

# Varied applications<sup>of</sup> cell grids

**Most non-mathematicians would be struggling to make meaningful connections between forest fires, earthquakes and urban gang recruitment. Not so William Newman. He spoke with Jenny Rankine.**



Newman, a professor from the University of California at Los Angeles, is an NZIMA-sponsored visiting expert who lectured on cellular automata and chaos theory in Auckland and in Christchurch in July, and renewed connections with New Zealand mathematicians.

Cellular automata arose from mathematical models of biological systems and descriptions of natural and engineering networks. It consists of a large, regular grid of cells, each in one of several states, modelled over time. Its roots are in formulae for object permutations and combinations in systems, fractal geometry and directed graphs.

To apply the discipline to forest fires, a mathematician assumes tree seeds are planted randomly in an area at a given time. New seeds will not take root where another tree is growing, leading to patterned clusters of mature trees. To stimulate fires, the mathematician imagines a random hand dropping matches or lightning bolts.

"The accumulation of flammable material on forest floor sets up clusters of trees for calamitous fires," says Newman. "In this imaginary landscape a cluster will be destroyed if lightning hits a tree. Eventually, equilibrium emerges between clusters of trees and fires. The model can suggest the best time and place for limited controlled fires to eliminate underbrush so that any accidental fires are self-limiting." This work has been of great interest to the US Forest Service.

Cellular automata are also applied to the distribution and size of earthquakes, which release accumulated stress from deformations in the earth's crust.

Newman says that many years ago, a UK meteorologist became interested in the use of maths to address conflict. "He gathered data on gangs from Chicago in the 1920s and in occupied Manchuria in the early 1940s. The stats plots exactly matched what we see in forest fires and the statistical distribution followed the power law, for example, describing how much more common smaller gangs were than those twice as big."

"Planting a tree is equivalent to recruiting a gang member. A forest fire is equivalent to the break up of a gang - the common feature is geometry, their relationship in space." Newman's research has led him to see gangs as a universal response to urban social problems, unrelated to any particular ethnicity or time.

"If our model has any sense, the place we can help prevent recruitment is in areas with very few gang members. We won't get very far where they are entrenched. Of course," he qualifies, "this is an extrapolation with no scientific basis as yet."



**William Newman.**  
Photo: Godfrey Boehnke.

During his visit, Newman renewed his friendship with Professor James Sneyd at the University of Auckland, who was involved with the 2003 NZIMA programme on modelling cellular function. They are both now working on the mathematics of brain tumours and Newman believes cellular automata may provide a useful approach.

"Cells don't just sit there - they reproduce, die and multiply. But maths methods about the behaviour of fluids are based on the notion that molecules of water are neither created nor destroyed. Cellular automata could provide a way to account for this."