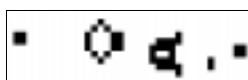
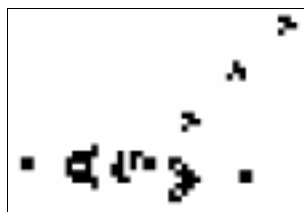


## 9 Bug Makers and Bigger Questions

In addition to admitting bugs, many of the LtL rules in the thin bug regime admit bug makers which are analogous to Life's glider gun. Life's glider gun was first discovered in 1970 by William Gosper, a computer hacker at MIT's AI Laboratory. Gosper's discovery was in response to Conway's famous challenge -- to disprove that a finite initial configuration of Life would not be able to generate infinite populations. Gosper used elaborate search algorithms to find the first glider gun. Let us depict his discovery, along with a stream of the gliders that it produces.



time 0



time 100

*Gosper's glider gun*

In our extensive CAM-8 experiments of Life we have never seen such a configuration emerge from a random initial state. However, many of the LtL bug makers do emerge from random initial states. (By the monkeys at a typewriter principle, Gosper's glider gun will exist in some random initial state, but we are discussing practicalities here.) Let us depict one of our favorite LtL bug makers.

This bug maker is admitted by the LtL rule  $(2, 4, 4, 5, 5)$ . It seems to be the key to understanding why this particular rule does not appear to die out. Even on a finite system, complex self-organization appears to continue for all times. At some time steps, the density becomes very low, but then a wave of activity emerges and sends the density back up. We plan to further explore the cause of this as well as the complex local structures admitted by this rule. The generator for this bug maker is very simple, so we illustrate its real size.

*LtL bug maker -- time 0*

After iterating the rule for 100 time steps, the following configuration emerges.



*time 100 -- bug maker for LtL rule (2, 4, 4, 5, 5)*

The question is: Why are we interested in such objects? As is well known by now, Life is universal (see [BCG]). A crucial part of the original proof of this used glider guns, strategically placed, to construct AND, OR, and NOT gates. The question thus arises: Are any of the large range LtL rules universal? If the answer is affirmative, perhaps our bug makers can be used as the glider guns were -- to construct the basic building blocks of a computer. Before getting too excited, we add that Conway himself thinks that this problem is extremely challenging.

Why else might we be interested in bug makers? This has to do with the question of whether, in the infinite system, eventually all complex self-organization relaxes and only finite still lifes and periodic objects remain under rules that exhibit Life-like dynamics. This is still an open question about Life itself, which has been extensively studied for 26 + years. However, CAM experiments of [BB] indicate that relaxation in Life occurs at a small

exponential rate. There are also are believers that Life is *self-organized critical* (see [BCC]). A third possibility is that Life is *supercritical* (see [BB]). It is conceivable that it admits indestructible local configurations that send out impenetrable streams of glider-like creatures. If Life does settle down at a small exponential rate, do the other LtL rules as well? The rule (2, 4, 4, 5, 5), whose bug maker we illustrated above, does not appear to die out, but perhaps when our computers get even faster we will find that it too relaxes, but slower than Life does. Or, perhaps there exists an indestructo monster admitted by our rule, making the supercritical idea a possibility. Of course, serious computer hackers have been seeking such a Life creature for over two decades, so this idea begins to remind one of the movie, *It's a Mad, Mad, Mad, Mad World* (see [Kra]), where the indestructo monster is represented by the large "W" that the car rally participants seek. Do we know what we are seeking? If we get close to the configuration in question, will we *recognize* it? Or, are things really mad -- do we seek the impossible? Perhaps, the latter, but until it is proven otherwise, such a possibility will evoke paranoia and remain a hurdle to surpass before making progress on determining the ergodic behavior of Life itself and also complex Life-like LtL rules.