Thermal Management of Electronic Components

Project Summary

The thermal management of electronic components is currently one of the most significant design issues in electronic packaging. Continuous increases in device performance and decreases in device footprints create a drastically increased power density. High power densities lead to elevated operating temperature levels and with elevated temperature levels comes an increase in device failure rate due to electrical and structural breakdown. Increased device failure rates are intolerable in most situations, and particularly in economics and communications applications. Power density levels are now identified by semiconductor industry associations as a barrier to future development.

The design of heavily populated boards, with many heat generating components in close proximity, presents a unique challenge to the thermal designer. Many components, operating at high power densities, must often be mounted on the same motherboard in close proximity. Typically, some components may have optimum and maximum operating temperatures far below those allowable for other components. The challenge is to minimize the neighbor effects, thus maintaining the different operating temperatures on the same board without allowing the hotter electronic devices to influence the operating temperature of the lower temperature components.

The goal for this project, which will be conducted in association with the NSF sponsored Purdue Cooling Technologies Research Center, is to develop computational fluid dynamics models to closely predict the behavior of the localized thermal interactions between components. A parametric study of the effects of power density, component proximity, component geometry, circuit board material and board packing density on the maintenance of optimal operating temperatures for the electronic and optical components will be completed. Design guidelines will be developed to assist thermal designers in alleviating potential thermal problems and decreasing the reliance on external cooling methods.