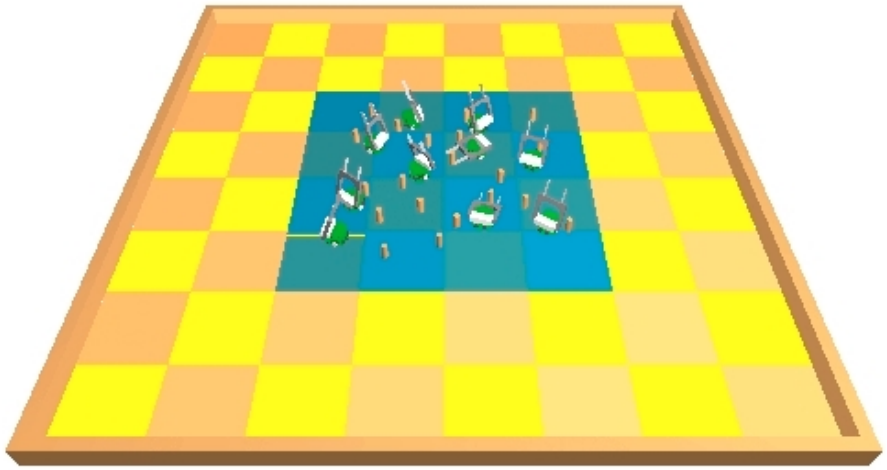
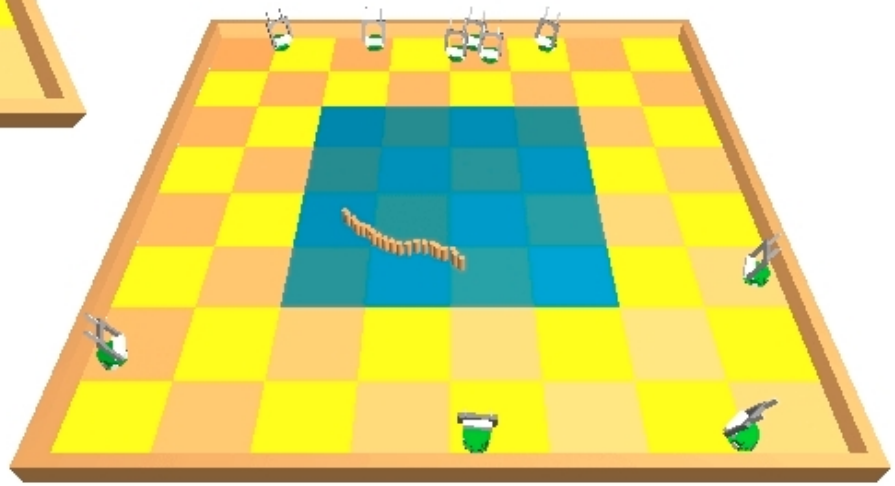
Distributed Task Allocation





Oran Switzer **Douglas Lanman**

Supervisor: **William Agassounon**

Distributed Task Allocation

Initial Goals:

- Study distributed task allocation in Webots using local perception.
  - Determine appropriate fixed thresholds for modified clustering experiment.
  - Compare results to analytical and numerical models.
  - Introduce refined task allocation methods for the modified clustering experiment including heterogeneous thresholds.

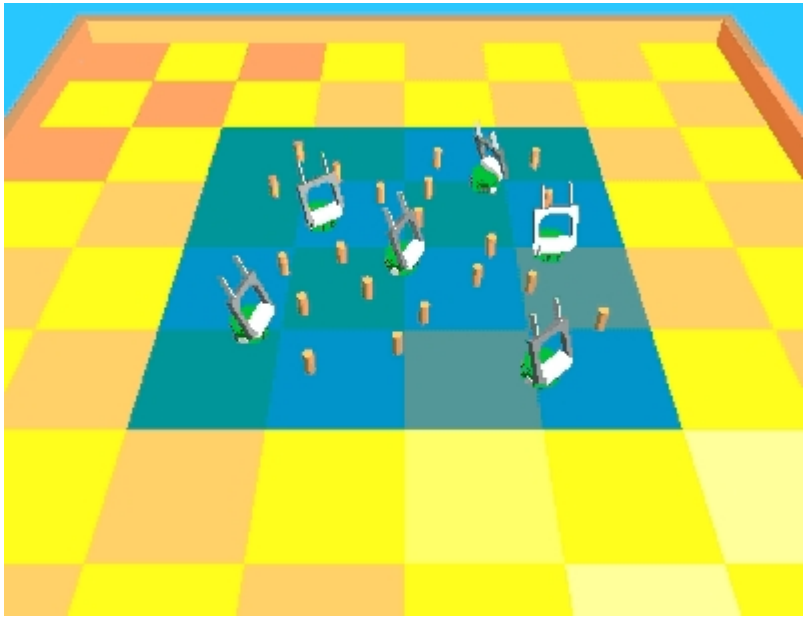
Primary Achievements:

- Successfully implemented modified clustering experiment in Webots.
  - Robust “virtual wall” supervisor and Khepera controller created.
  - Fully distributed task allocation achieved with the Khepera controller.
  - Supervisor monitors the progress of the modified clustering experiment.
  - Data gathered in experiment can be viewed with a set of Matlab programs.
  - Provided platform to study heterogeneous thresholds (mixed controllers); not enough time to experiment and no models available.

