Self-organization of sandpile models

March 31 2008

Dutch mathematician Anne Fey has investigated probability calculations in mathematical sandpile models. Although the rules of the model are simple, the wide-ranging behaviour that emerges from these is fascinating. Fey's research concerned various forms of self-organisation in these models. Practical applications are, for example, movements in the Earth's crust, stock market fluctuations and the formation of traffic jams.

These mathematical models are defined on a grid. Each grid point has a height, or quantity of sand, that must be below a limiting value. With each time interval, the height of one of the points increases. If a height exceeds a limiting value the sand must be moved to nearby points until all points are once again under the limiting value.

Although the rules of the model are simple, the wide-ranging behaviour that emerges from these is fascinating. Sandpile models exhibit various forms of self-organisation and patterns are formed which are stable over the course of time. That is seen most clearly in the case where only the height of the mid-point increases. The sand then spreads out symmetrically in highly angulated forms, in which fractal patterns develop. Fractal patterns have an infinite quantity of details in which designs are repeated on an increasingly smaller scale – this is comparable to ice crystals and certain corals.

In the other situations, the choice of the point where the height increases is random. Then 'self-organised criticality' occurs, a deeper form of self-organisation that is also studied in diverse research areas such as

movements in the Earth's crust, stock market fluctuations and the formation of traffic jams.

Source: NWO