ARTIFICIAL LIFE ON A SHOESTRING

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"Artificial life is a new way of doing science, one arising not out of the laboratory but out of the computer. The power of the computer to depict—and create—emerging systems has transformed our understanding of evolution, the origins of life, and the essential dynamics of natural phenomena, enabling scientists to move beyond life-as-we-know-it to life-as-it-could-be. In the hands of artificial life researchers, the computer is not merely a tool but a breeding ground. The artificial organisms that emerge will not only perform our labors but will help us crack nature's codes. Eventually, we may come to grant them the autonomy due other living creatures."[1]

While this may sound like pretty heady stuff, artificial life provides even elementary school students with an open-ended environment for stimulating scientific thinking, discovery, and collaborative problem solving. Logo provides a fertile laboratory for inventing new life forms and modeling existing creatures. Artificial life research combines elements of psychology, physics, artificial intelligence, mathematics, biology, art, and computer science with important intellectual ideas, including: emergence, feedback, design, and systems-oriented thinking. Like children, artificial life researchers build complex things from simple elements. The intellectual tools sharpened in the activities described in this presentation have relevance and transference beyond the field of artificial life research. If it is in fact important for students to develop sophisticated problem solving and process thinking skills then I am hard-pressed to think of a more fertile intellectual pursuit than creating a new universe and its inhabitants.

"In certain fields, such as high-energy physics and much of current mathematics, it is difficult to make cutting edge ideas accessible and relevant to children. But that is certainly not the case with artificial life. Children all share a strong interest in living things and animal behavior. Moreover, the general approach to artificial life research is one that meshes nicely with children's natural ways of learning. Artificial life researchers often learn by building things. They start with simple, easily understood rules or units, and they study how complexity emerges from interactions among these units."[2]

An example of an artificial life unit for kids could begin with students doing much of the Elementary School Science curriculum's well known unit on observing different aspects of mealworms; anatomy, movement, senses, eating, reproduction, behaviors. The mealworm unit encourages students to observe the mealworms carefully and to feel uninhibited while forming hypotheses and testing these hypotheses. From the live mealworms, students can proceed in many directions, using LogoWriter, LEGO TC logo, and the Phantom Fishtank to create their own new creatures. To paraphrase Mr. Wizard, Don Herbert, scientific inquiry is rooted in making the familiar strange and the strange familiar.

The creatures students invent may be models of real-life animals or new organisms, never before imagined. Issues of locomotion and movement can be modeled in LogoWriter, LEGO TC logo, and the Phantom Fishtank. Some behaviors, emotions, and responses to stimuli through different senses can be better simulated with LogoWriter or LEGO TC logo. For example, the sense of touch can be dealt with by a screen creature in LogoWriter who will bump its way through a screen maze or by a LEGO creature programmed to navigate a physical maze. Sight and visual perception may also be modeled in both environments. Smell, hearing, and taste are better simulated in LogoWriter because they are not

dependent on the limited LEGO physical sensors. Issues of reproduction and colonization may be explored with the Phantom Fishtank.

From these simple beginnings, all kinds of complexity and diversity can emerge. What happens when we combine several senses or the mechanical emotions of psychologist Valentino Braitenberg's vehicles? How does a creature with one eye behave differently than a creature with two eyes? What happens if a predator is added to your world? A colleague, Eadie Adamson, even simulated social behaviors by inventing "party animals" in LogoWriter. There were male and female party animals, shy ones and aggressive ones. Some traveled in cliques, others were loners. If a member of the opposite sex approached a shy animal, he/she would turn red and evade the aggressor.

While the creations and experiments shared in this session are simple when compared to the pioneering work of Mitch Resnick and his *Logo, a great deal of learning is possible in one of the Logo environments found in schools today. Participants in this lab session will learn how upper elementary through high school students may explore and create artificial life forms in these three software environments. Ideas for creating Logo-based Braitenberg vehicles and translations of the 1977 Logo Memo for LogoWriter and LEGO TC logo will be among the ideas shared in the accompanying handouts.

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Footnotes:

[1] Steven Levy, *Artificial Life...* (Pantheon Books: New York, 1992) introduction

[2] Resnick, M. (1987), "LEGO, Logo, and Life," Paper presented at the First Artificial Life Workshop, Los Alamos, NM.

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