- Validated both analytical and numerical models.
  - Simulations with several different group sizes confirmed the results of analytical and numerical models created by William.

- Demonstrated that fully distributed task allocation can be achieved, reducing power consumption and improving team performance.

The Modified Clustering Experiment: Overview



Design Specifications:

› 160x160 cm arena; 80x80 cm working area

› virtual wall separating working area and resting area

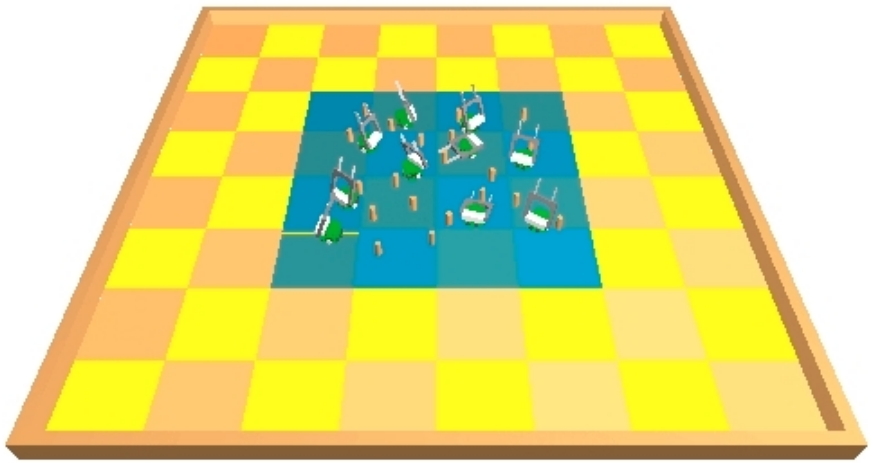
› actual wall surrounding arena

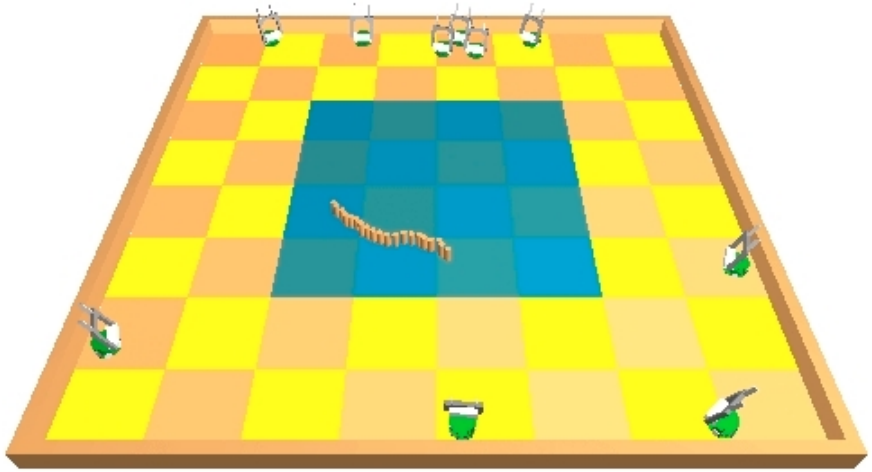
› 20 seeds; variable number of Khepera units

Fixed Thresholds:

› “threshold” determines how much time the robot will continue working.

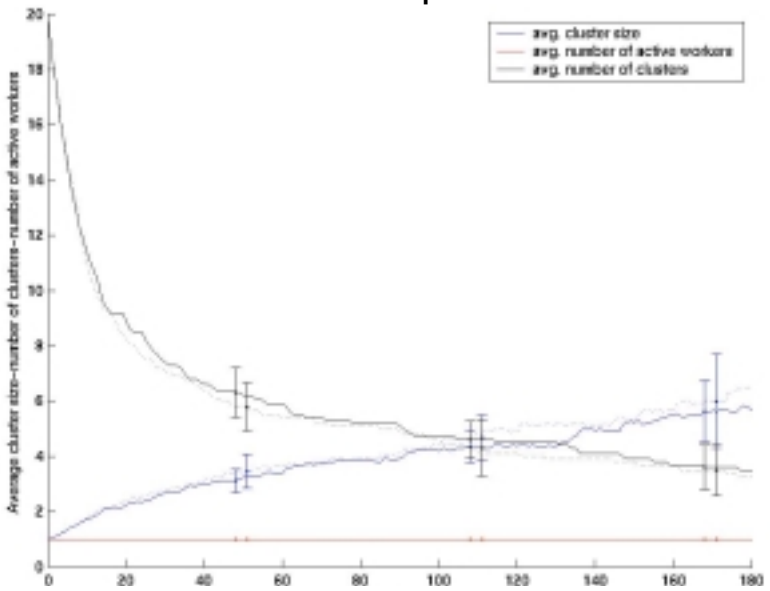
› “wait time” determines how many steps the robot will wait in the resting area before returning to the working area.



