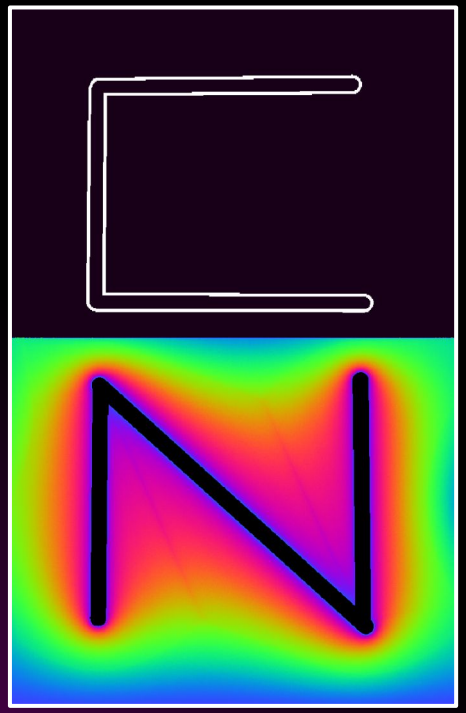
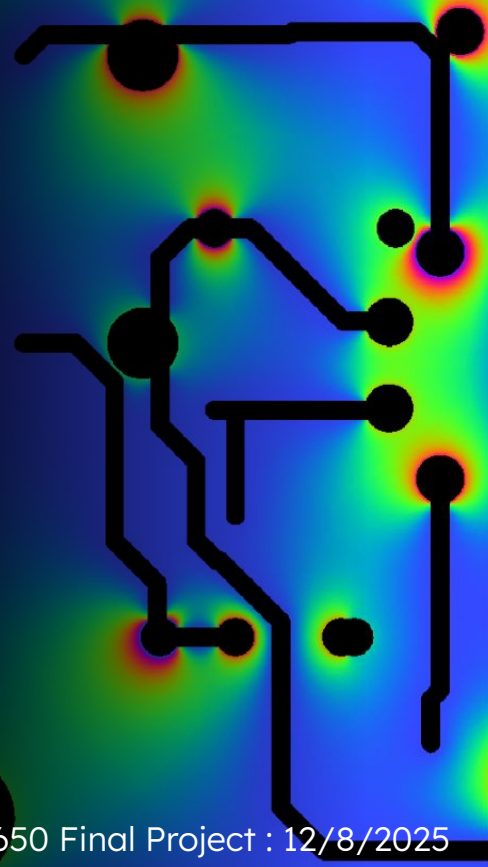


CIRCUIT NOVA

WebGPU Walk on Stars for Interactive PCB Design and Simulation

Lewis Ghrist | Oliver Hendrych | Johnny (Hongyi) Ding

CIS 5650 Final Project : 12/8/2025



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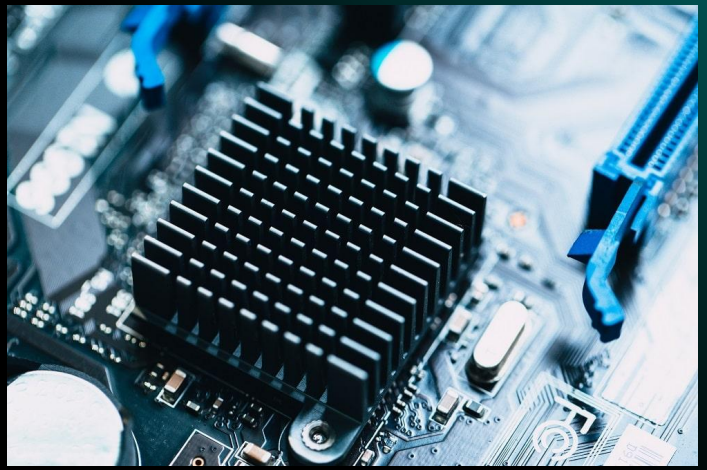
MOTIVATION

