The Effectiveness of using CFD modelling in optimising the cooling of a low power compute server

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Abstract: Power consumption of devices is a significant environmental impact for personal computing and innovative sustainable devices are needed to address this issue. Any device needs to address the power drawn for the operation of the boards and their cooling which can be up to a third of the power used for such a server. A device designed to address this issue is a new low power personal super computer (compute server). This server uses many low power CPUs on the same board, packed into a tight space and generating a significant amount of heat that needs to be safely dissipated. Many of these servers can also be daisy chained together to increase computing capacity when needed. This heat generation requires significant cooling and considerable power savings can be made to the system if traditional fan cooling in the server case is not used. A device case therefore needed to be designed that allowed effective passive cooling of the components. Other design considerations were size, cost effectiveness and safety in a stackable distinctive case that became a challenging engineering design problem.

It is time consuming and expensive to optimise designs through prototyping and physically testing. Modelling can be a cost effective, sustainable and faster alternative. Computational Fluid Dynamics (CFD) has already been used in the aerospace industry to maximise understanding of physical phenomena, minimise physical testing and prototyping and improve the overall design of products. However such industries are large and have capacity to invest in such analysis tools. There is less understanding of the capability, effectiveness and capacity for use of modelling in smaller, niche or quick turn around projects.

CFD allowed the position and size of the case ventilation openings to be optimised; minimized manufacturing costs and desk real estate; determined the efficacy of dissipating the heat via a heat sink for the highest chip temperature; and allowed a client driven design approach. These factors were inter-related so the effectiveness of each solution and determination of optimal combinations of case characteristics was not straightforward. The initial design was changed significantly as a result of the modelling and considerable time and cost saved as a result of using CFD rather than prototyping and testing.

Using CFD modeling for a smaller engineering design problem can be very beneficial but issues arise. If undertaken by an experienced analyst it can significantly reduce product development time, increase understanding of the physical situation, improve innovation and give confidence in the product performance. Lack of understanding of the tool by the client can however lead to distrust in results and endless alterations to the design that are time consuming and resource expensive. Business size only affects the scale and number of engineering design problems CFD can be beneficial for, with little distinction in their complexity. The justification for small businesses using numerical tools in a systematic way to allow increased understanding with each design problem becomes more difficult as putting engineering analysis into the product development process requires investment in time, people and resources.

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