Physics

Avalanches and mixed solids

From cakes to headache tablets, the quality of many everyday products depends on how uniformly and reliably one can mix powders. However, there exists no widely accepted theory that describes the mixing of solid particles, and industrial engineers generally can't determine in advance the effectiveness of any given process for mixing granular solids.

As a step toward elucidating the basic physical principles underlying the mixing of solids, researchers have now proposed a simple model that captures some of the key features of slow granular mixing — a process frequently used in industry. Chemical engineers Guy Metcalfe, Troy Shinbrot, J.J. McCarthy, and Julio M. Ottino of Northwestern University in Evanston, Ill., describe their approach in the March 2 NATURE.

The researchers focused on the mixing behavior of particles in a hollow vertical disk partially filled with dyed crystals of table salt. The transparent cylindrical container is thin enough that as it rotates about a horizontal axis, the particle motion inside is effectively two-dimensional.

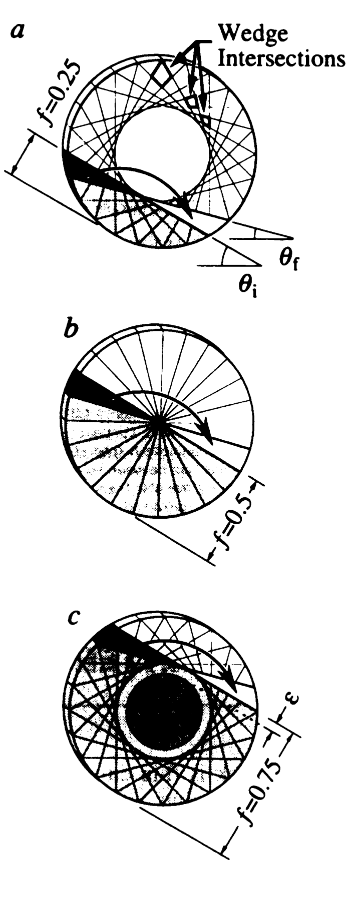
As the disk slowly rotates, the enclosed material's upper surface becomes increasingly steep, eventually triggering an avalanche. Such an avalanche transfers a thin wedge of material from the upper to the lower part of the inclined surface (see diagrams). This material remains there until the disk's rotation brings it back to the top. By considering the geometrical behavior of these wedges without going into the details of particle motion, Ottino and his coworkers found they could make useful predictions about granular mixing.

When the disk is exactly half full, wedges of material suffer repeated avalanches, but no mixing between the wedges occurs. If the disk is less than half full, material from a given avalanche doesn't stay in the same wedge in successive avalanches. The material gets mixed up. When the disk is more than half full, wedges of material mix, but because these wedges don't penetrate to the disk's center, the process leaves an unmixed core.

Computer simulations and calculations based on the geometry of avalanche mixing show that the most efficient mixing occurs when the disk is a quarter full. Experiments produce practically the same result.

The researchers have demonstrated "that a simple but original model can describe a good deal about the particularly important process of mixing," comments Robert P. Behringer of Duke University in Durham, N.C., in the same issue of NATURE.

Now, Ottino and his coworkers want to extend their model to more complicated situations in which mixing occurs in three dimensions and in noncylindrical containers. They would also like to see what happens when particles have a range of sizes.



Ottino et al./NATURE

Avalanche mixing in quarter-filled (a), half-filled (b), and three-quarter-filled disks (c). As the disk slowly rotates, material from an uphill wedge (dark gray) shifts to a downhill wedge (white).

Science & Society

A risky business, writing regulations

A bill requiring federal agencies to conduct cost-benefit and risk analyses of both new and existing health, safety, and environmental regulations passed the House of Representatives by a wide margin last week. The legislation covers everything from drinking water standards to wildlife protection.

The Risk Assessment and Cost-Benefit Analysis Act, part of the Republican's Contract with America, would force regulators to quantify in great detail how rules would increase or decrease risks to humans and the environment (SN: 2/11/95, p.87). Regulators would have to use "scientifically objective and unbiased" assessments to demonstrate that the benefits of rules would outweigh their costs, the bill states.

The risk assessments would have to include available laboratory and epidemiological data on the regulated activity or toxin. When describing the risk, regulators would have to provide examples of more serious, less serious, and equivalent risks familiar to the public.

In the case of particularly expensive regulations, independent panels would evaluate the agencies' assessments; they would also review annually the agencies' cost and risk assessment programs. The panels could include members of industries covered by the regulations under review.

Robert S. Walker (R-Pa.), chairman of the House Science Committee, says the bill would relieve the country of unnecessary regulations. But opponents, including members of the administration, say the legislation could override existing laws that protect human and environmental health. What's more, they claim, the many requirements of the bill would prove expensive to government and industry and would be impossible to implement.

Regulators can't determine all the costs of polluted water, for example, or the real risks of some chemicals to people of various health and ages, critics assert.

Congress may dip into FY 1995 budget

Members of Congress have begun trying to fulfill their promise to cut the federal budget — including funding for science and technology (SN: 1/14/95, p.20) — by voting to take back money already appropriated to agencies for this fiscal year.

This week, the House Appropriations Committee passed two bills that would cut \$17 billion from the FY 1995 budget. The full House and Senate must pass the bills and the President must sign them before they can be implemented.

The Department of Energy, one of the agencies hardest hit by the legislation, would lose \$145 million from the \$6 billion appropriated in FY 1995 for environmental cleanup. The department would have \$200 million less for clean-coal technology. Other DOE programs would also face cuts.

The House bills would cut \$107 million from the \$431 million FY 1995 appropriation for the National Institute of Standards and Technology's Advanced Technology Program, which helps industry develop high-risk technologies.

The National Science Foundation would lose only about \$132 million from its academic research infrastructure account, which the President had also proposed cutting in his FY 1996 budget.

A pricey business, weapons destruction

Destroying the country's chemical weapons stockpiles will cost about \$11.3 billion, over 30 percent more than the U.S. Army estimated in 1993, the General Accounting Office asserted in a Jan. 12 letter to the Secretary of the Army.

The Army has a history of underestimating these destruction costs: In 1985, it put the price at \$1.7 billion.

Last fall, a former safety manager of the country's main chemical weapons incinerator asserted that the plant had serious flaws (SN: 12/10/94, p.394).

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