

Passage II

SOCIAL SCIENCE: This passage is adapted from the article "Model Behaviour" by *The Economist* (©2009 by The Economist Newspaper Limited).

The warmongering orcs depicted in the *Lord of the Rings* trilogy are evil, unpleasant creatures that leave death and destruction in their wake. But if you find yourself in a burning building a few years from now, they might just save your life. That is because the technology used to make hordes of these menacing, computer-generated monsters move convincingly on screen turns out to be just what is needed to predict how crowds of humans move around inside buildings.

The simulation of the behaviour of crowds of people and swarms of animals (not just mythological ones) is being applied to many unusual situations.

When the first film in the *Lord of the Rings* trilogy was released in 2001, much was made of its heavy reliance on computer-generated imagery. But what was perhaps most impressive were the epic battle scenes, which broke new ground in special effects by showing huge numbers of characters with an unprecedented degree of detail and realism. For this the trilogy's director, Peter Jackson, largely has Stephen Regelous to thank. Regelous is the founder of Massive Software, based in Auckland, New Zealand. His firm's software made it possible to generate as many as half a million virtual actors in a single shot, each behaving in an independent and plausible manner.

That is because every character was, in effect, given a brain, says Diane Holland, Massive's chief executive. Each one was modeled as a software "agent" with its own desires, needs and goals, and the ability to perceive the environment and respond to the immediate surroundings in a believable way. Any given orc, for example, could work out which other fighters on the battlefield were in its line of sight, and hence whether it should flee or attack. This produced far more realistic results than orchestrating the motions of the digital extras in a scripted, choreographed way.

Taking a similar approach is Dr. Demetri Terzopoulos, a computer scientist at the University of California in Los Angeles. He is using agents to simulate the behaviour of commuters passing through Pennsylvania Station in New York. His agents have memory, but they also have a sense of time and the ability to plan ahead. An agent entering the station will typically seek out the ticket office, stand in line to buy a ticket, and then perhaps kill some time watching a street performer if he has a few minutes before his train arrives, says Terzopoulos. If he is running late, by contrast, he may try to push his way to the front of the ticket line before sprinting for the platform.

Terzopoulos's research has shown that agents can simulate complex behaviours with great realism. Working with Qinxin Yu, a graduate student, Terzopoulos has modeled how people behave in public when some-

one collapses. People crowd around to help, and some agents will even remember if they recently saw a police officer nearby, and run to get help, he says. Such realism is useful in the development of automated closed-circuit television security systems. Using real cameras for such research would raise privacy concerns, so he is making agent simulations available instead to researchers who are training cameras to detect unusual behaviour. Another intriguing application is to help archaeologists study ancient ruins. Using a model of the Great Temple of Petra in Jordan, Terzopoulos has evaluated how it would have been used by the people who built it. He has concluded that the temple's capacity had previously been greatly overestimated.

Agents need not even represent humans. Massive has been working with BMT Asia Pacific, a marine consultancy, to model the behaviour of the thousands of ships operating in Hong Kong harbour. This involves simulating the behaviour of the ships themselves, each of which may be under the control of several people, says Richard Colwill of BMT. And rather than assuming that everyone will adhere to the maritime traffic code, which determines who has right of way, it can incorporate acts of bravado and incompetence. "We get about 150 collisions each year in Hong Kong," says Colwill. His firm plans to use the software to determine which traffic-management strategies will be least disruptive during the construction of an immersed road tunnel that will need to be lowered into the harbour.

As agent software becomes better able to capture complex real-world behaviour, other uses for it are sure to emerge. Indeed, this could soon become a crowded field.

11. The main idea of the passage is that:
- A. using computer-generated simulations in movies has both advantages and disadvantages.
 - B. the *Lord of the Rings* trilogy made cinematic history with its computer-generated simulations.
 - C. computer-generated simulations can be applied to predict behavior in a number of situations.
 - D. Terzopoulos has expanded the field of computer-generated simulation beyond its uses in film.
12. In the passage, the author's attitude toward computer-generated simulations can best be described as:
- F. fearful of their negative consequences.
 - G. optimistic about their potential uses.
 - H. boastful about their success.
 - J. skeptical of their accuracy.

13. Which of the following statements best describes the organization of the passage?
- A. A problem with computer-generated simulations is identified, and several solutions are proposed.
 - B. An example of computer-generated simulation is followed by a generalization and more examples.
 - C. Summaries of the work of various computer researchers are presented in chronological order.
 - D. A claim about the efficacy of computer-generated simulations is followed by attempts to refute it.
14. Which of the following questions is directly answered in the passage?
- F. What behaviors can't be modeled by computer-generated simulations?
 - G. What is the intended use for the software being developed by Massive Software and BMT Asia Pacific?
 - H. How do researchers give a brain to a computerized character?
 - J. How do programmers decide which characteristics and actions to include in their software?
15. The main purpose of the seventh paragraph (lines 68–82) is to:
- A. illustrate the dangers of predicting crowd behavior through computer simulation.
 - B. summarize Hong Kong's lengthy history of using computer simulations of crowd behavior to direct harbor traffic.
 - C. contrast BMT Asia Pacific's computer simulation of crowd behavior with actual crowd behavior.
 - D. extend the discussion of using computer simulations to predict crowd behavior to situations involving inanimate objects.
16. According to the passage, the director of the *Lord of the Rings* trilogy owes thanks to which of the following people?
- F. Demetri Terzopoulos
 - G. Diane Holland
 - H. Stephen Regelous
 - J. Richard Colwill
17. The passage indicates that in relation to Terzopoulos's work in computer-generated simulations, Massive Software's work is:
- A. more experimental in nature.
 - B. less often used in films.
 - C. more realistic in films.
 - D. similar in approach.
18. The passage indicates that Terzopoulos accounted for which of the following situations in his study of commuter behavior at Pennsylvania Station?
- F. A train arriving behind schedule
 - G. A train being full
 - H. A commuter getting lost
 - J. A commuter running late
19. According to the passage, using computer simulations instead of cameras to study public behavior is preferable due to concerns about:
- A. privacy.
 - B. cost.
 - C. labor.
 - D. safety.
20. In lines 85–86, the phrase *a crowded field* most nearly refers to:
- F. the research and development of agent software to simulate real-world situations.
 - G. a harbor in need of traffic-management strategies.
 - H. an open area where real-world crowd behavior is studied.
 - J. a filming location for the *Lord of the Rings* trilogy.