INT D 554/PSYCO 457

Week 7: Machina Speculatrix

The Tortoise Reviewed

Our LEGO Tortoise

William Grey Walter

- **William Grey Walter built the first autonomous robots in 1948 and 1949.**
- **They were recently rediscovered and recreated in Bristol**
- **His work is described in the 1953 book *The Living Brain***
- **He was a "scientific character"**
  - **"His popular and academic reputation encompassed a heterogeneous series of roles ranging from robotics pioneer, home guard explosive experts, wife swapper, t.v.-pundit, experimental drugs user, and skin-diver to anarcho-syndicalist champion of leucotomy and electro-convulsive therapy." (p. 616).**

Machina Speculatrix

- **We are interested in Grey Walter because of his pioneering work in building autonomous robots, the famous Tortoise or *Machina speculatrix***
  - **"An electro-mechanical creature which behaves so much like an animal that it has been known to drive a not usually timid lady upstairs to lock herself in her bedroom, an interesting blend of magic and science"**

A Simple Machine

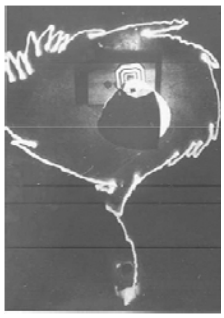
- **Grey Walter's research program "held promise of demonstrating, or at least testing the validity of, the theory that multiplicity of units is not so much responsible for the elaboration of cerebral functions, as the richness of their interconnection"**
- **In this sense it was a reaction against Ashby's homeostat**
- **Here is some classic footage of the robot in action**
- **And some more footage…**

Recording Complex Behavior

- **Candles were fixed to the turtles' shells, and long exposure photographs were taken as the machines moved**
- **Traces of light in the photographs recorded the paths of the machines**
  - **"Some of these patterns of performance were calculable, though only as types of behaviour, in advance; some were quite unforeseen" (Grey Walter, 1953, p. 130)**

Elsie's Behavior: Getting Around?

- **"The machine circles around [the light] in a complex path of advance and withdrawal"**



Elsie Returns Home

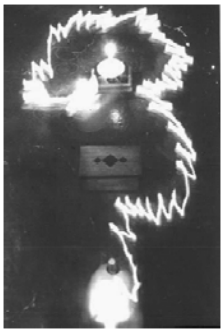
- **"Started in the dark the creature finds its way into a beam of light and homes on the beam into its feeding hutch"**
- **Why does she do this?**
- **Is this different than the prior behaviour?**

Elsie's Complex Behaviour

- **A screen hides the light, it can't be seen**
- **Elsie oscillates, but then hits and moves the screen**
- **When the light appears, she circles it at a distance**
- **Why?**

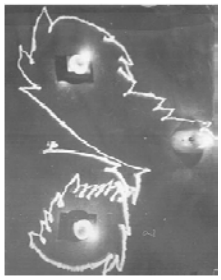
Elsie's Behaviour: Avoidance

- **Elsie successfully avoids a stool and approaches the light**
- **What must be built into Else to permit this to happen?**



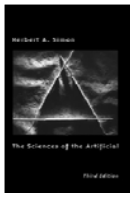
Elsie's Behaviour: Free Will

- **"The solution of the dilemma of Buridan's ass. The photoelectric cell which functions as the creature's eye scans the horizon continuously until a light signal is picked up; the scanning stops, and the creature is directed towards the goal. This mechanism converts a spatial situation into a temporal one and in this process the dilemma of two symmetrical attractions is automatically solved, so that by the scholastic definition the creature appears endowed with `free-will'. It approaches and investigates first one goal and then abandons this to investigate the other one, circling between the two until some other stimulus appears or it perishes for want of nourishment."**



The Parable Of The Ant

- **"Viewed as a geometric figure, the ant's path is irregular, complex, hard to describe. But its complexity is really a complexity in the surface of the beach, not a complexity in the ant" (Simon, 1996, p. 51)**
- **One way to complicate Elsie's environment is to include another agent**

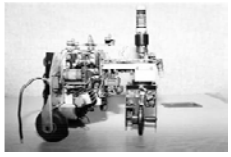


Elsie's Social Behaviour

- **Elsie dances with Elmer, and vice versa, because of the candle**
- **The two then race to the hutch, with Elsie winning**
- **Where does this behaviour come from?**

Basic Principles

- Two radio tubes
- Two sensors (light and touch)
- Photocell is linked to steering mechanism
- No light -- continuous forward exploration combined with oscillation
- Weak light -- steering inhibited, and machine moves forward towards the light
- Strong light -- dazzled state, steering kicks back in at double speed
- Touch sensor activates more random oscillation to permit obstacle avoidance



The Next Step

- The behaviour of the tortoises was very complex
- One reason for this complexity was the fact that they were “many-situated” – sensed more than one aspect of the environment
- Our goal is to build, program, and observe a similar robot ourselves!