



What about those ants?

Swarm Intelligence for Virtual Environments

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Virtual Environments



- Multiuser environments where people interact simultaneously
- Uses include:
 - Simulation of design
 - Architectural and Construction education




Virtual Environments and Construction Industry



- Architectural visualisation for:
 - Evaluation during the design process
 - Communicating ideas and spatial relationships to builders
 - Giving a realistic impression of the building to clients




Virtual Environments and Construction Industry

- Benefits of virtual environments for architectural visualisation include:
 - Visualising on different scales
 - Modifying while you are in it
 - Viewing from different angles
 - Simulating the effect at different times of the day



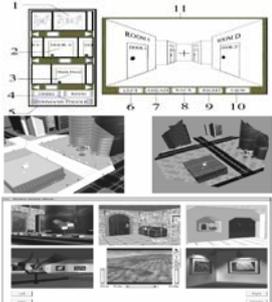

Wayfinding

- Knowing where you are, where you want to go, and how to get there
- Attempts at improving wayfinding include:
 - Landmarks / Visual cues / Aural cues
 - 2D Maps / 2D Thumbnail images
 - 3D Maps / 3D Thumbnail worldlets
 - Multiple views
 - Guided Tours
 - Queries




Wayfinding

- Maps
 - An interactive spatial cognitive map as well as providing a traditional 3D world
 - 3D Thumbnails have been used to aid navigation





Wayfinding



Wayfinding

- Problem
 - The world is assumed to remain static
- Hence
 - There needs to be a mechanism to allow the world to remain dynamic

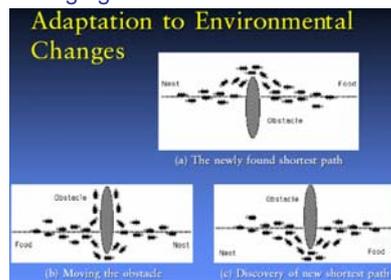
Swarm Intelligence



- “Any attempt to design algorithms or distributed problem-solving devices inspired by the collective behaviour of social insect colonies and other animal societies”

Swarm Intelligence

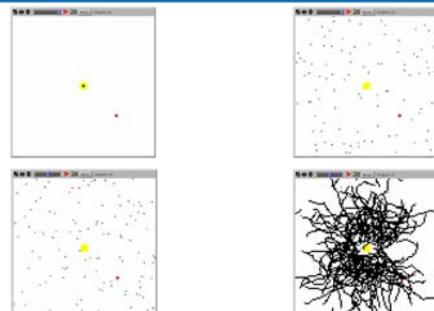
- Ants' Foraging Behaviour



Swarm Intelligence

- Ants' Foraging Behaviour:
 - Stigmergy: Indirect communication by altering the state of the environment affecting actions of others
 - Pheromone: A chemical trail to the food source left by ants for attracting others to follow

Wayfinding Swarm



Wayfinding Swarm

- Wayfinding Swarm in Virtual World:
 - Stigmergy: A way of discovering many different paths to a destination
 - Pheromone: Used as repellents to discourage other crawlers from traversing the same path



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In summary

- Virtual Worlds for Design and Construction
 - Allows “unvisitable” places to be “visitable” e.g. historical sites, historical architectures
 - Allows interaction with design enabling designers to modify the design while being within it
 - Improved visual communication to the clients
 - Improved collaboration between the designers and the clients



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In summary

- Swarm for Wayfinding
 - Allows decentralised searching of the virtual spaces e.g. each individual can decide where to go
 - Can change the destination at will
 - Allows the environments to remain dynamic as to be used for evaluating and simulating designs during design processes



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References

- Anderson, C., G. Theraulaz, and J.L. Deneubourg. 2002. Self-assemblages in insect societies. *Insectes Sociaux* 49(2): 99-110.
- Bonabeau, E., M. Dorigo, and G. Theraulaz. 1999. *Swarm Intelligence: From Natural to Artificial Systems*. Oxford University Press
- Dorigo, M., T. Stützle. 2004. *Ant Colony Optimization*. The MIT Press.
- Franks, N. R., A. B. Sendova-Franks, and C. Anderson. 2001. Division of labour within teams of New World and Old World Army Ants. *Anim. Behav.* 62: 635-642.
- Herder, J., R. Würzberger, U. Twelker, and S. Albertz. 2002. Use of Virtual Environments in the Promotion and Evaluation of Architectural Designs. *Journal of the 3D-Forum Society* 16(4): 117-122.
- Kennedy, J., and R. C. Eberhart. 2001. *Swarm Intelligence*. Academic Press



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