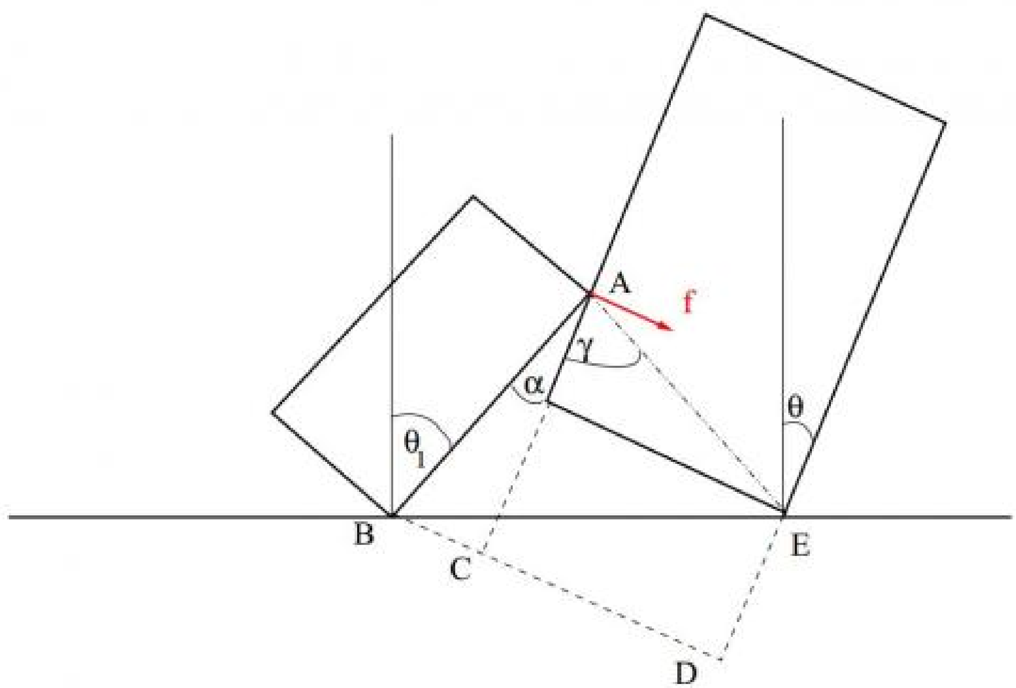
Physicist creates math model to predict maximum incremental domino size

January 11 2013, by Bob Yirka



Successive dominoes. The tilt angle θ is taken with respect to the vertical. Domino 1 hits 0 at the point A. The rotation axis of 1 is the point B and E is that of 0. The normal force f that domino 1 exerts on domino 0 is also indicated. Credit: arXiv:1301.0615 [physics.pop-ph] arxiv.org/abs/1301.0615

(Phys.org)—J. M. J. van Leeuwen, a physicist at Leiden University in The Netherlands has created a mathematical model that predicts the maximum incremental size of falling dominos. He's found, as he describes in a paper he's uploaded to the preprint server *arXiv*, that in a perfect world, the maximum growth factor is approximately 2.

Most everyone has seen dominos in action. Small pitted black planks with white dots on them are placed on their ends next to one another – then at some point, the first is knocked over onto the second. The force of the first falling onto the second causes it to fall, knocking it down onto the third, etc. This continues until all the dominos have been knocked over without any other outside interference. Most domino exhibitions feature planks that are all of the same size, though most intuitively understand that different sizes could be used, which means a smaller domino can knock over one that is larger. But how much larger? That's the question Leeuwen posed to himself. He turned to math to find the answer and in so doing created a model that predicts not only how much larger a domino can be, but the chain length patterns that would occur using different growth factors.

Dominos fall the way they do because when one is stood on end, it possesses potential energy. That energy is released when it is pushed over. But because the force necessary to push the domino over is less than the amount of potential energy stored, it is able to knock over a nearby domino that is larger than it is, a phenomenon known as force amplification.

To create a mathematical model, Leeuwen had to remove some real world factors that have an impact on chain reactions that occur when dominos are felled. Real dominos tend to slide at the bottom as they are knocked over, for example, and sometimes when one strikes another the result is an elastic collision that prevents the second domino from falling over. Also, sometimes dominos slide against one another as one strikes another. The result was a model that suggests the largest growth factor in a perfect world is 2, meaning one domino can knock over another that is twice its size.

The model also showed how quickly plank size can grow and still allow for a complete chain reaction. Starting with a plank just 10 millimeters high and assuming a growth factor of just 1.7, the model shows the planks growing to a size of the empire state building using just 244 planks.

More information: Domino Magnification, arXiv:1301.0615 [physics.pop-ph] arxiv.org/abs/1301.0615

Abstract
The conditions are investigated under which a row of increasing dominoes is able to keep tumbling over. The analysis is restricted to the simplest case of frictionless dominoes that only can topple not slide. The model is scale invariant, i.e. dominoes and distance grow in size at a fixed rate, while keeping the aspect ratios of the dominoes constant. The maximal growth rate for which a domino effect exist is determined as a function of the mutual separation.

via Arxiv Blog

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