Turtles, Termites and Traffic Jams.
(1997)
Resnick, M

Chapter 1. Foundations.

Decentralised systems are widespread and the interest in these systems is growing rapidly to overtake a centralised control approach.

The centralised mindset seems to be the default. e.g. flock of birds do not have leaders, they are leaderless and self organised.

Resnick's investigation consists of probing peoples thinking, developing new conceptual tools and developing new computational tools.

Decentralisation is being seen in Russia, IBM, economic management, Darwin's evolution.

Decentralisation of organisations, technologies, scientific models, theories of self and mind, theories of knowledge.

Chapter 2. Constructions

How do we teach decentralised systems thinking? Papert (1991) advocates the constructionist approach. "Constructionism involves two types of construction. First, it asserts that learning is an active process, in which people actively construct knowledge from their experiences in the world. To this, constructionism adds the idea that people construct new knowledge with particular effectiveness when they are engaged in constructing products which are personally meaningful." Pg 23

LEGO/Loco allows kids to build robots with simple command structures which support both centralised and decentralised exploration.

StarLogo is a program which does not have the real world aspect of Lego/Logo but does enable exploration with thousands of entities. It is designed to be simple to use and builds on the Logo language, on ideas from neural networks and on cellular automata.

"For many colony type explorations, having lots of turtles is not just a nicety, it is a necessity. In many cases the behaviour of the colony changes quantitatively when the number of turtles in increased." Pg 33

StarLogo uses Turtles, Patches and an Observer. "the existence of patches encourages new ways of thinking …… creatures can leave "reminder markers" in the environment instead of burdening their own memories." Pg34

Designers of most programming languages are interested in improving speed and performance, or in providing advances capabilities for expert programmers. StarLogo, by contrast, is designed for a larger group of users, including non-expert programmers. And if focusses not on improving speed of computation but on helping people think about and experiment with important scientific ideas in new ways." Pg 41

Chapter 3. Explorations

StarLogo is more aimed at stimulation than simulation.

Slime Mould. Slime mould cells exist independently as tiny amoebas when food (bacteria) is plentiful and reproduce by division. When food is scarce, reproduction stops and the cells for a cluster with ten's of thousands of cells and begins crawling in search of a more favourable environment. On locating a suitable environment, it differentiates into a stalk supporting a round mass of spores which detach, spread and start a new cycle. There is no central control. The StarLogo model had turtles wandering randomly and dropping pheromone and following the pheromone gradient if it found one. The patches diffused and evaporated the pheromone. With enough turtles they developed clumps.

Artificial Ants. Ants collect food in a deliberate way without centralised control. The Starlogo model had turtles wandering randomly in search of food or a pheromone trail (which they would follow uphill). If food was found the turtle would carry it towards the nest-scent (with some randomness), drop it on arrival all while continuing to drop a pheromone trail. The Patches diffused the nest-scent, and diffused and evaporated the pheromone. Strong pheromone trails would develop to the closest discovered food source until depleted.   Hence, the turtle would concentrate on depleting one food-source at a time.

Traffic Jams.   The StarLogo model had turtles moving forward and accelerating slowly to max speed unless a car (or radar trap etc) was detected in front whereby the turtle decelerated rapidly. The traffic jam formed due to a trigger (radar trap) but also without a trigger due to random inhomogeneities.   The traffic jam moved in the opposite direction (i.e. backwards) to the direction of the cars (i.e. the emergent 'object' behaved quite differently to the lower level parts)

Termites. Termites build elaborate nests.   The StarLogo model had turtles walking randomly and on locating a wood-chip picking it up. When another wood-chip was located the turtle put the one being carried down, forming a pile. Large piles developed despite wood-chips being taken from existing piles because once a pile was diminished to 0 another pile could not start in that location.

Turtles and Frogs. Frogs and turtles inhabited lilly pads with each species having a preference for at least 30% of its neighbours being of the same species. This resulted in a complete segregation of the species. Another example of this behaviour was noted being the segregation of the sexes at a social gathering where a slight imbalance in a group with create a tendency for the under represented sex to leave which further accentuates the imbalance.

Turtle ecology. "If you don't know where you are going you might end up somewhere else" baseball manager Casey Stengel pg 88. A StarLogo program grew food continuously at random on the patches and the turtles walked randomly, using up energy, until they bumped into some food which increased their energy. The turtles died if they ran out of energy. An initially high Turtle population would drop rapidly and then stabilize. However, the higher the initial population the faster the food was diminished and the lower the final stable population. So the Turtle's could go extinct despite a positive food supply. When reproduction was added, population oscillations around a stable value but if the oscillation dipped to zero the Turtles went extinct.

New Turtle Geometry. Many turtles beginning from the origin and taking 50 steps in a random direction will form a circle. A parabola, sine wave or X are also possible. Another way of forming a circle is for a turtle to walk a many sided polygon. Yet another way is for a large number of turtles at the origin to repel their neighbours just a little bit with a little bit of random. StarLog introduces new ways of thinking.

Forest Fire. A Forest Fire will spread from one side of the screen to the other if there is a continuous path of trees. There is a critical tree density of 59% when the fire will spread all the way across the screen. 59%, not 50% because the fire can be stopped by a diagonal line across the screen.

Recursive Trees. Can be drawn (left to right) with a single turtle recursively tracing the tree or (from the base up) by a turtle which bifurcates at each juncture.

Chapter 4. Reflections

The centralised Mindset is prevalent amongst novices and scientists alike. There are examples in biology etc. etc. etc. and conspiracy theory. The centralised mindset assumes phenomenon are initiated by lead or by seed.

Why do people tend to the centralised mindset? Some things are. Social systems of power and authority are. Our conception of ourselves as a free agent is.

Guiding Huristics for Decentralised Thinking.
(see pg 134)

Positive feedback isn't always negative. Positive feedback often plays an important role in creating and extending patterns and structures.

Randomness can held create order. Most people view randomness as destructive, but in some cases it actually helps make systems more orderly.

A flock isn't a big bird. It is important not to confuse levels. Often people confuse the behaviours of individuals and the behaviours of groups.

A Traffic jam isn't just a collection of cars. It is important to realise that some objects ('emergent objects') have an ever changing composition.

The Hills are alive. People often focus on the behaviours of individual objects, overlooking the environment that surrounds the objects.

Chapter 5. Projections

People need to learn about decentralised thinking with hands on engagement.