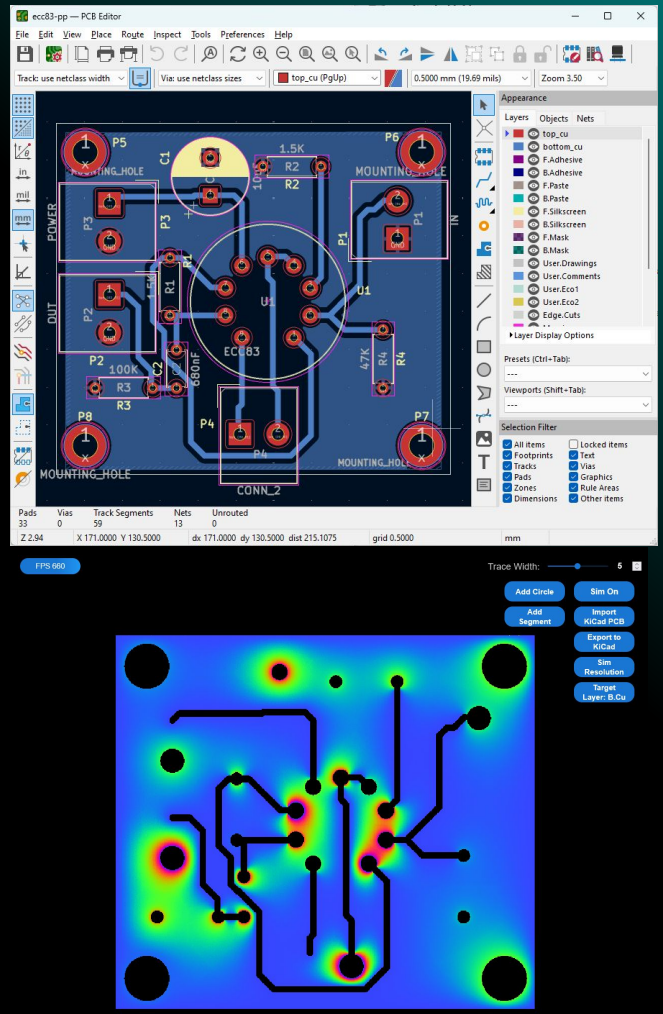
- PCB Designs are thermally limited
- Common components produce a lot of heat
  - Motor Controllers
  - MOSFETs
  - Processors
- Heat buildup can damage circuits and components
- Open source difficult are to work with



OVERVIEW

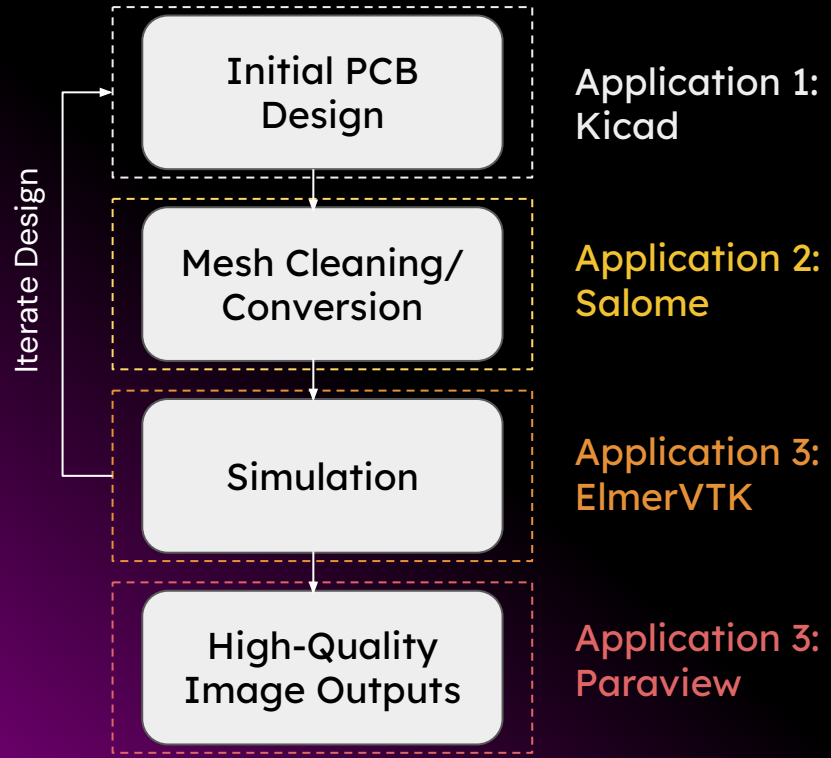
Open Source PCB Thermal Simulation

- In-browser PCB validation
- Integration with KiCad
- WebGPU Walk-on-Stars simulation for thermal boundaries
- User interaction for live updates