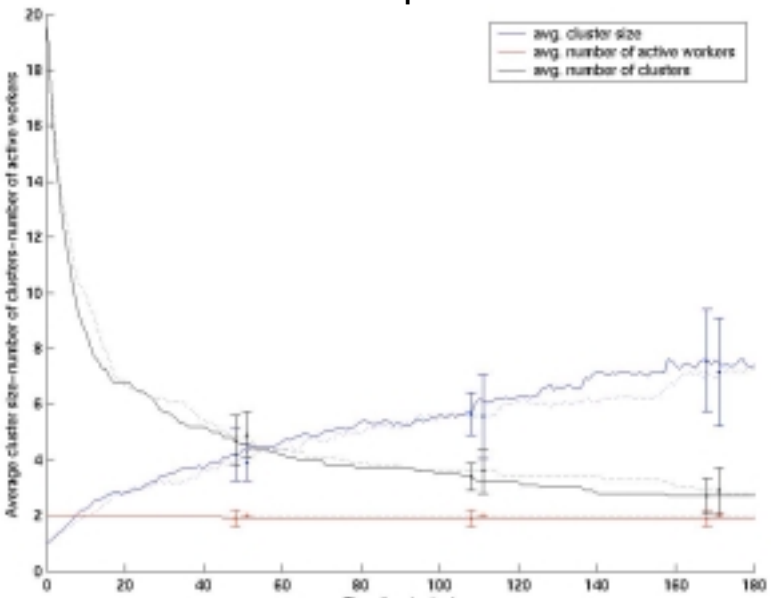


The Modified Clustering Experiment: Validation

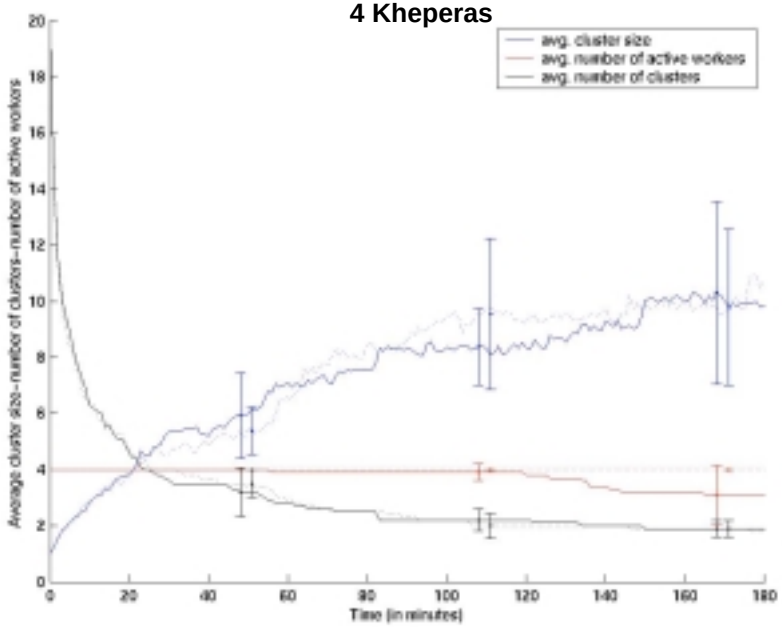
1 Khepera



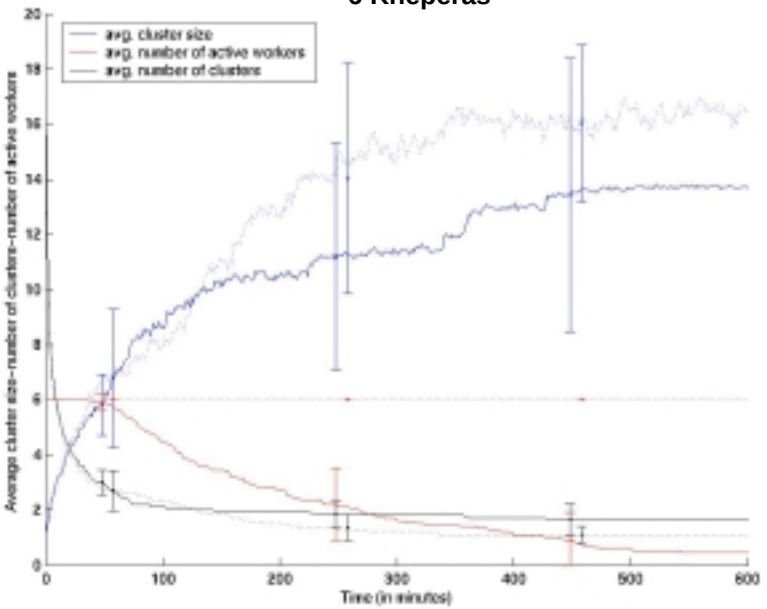
