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Fire Safety

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Simulation of Emergency Evacuation with Optimization of the Internal Configuration of the Aircraft Using Ant Colony Optimization (ACO)

Abdalla, A. M., Belo, E. M.

UNIVERSIDADE DE SÃO PAULO
ESCOLA DE ENGENHARIA DE SÃO CARLOS
DEPARTAMENTO DE ENGENHARIA AERONÁUTICA

ENGENHARIA AERONÁUTICA
USP · SÃO CARLOS

1 Introduction

- In a process of aeronautical certification of an aircraft, it is required to carry out some tests. One of those is the passengers evacuation test;

- Testing costs are high and the volunteers for that may be exposed to risks because they have no prior knowledge of the aircraft.

2 Introduction - the goal

The main goal is to select the most efficient simulation for emergency evacuation for:

- An aircraft that can carry between 100 and 150 passengers, comfortably installed;

- Minor time for emergency evacuation;

- Low external surface area and high internal volume fuselage.

3 Introduction - the algorithms

This work addresses the following optimization algorithms:

- Statistical Entropy – Parametric design by selecting the dominant configuration of the aircraft;

- Genetic Algorithm [GA] – Optimize the variables and evaluating functions;

- Ant Colony Optimization [ACO] - Find the best evacuation route in the shortest time.