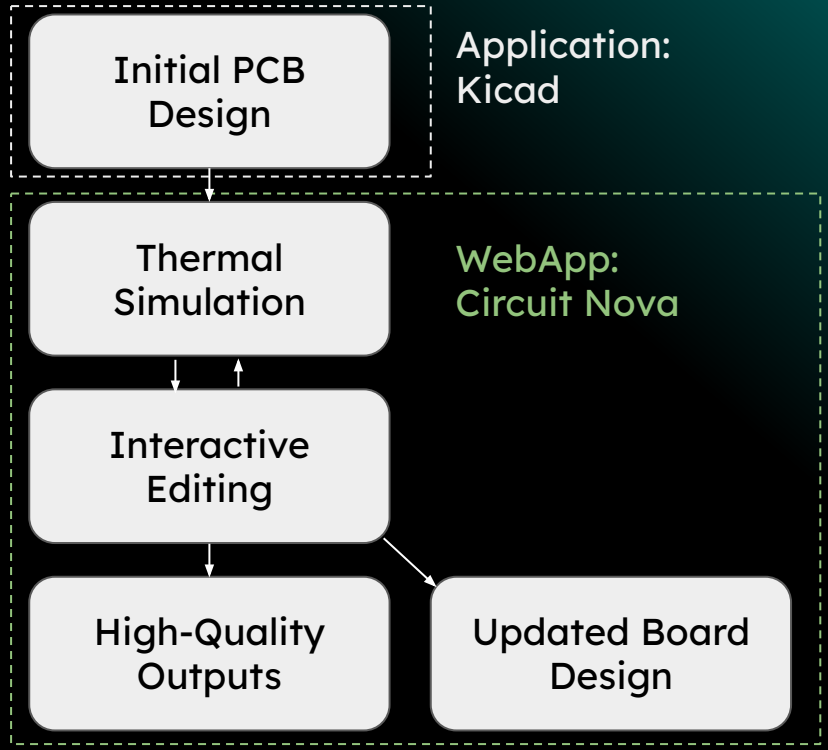


WORKFLOW

Current Open Source



Circuit Nova



reference: https://jrainimo.com/build/2024/11/oss-thermal-simulation-of-pcbs/

WORKFL

Current Open Sou

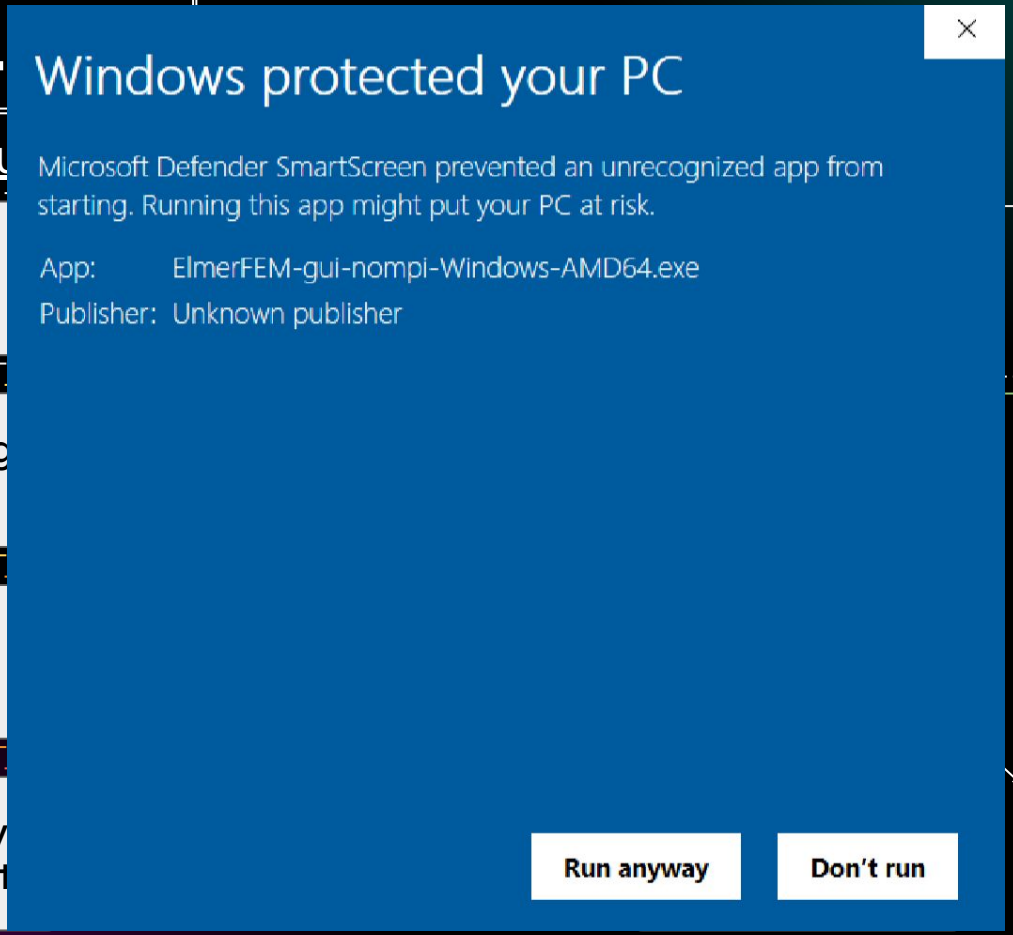
Initial PCB Design

Mesh Cleaning Conversion

Simulation

High-Quality Image Output

Iterate Design



Application: Kicad

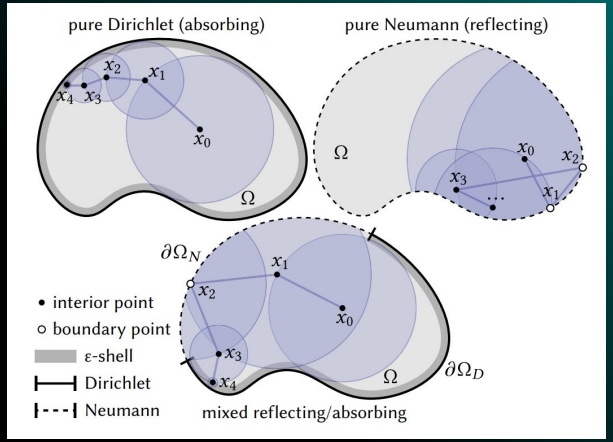
WebApp: Circuit Nova

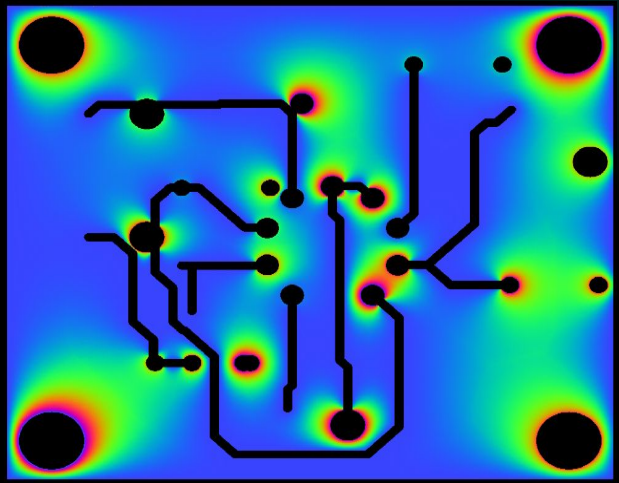
Updated Board Design

reference: https://jrainimo.com/build/2024/11/oss-thermal-simulation-of-pcbs/

IMPLEMENTATION : Walk On Stars

- Launches independent random walks from query points (Easily Parallelizable)
- Uses closest point queries to speed up walks (BVH)