2 Kheperas



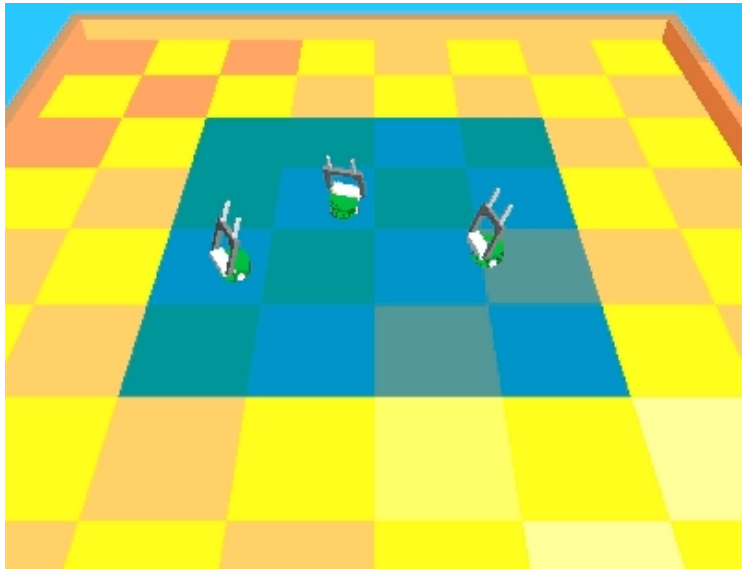
4 Kheperas

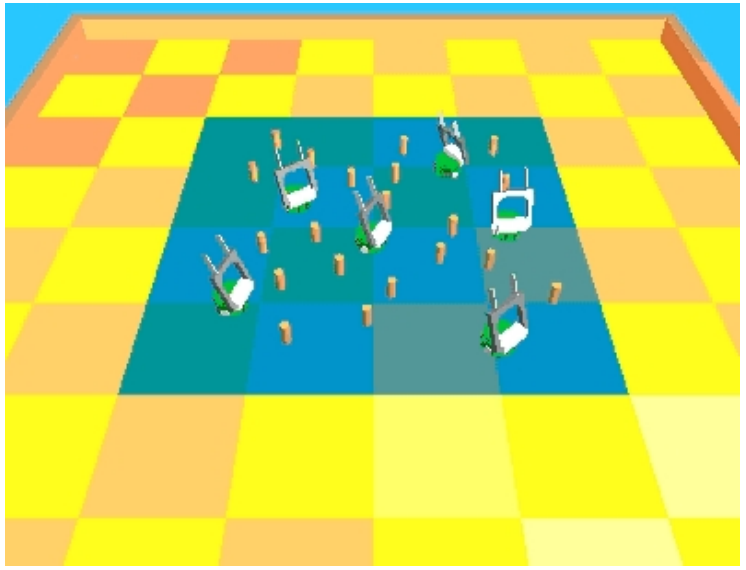


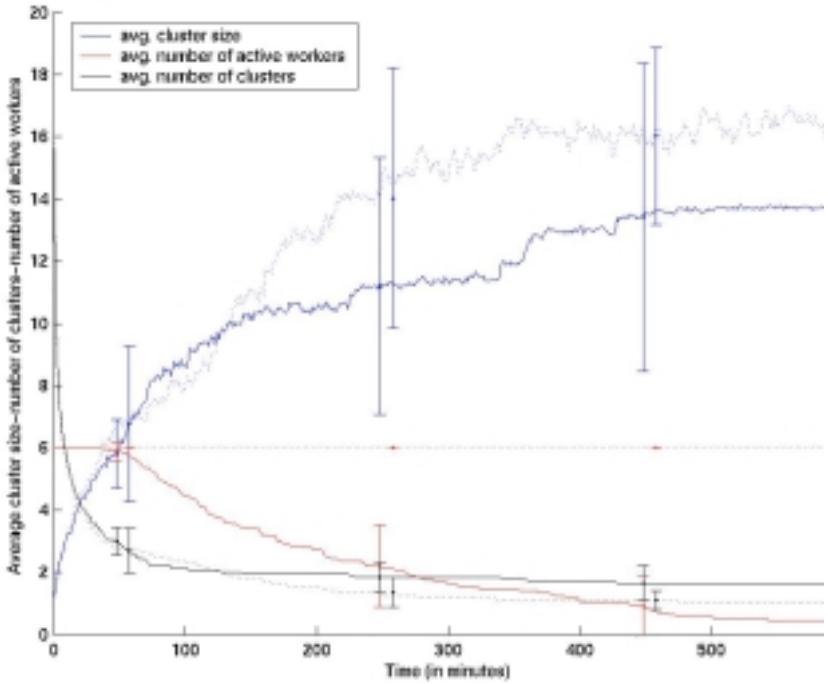
6 Kheperas

