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Heat Spreader Design for Electrical Optimization

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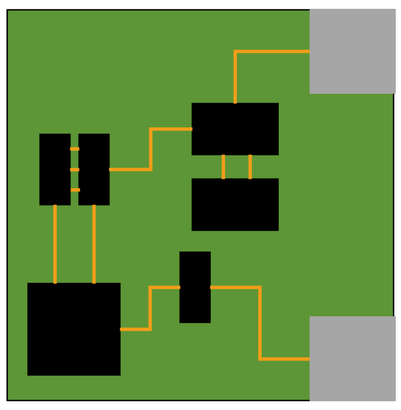
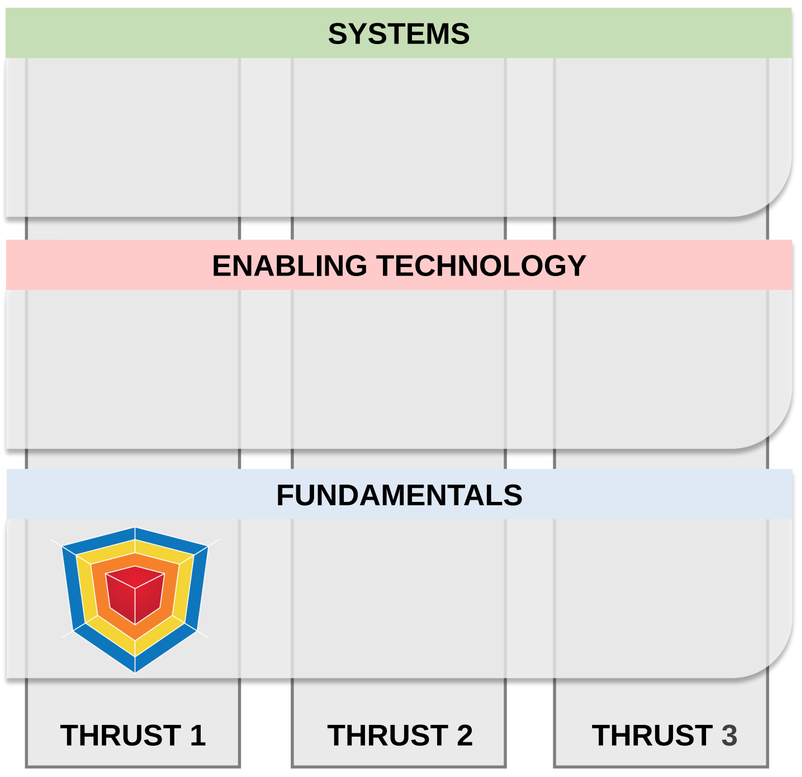
How can a passive heat spreader be designed to augment circuit performance metrics?

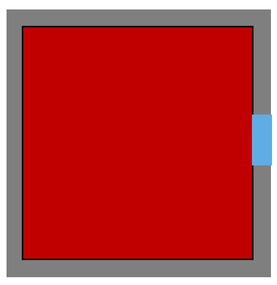
- Heat spreaders are traditionally designed after the electrical circuit for sole purpose of extracting heat.
- This investigation explores different topology optimization formulations to design heat spreaders for circuits
- By optimizing objectives that correlate directly to electrical performance, unconventional designs are discovered that may increase performance.



Sample Circuit

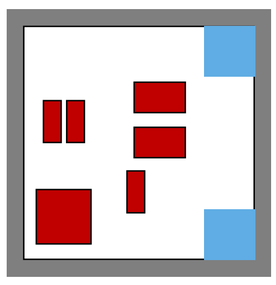


SIMP Based Topology Optimization of Passive Heat Spreaders



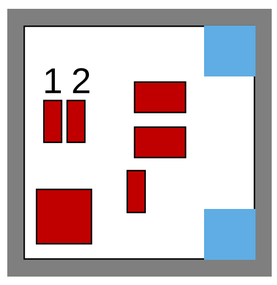
$$\min_{\rho} \int TF$$
$$s.t. \quad T \le T_{min}, \quad V \le V_p, \quad R \le R_{min}$$

"Minimize the sum of the temperature on the domain"



$$\min_{\rho} \int TF$$
$$s.t. \quad T \le T_{min}, \quad V \le V_p, \quad R \le R_{min}$$