- Walk results are averaged together via Monte Carlo Estimation
- Implemented with two compute shaders and a render pass





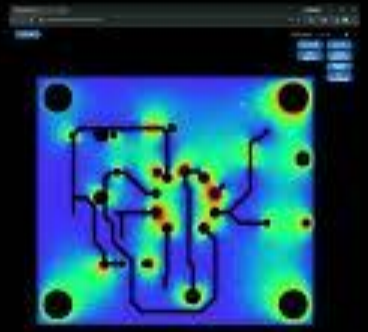
For more information see:
https://rohan-sawhney.github.io/mcgp-resources/

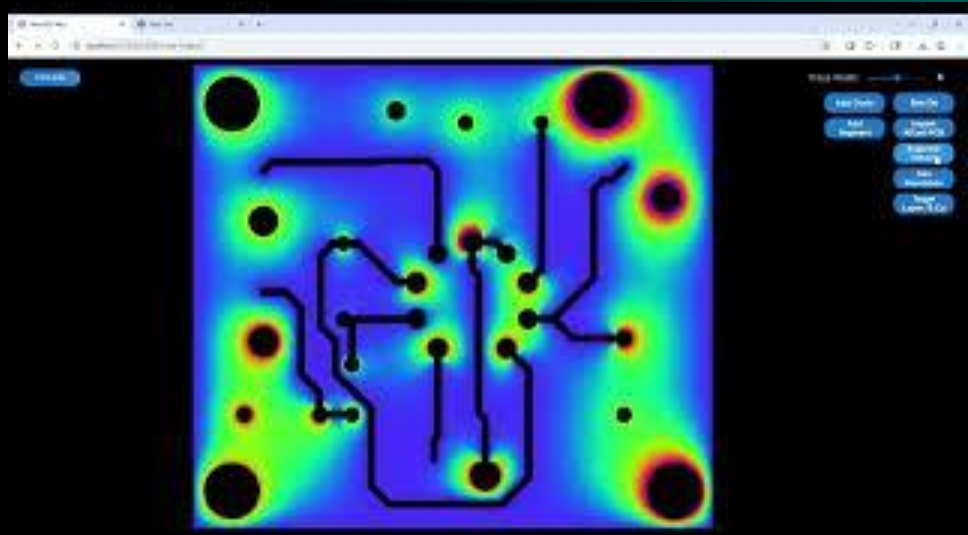
IMPLEMENTATION : User Interaction

Framework: React and Material UI

- Import and export as KiCad PCB formats
- Geometry selection, addition/deletion and alteration
- Change boundary conditions and values
- Simulation zone selection
- Change simulation resolution
- Toggle simulation on/off

DEMO





Live Demo: https://johnnysist.github.io/CIS5650-Final-Project/

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