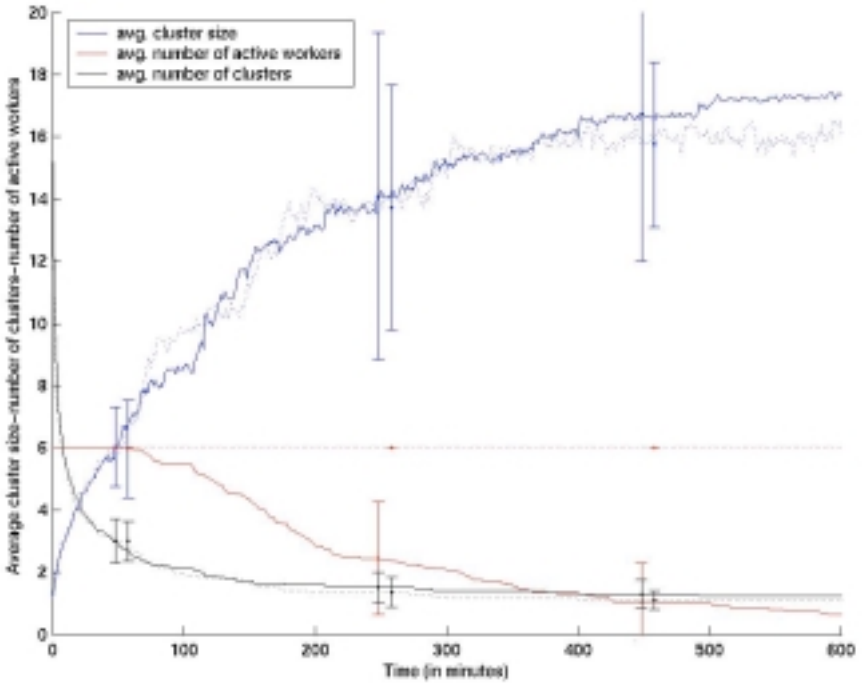


Comparing Navigation Algorithms

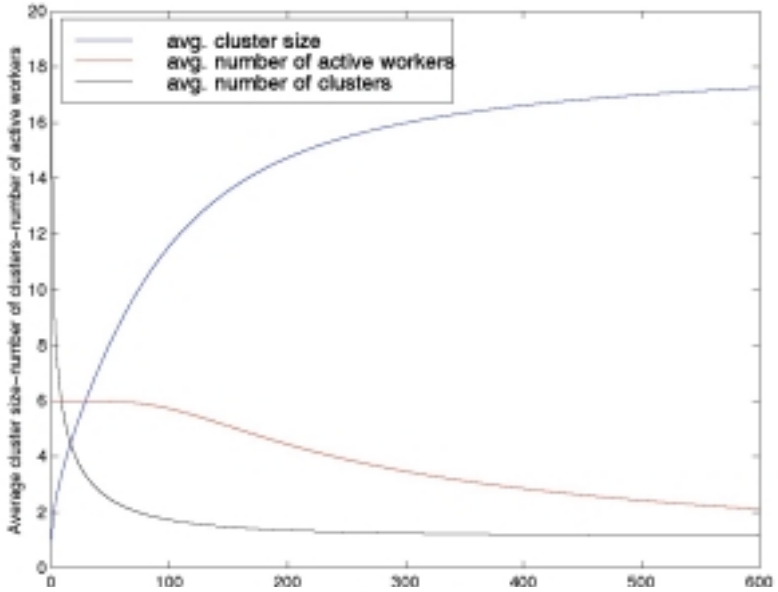


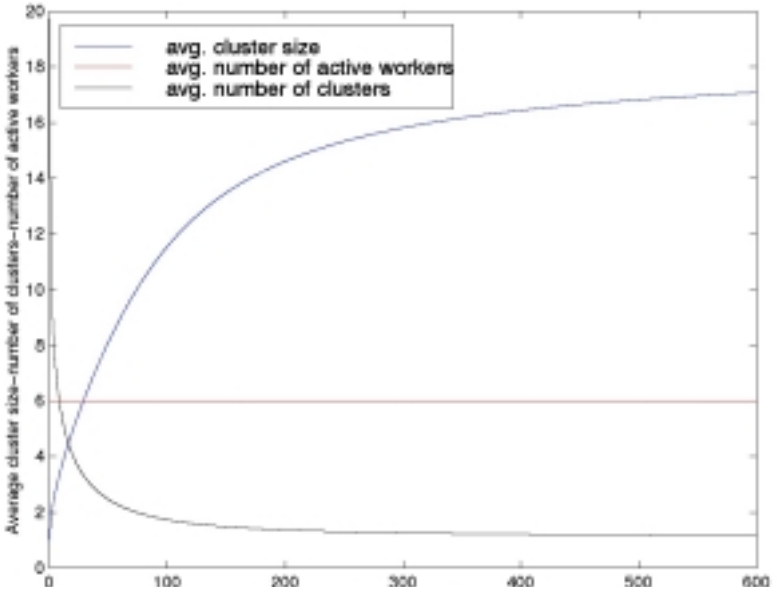