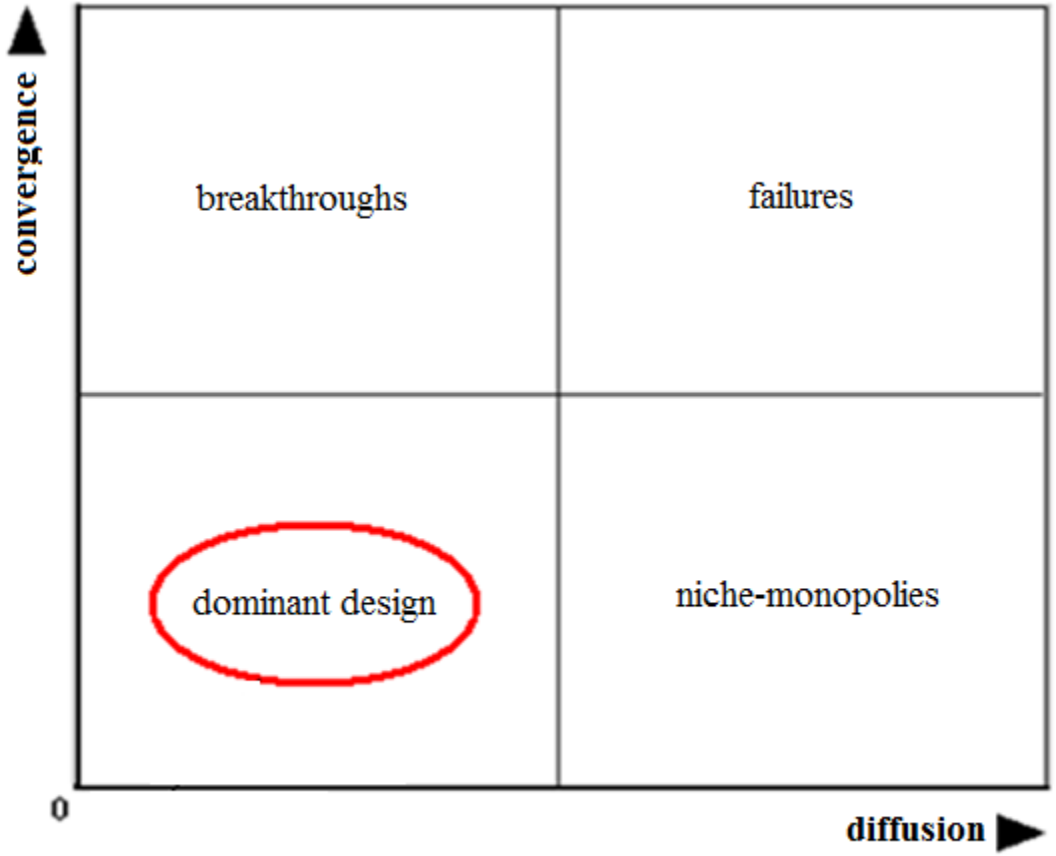
4 Genetic Algorithm

- Effective algorithm based on Natural Selection Theory;
- Each problem solution is an individual;
- Individual characteristics are encoded in “chromossomes”;
- Based on a fitness function, better individuals have best chances in the selection phases;
- Employs the concepts of crossing-over and mutation;
- After many iterations, the population converge to the fitness function maximum.

5 Statistical Entropy

- Determines the evolution curve of designs and future direction of this evolution;
- Choice of dominant designs -> Parametric Design;
- At industry level is essential to get the diffusion of design principles, and the convergence of design principles;
- A low I-value indicates a high degree of diffusion of a product design, while a high I-value indicates a low degree of diffusion.
- Similarity for values of convergence.

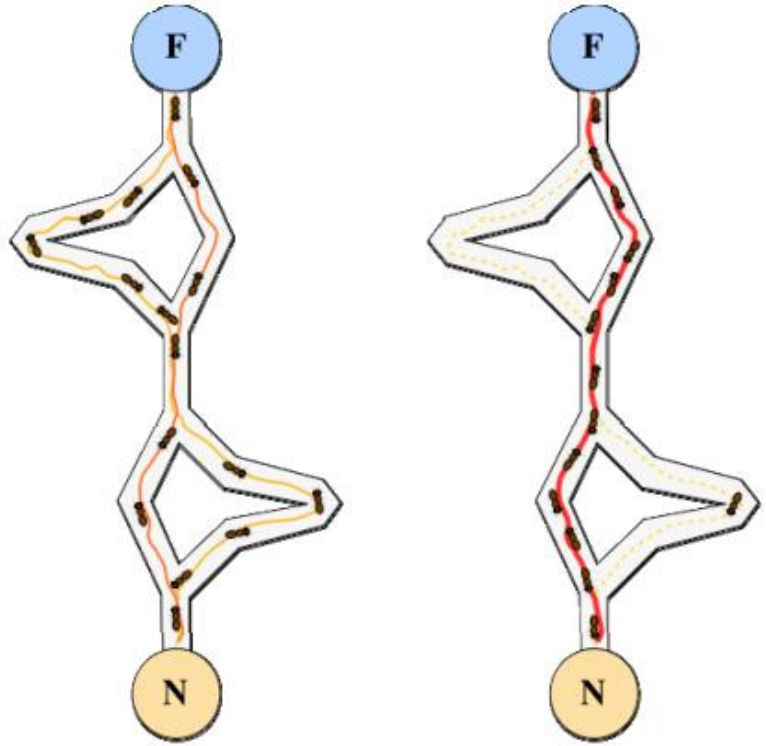
6 Statistical Entropy



Low diffusion I-value (large impact on later design).
Low convergence value (following existing designs).

