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Software helps industry to design lighter, more efficient parts

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Computer-aided engineering (CAE) systems help manufacturers to design parts with the ideal topology (inner and outer shape and structure) to withstand the conditions under which they will operate, such as specific temperature and pressure conditions, vibrations, and various stresses and strains, and to produce them with as little raw material as possible. In sum, CAE enables industrial design software to optimize part topology.

By deploying topology optimization software, manufacturers virtually sculpt lighter parts using a given amount of raw material and monitoring their strength.

These attributes are a function of the design. "You input parameters into the software with the properties and other characteristics the part needs to have, and the program shows the design path that has to be followed in order to achieve your goals," says mechatronic engineer Ricardo Doll Lahuerta, principal investigator for a research project that is promoting a significant quality enhancement in this type of tool.

Recently launched, and with several upgrades in progress, Virtual.Pyxis has already been licensed to advanced research departments of major multinationals and the Massachusetts Institute of Technology (MIT) in the United States, one of the world's leading research and education institutions.

The tool enables engineers to design stronger and more versatile parts while shortening lead time and development cost.

This type of software typically requires information on the conditions under which the part will operate, such as stress, compression, vibration and temperature, as well as other design constraints, including maximum flexibility and deformation. Details of the manufacturing process to be used, such as polymer injection, casting or 3-D printing, are also key inputs for CAE programs.

Virtual.Pyxis is distinguished mainly by its next-generation algorithm, which gives it the capacity to process a far larger number of variables and constraints for considerably less cost than commercially available programs.

"Our algorithm can process more variables without the need for much more computational capacity," Lahuerta explains. "As a result, any structural design can be developed with greater precision at a much lower cost. It's especially useful for designing mechanisms that need to be flexible, in which case many more variables have to be computed. Most of today's topological optimization programs pursue maximum rigidity, but that's not always ideal in a design project."

Virtual.Pyxis is capable of more complex analysis and can work with non-linear materials. It also enables the design of very precise frequency constraints, an important attribute to ensure that adjacent parts vibrate at the same resonant frequency. It is also capable of using different external calculus solvers, including those most used by the machine and metalworking industries.

VirtualCAE's software has immediate applications in a swathe of industries. It is already being used to design automotive components, farm implements, railroad equipment, and safety-linked vehicle parts. It can also be used to develop lower-cost production processes, as in the case of certain parts made by casting instead of creasing, folding and welding. Castings have better mechanical properties, last longer, use fewer components, and can be assembled faster because no welding is required. "FAPESP's support has been essential," says Valmir Fleischman, VirtualCAE's founding partner.

Even more applications are foreseen in the future. For example, enhanced prosthetic and orthotic devices. "Excessive rigidity in bone prostheses, for example, tends to weaken the bone to which they're connected. The program enables prostheses to be designed with the ideal degree of flexibility," Lahuerta says.

He adds that the development of 3-D printing, which builds objects gradually, layer by layer, will enable parts to be produced from various materials combined in a structure with more advanced properties. These objects would be far harder to obtain with today's manufacturing processes.

"In the future, we'll be able to design the inner structure of a part combining materials on an ever-smaller scale until we reach the atomic scale, significantly extending design possibilities. For example, we'll be able to design a part with certain intelligent characteristics, making it lighter and more efficient. With the software tools currently available, this would require prohibitively expensive computational capacity," Lahuerta says.

"Our software is easier to customize, and with access to training in its use, our customers are often able to pay for their investment in Virtual.Pyxis out of their very first design," says Leandro Garbin, a founding partner of the firm that is putting all its chips on innovation.

The program is still being upgraded, but VirtualCAE has already licensed it to important multinationals such as Thyssenkrupp (China unit), the American agricultural equipment manufacturer AGCO, and even one of MIT's research laboratories that provides services to the US Department of Defense. Thanks to innovation, the firm has opened branch offices in Germany and the US and has representatives in Mexico, Colombia, Turkey, China and Taiwan.

Provided by FAPESP