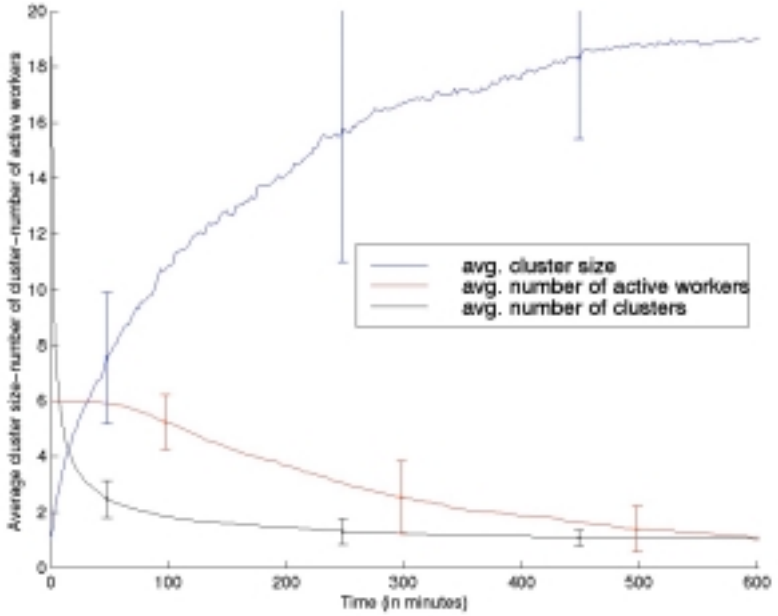


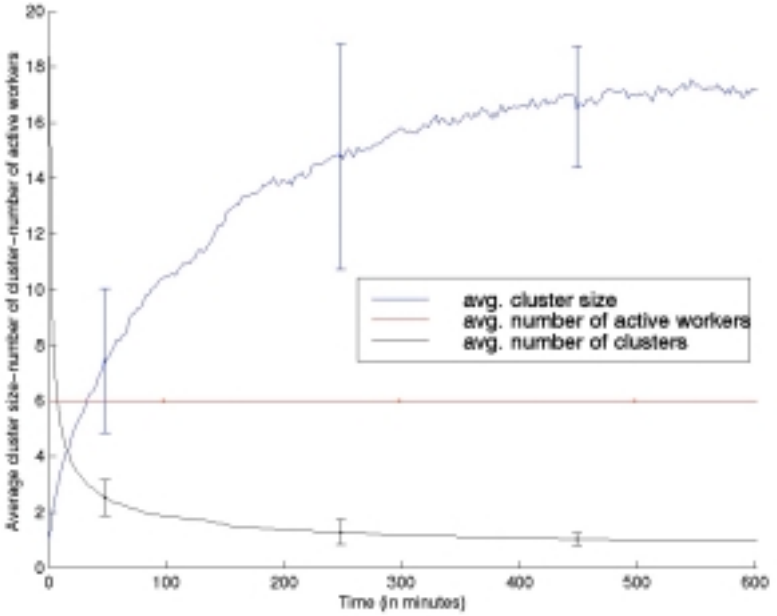


Analytical and Numerical Models (6 Robots)









Comparing Webots Simulation and Models (6 Robots)

