A theoretical model for vibrations in laptops provides design strategies for reducing hard drive failures

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Laptop housings are designed to be hard and inflexible to protect laptops from everyday wear and tear, but a softer, more flexible material may provide a more suitable housing for suppressing vibrations. Credit: Ingram Publishing/Thinkstock

Laptops have the advantages of being more versatile and portable than their desktop counterparts. But these attributes impose considerable demands on the electronic components in a laptop—particularly the hard drive. The magnetic disk inside a hard drive rotates at a rate of several thousand revolutions a minute. At the same time, a read/write head moves only a few nanometers above the disk surface to access information on the disk. At such high speeds, large vibrations can

permanently damage the hard drive.

To help reduce hard drive failures, Jianqiang Mou and colleagues from the A*STAR Data Storage Institute in Singapore have now developed a computer model that can predict and minimize the effects of vibrations on the hard drive and ultimately help to improve laptop design.

Current designs of many laptops actually compound the problems caused by vibrations. For instance, to provide protection from external impact and accidents, laptops are often encased in special housings intended to absorb accidental drops and other shocks. Such laptop designs can actually be counterproductive if not done properly, explains Mou. "The commercial notebook computer industry rarely understands how chassis design can substantially affect the performance of the hard drive. Some notebook computers are designed with vibration sources, for example the loud speaker, located close to the hard drive."

To get back to the fundamentals of laptop design, the researchers developed a theoretical framework that models the propagation of vibrations from various components in a laptop, such as the speakers, to the hard drive. Underpinning this framework are mathematical equations that describe the transmission of vibrations in laptops, and these equations form the input for a computer model applied to specific laptop designs.

The results of the researchers' calculations can be used to inform general laptop design strategies. For example, often very stiff materials are used for laptop cases to provide enhanced mechanical strength. However, stiff materials tend to transmit high-frequency vibrations more strongly than flexible materials, and it is difficult for hard drives to compensate for these frequencies. Softer materials are preferable as they suppress higher frequency vibrations, leaving only slower vibrations which are easier for hard drives to compensate.

"Our study provides an effective approach for computer and hard drive makers to optimize the chassis design and component mounting," adds Mou. "Furthermore, the methodology presented in our paper can be applied for analysis and optimal design of other computer chassis, such as servers in data centers."

More information: Lai, F., Mou, J. Q., See, I. B. L. & Lin, W. Z. Modeling and analysis of notebook computer chassis structure for optimization of component mounting. *International Journal of Mechanical Sciences* 76, 60–69 (2013). dx.doi.org/10.1016/j.ijmecsci.2013.08.012

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