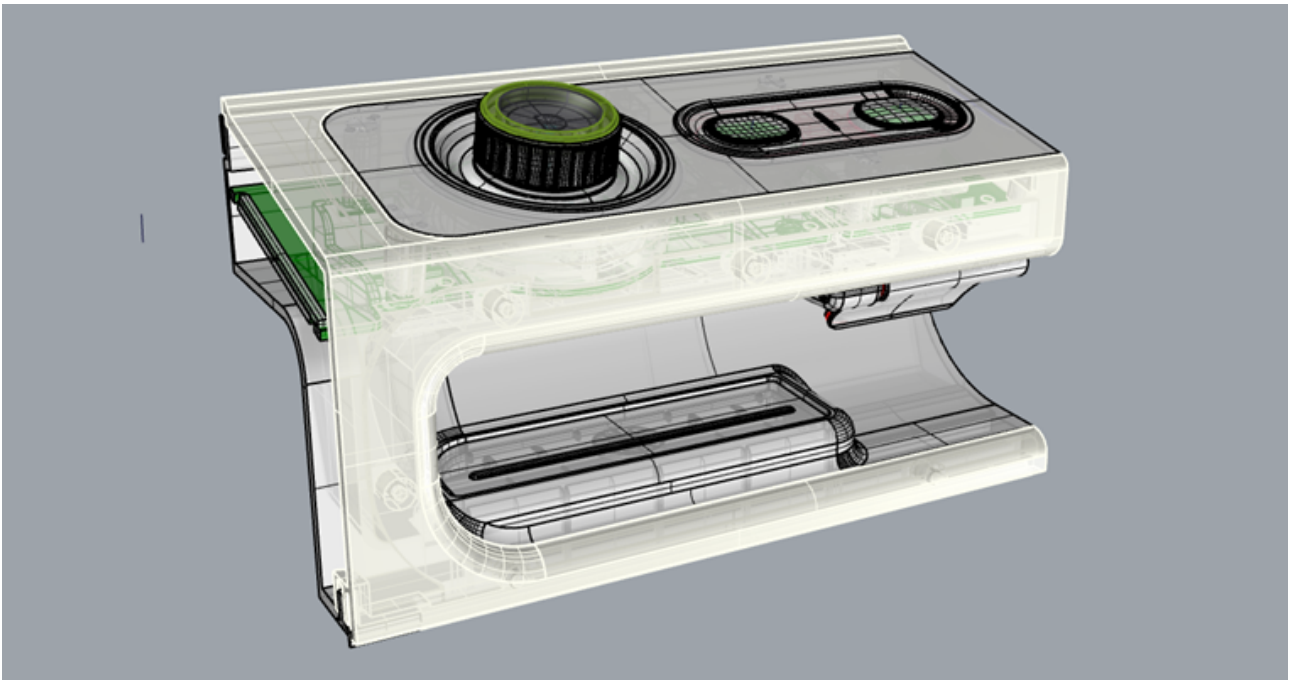
Lean prototyping method

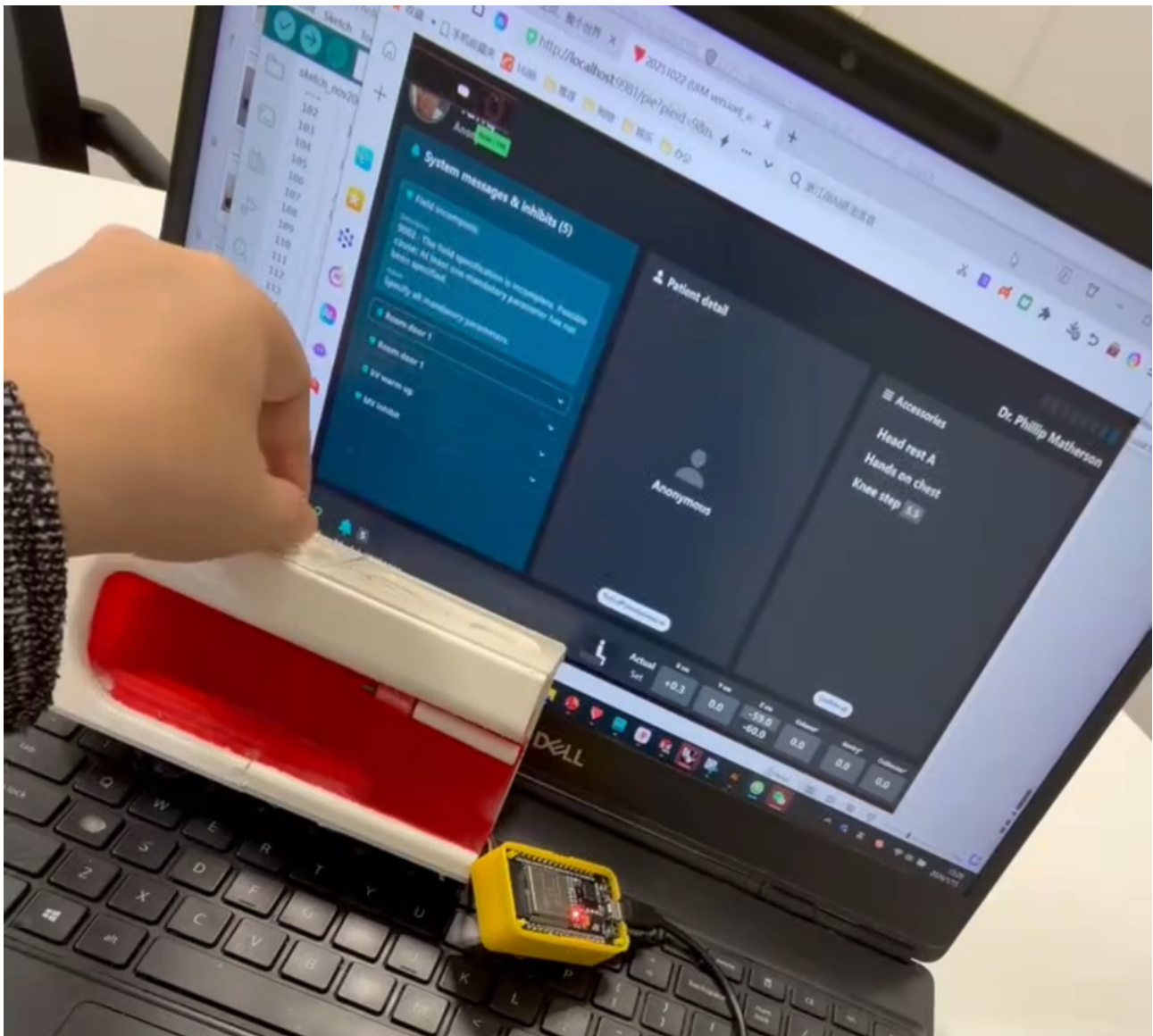
ProtoPie + Arduino for Early Hardware–UI Validation

Using ProtoPie (prototyping software) together with Arduino (an open-source electronics platform), our internal UX&D team can rapidly build functional, hardware-interactive prototypes without depending on external suppliers.

Solution

The approach produces a 1:1 scale, fully functional hardware–UI system that delivers realistic tactile feedback, including rotation direction, pressing, and interaction rhythm. Compared with supplier-built prototypes, the lightweight 3D-printed enclosure supports greater flexibility for spatial exploration—making it easier to modify, extend, and iterate—while preserving ergonomic fidelity.





By directly connecting physical hardware to ProtoPie interactions, the prototype translates virtual UI logic into real-world behavior. This enables early, meaningful usability evaluation grounded in actual tactile and interaction patterns.

Impact

This lean prototyping approach delivers measurable **time and cost savings**. Based on an estimated three early-stage usability tests per year, it **saves approximately £46,671 over five years** compared

with supplier-manufactured functional prototypes. It also **reduces prototype lead time by approximately seven months.**

Beyond efficiency, the method reduces program risk by enabling validation before integrated engineering systems become available. The prototype's high modifiability supports rapid iteration and user-centered decision-making—capabilities that are harder to achieve with externally supplied prototypes.