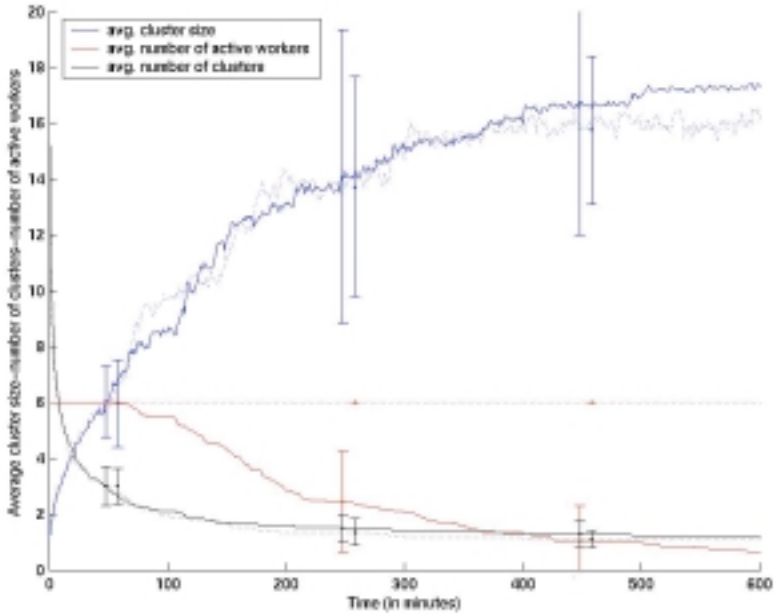
Asymptotic Average Cluster Size

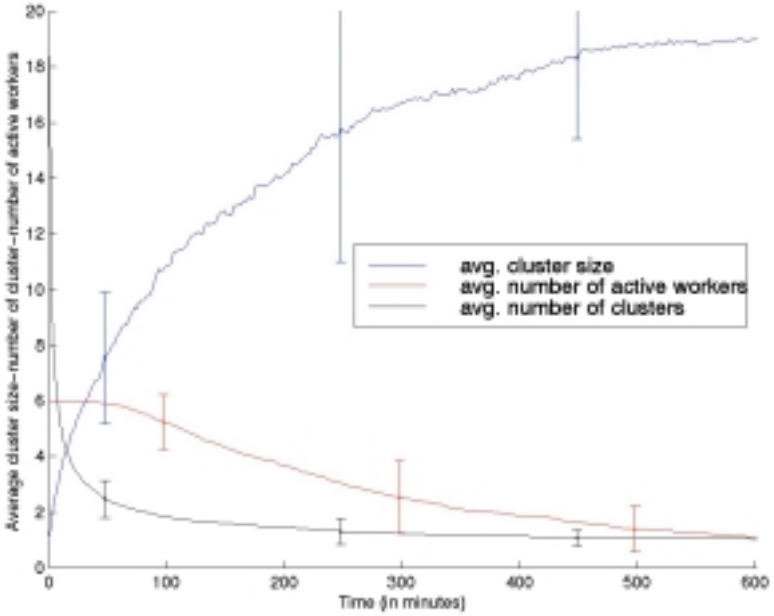
› Without Task Allocation

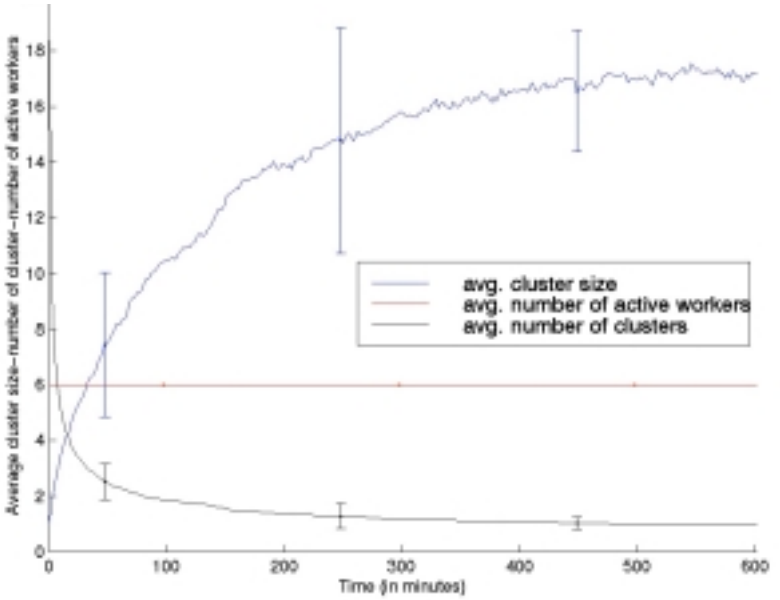
Mathematical limit:	17.19
Analytical:	17
Numerical:	17
Webots:	16

› With Task Allocation

Analytical:	17
Numerical:	19
Webots:	17







Comparing Webots Simulation and Models (10 Robots)