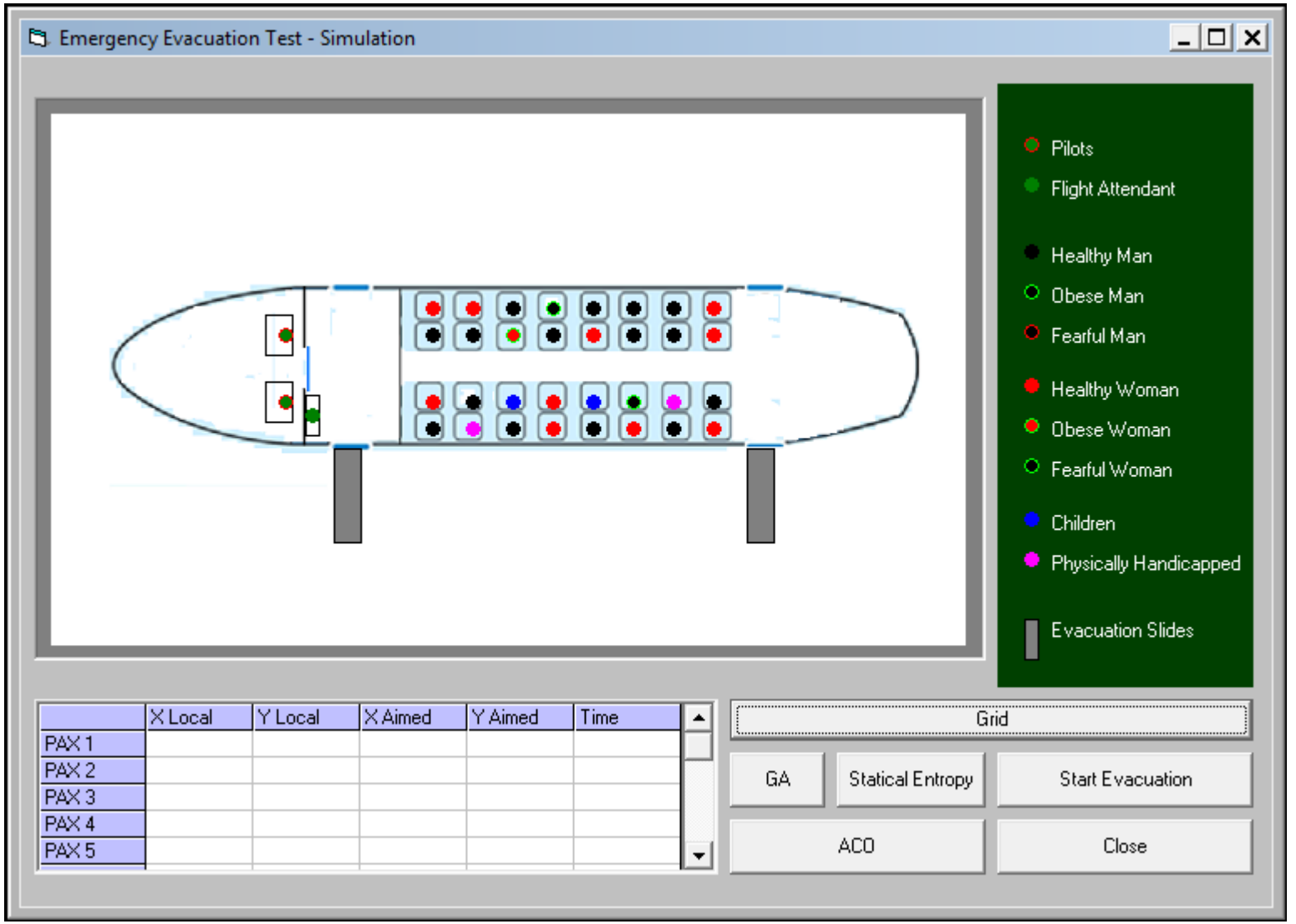
7 AEES_ACO

- Based on Ant Colony Optimization
- Used to find the best route to an exit and to simulate behavior of each passenger
- Aided by QFD



Goss et al. 1989, Deneubourg et al. 1990

8 Evacuation Software - Test



9 FAR 25 Compliance – Passenger Generation

- Each time evacuation estimation is done, a new group of passengers is randomly generated, defining physical and psychological characteristics (Following FAR 25 - Appendix J):
- Gender
- Weight
- Age
- Handicapped
- Nervous / Calm
- Fearful / Courageous

10 FAR 25 Compliance – Other Requirements

- Pre-configured distribution of carry-on baggage and other similar articles at aisles and near emergency exits;
- Time used to pass through an exit should be measured in order to feed the system and correctly simulate the test.