"Minimize the sum of the temperature on the heating components"



$$\min_{\rho}(T_1 - T_2)$$
$$s.t. \quad T \le T_{min}, \quad V \le V_p, \quad R \le R_{min}$$

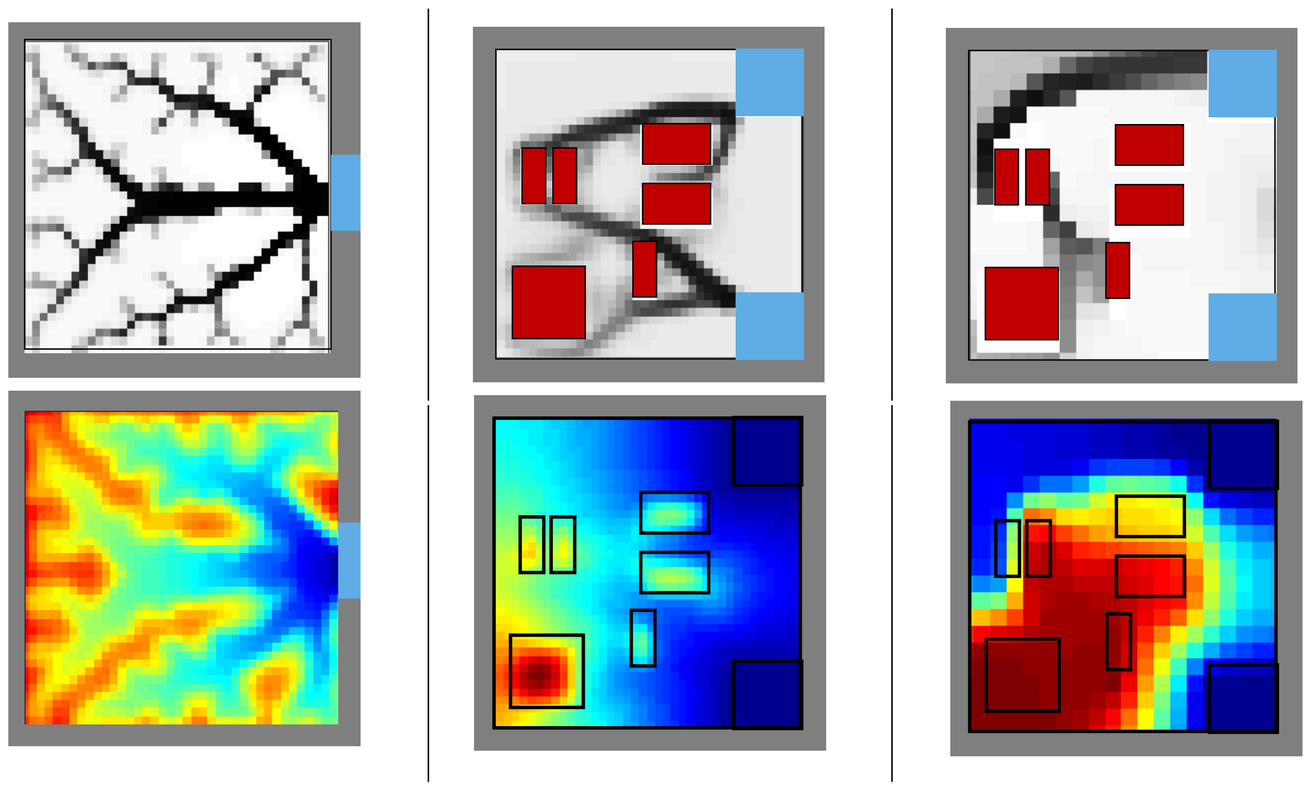
"Minimize the temperature of 1 and maximize the temperature of 2"

- Consider the following metrics for an RLC circuit:

$$\text{Loss} = I^2 R(t), \quad \text{Damping} = \frac{R(t)\sqrt{C}}{2\sqrt{L}}$$

- Both loss and damping are functions of temperature dependent resistance, but they are competing objects.
- By designing the temperature response on the domain, electrical performance may be augmented

Preliminary Topology Optimization Solutions



Conclusions and Future Work

- Topology optimization was successfully used to design temperature maps for electrical performance metrics
- Future work will look to evaluate the magnitude of these changes on circuit performance

Acknowledgements
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P/O/E/T/S