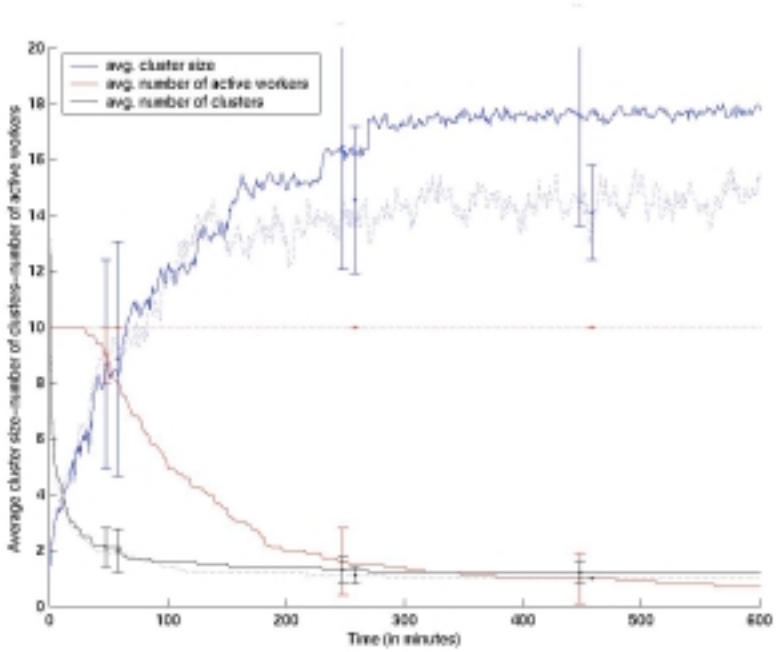
Asymptotic Average Cluster Size

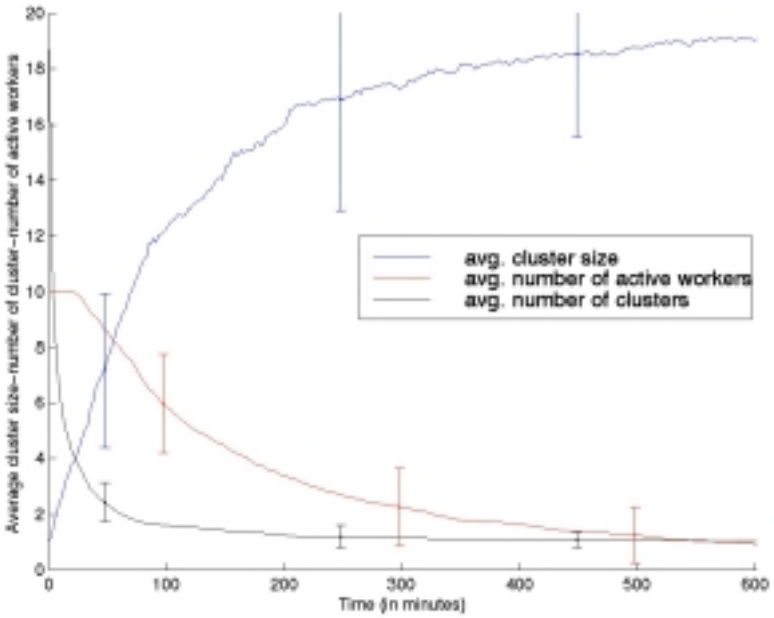
› Without Task Allocation

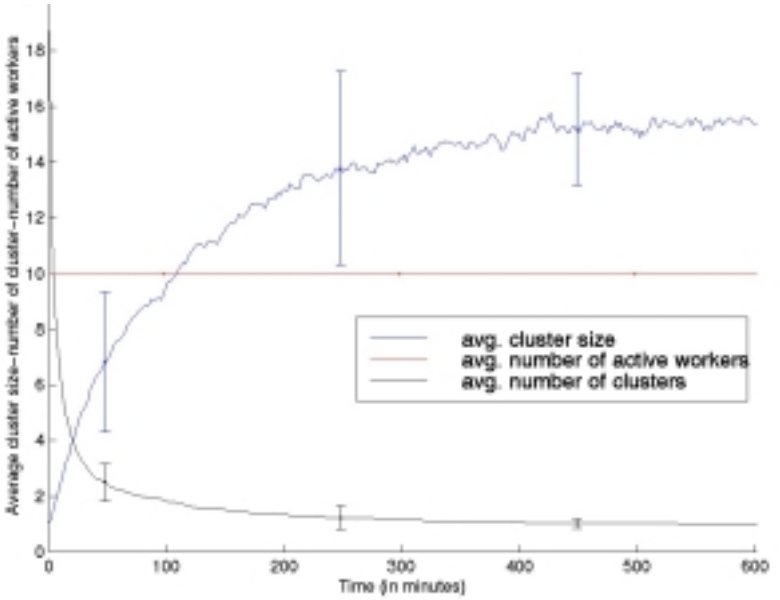
Mathematical limit:	15.40
Analytical:	15
Numerical:	15
Webots:	15

› With Task Allocation

Analytical:	18
Numerical:	19
Webots:	18







Distributed Task Allocation

Summary:

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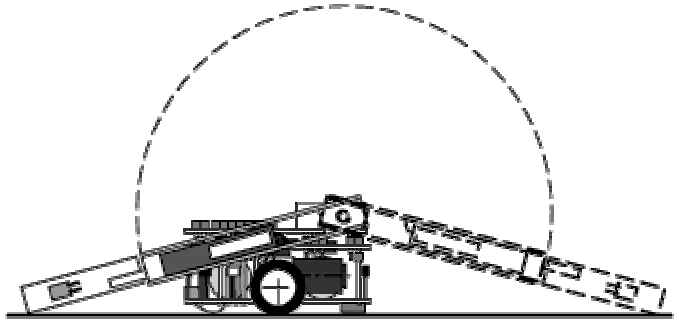

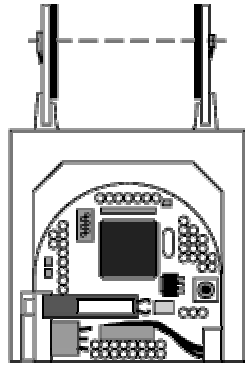

Possible Extensions

Khepera experiments:

- **The modified clustering experiment will be run using actual Khepera units with radio turrets and a powered floor.**
  - The realization of a true virtual wall will require outfitting Kheperas with sensors to detect the boundary between working area and resting area.

- **Explain observation that “straight” navigation is better than “random curve” navigation.**
  - Increase average “speed” of “curved” navigation and re-evaluate performance.
  - Develop analytical model.

- **The modified clustering experiment could be extended to include multiple tasks.**
  - Robots could decide to perform another task rather than rest; this would allow fully distributed allocation of robots for a multitude of tasks.
  - “Staged” construction could be achieved because robots would perform preliminary tasks if a “bottleneck” was reached.

- **Study heterogeneous thresholds.**
  - Use Webots implementation to study mixed teams.
  - Extend analytical and numerical models to account for mixed teams.

- **Advanced distributed task allocation algorithms.**
  - Consider dynamic thresholds.
  - More robust/useful measures of demand.
  - “Learning” appropriate thresholds; adapt to variable number of seeds, arena size, and groups.