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INVESTIGATION OF INFLUENCE OF PEOPLE'S "HERDING BEHAVIOR" FOR EVACUATION TIME FROM PASSENGER SHIPS

„Herding behavior" of people during evacuation process is analyzed at the paper. The psychological aspect of this phenomenon and the problem of panic among the passenger is briefly discussed. Example of the analysis of the evacuation from passenger ship was done with taking into account the impact of choice of the direction of escape route.

SYMULACYJNE BADANIE WPŁYWU „ZACHOWANIA STADNEGO" GRUPY LUDZI NA CZAS EWAKUACJI LUDZI ZE STATKÓW PASAŻERSKICH

W artykule analizie poddane zostanie zjawisko „zachowania stadnego" grupy ludzi podczas ewakuacji. Pokrótce omawia się aspekt psychologiczny tego zjawiska oraz problem wystąpienia paniki wśród pasażerów. Dokonano przykładowej analizy ewakuacji ze statku pasażerskiego uwzględnieniem wpływu wyboru kierunku ewakuacji.

1. INTRODUCTION

One way to create more accurate methods to estimate the evacuation time is a detailed analysis and taking into consideration as many parameters that may affect the evacuation as possible. Parameters affecting the safe evacuation are under investigation in many centers in the country and abroad. To perform a proper analysis of evacuation time it is necessary to know the various areas of science. This comprehensive approach allows for more accurate estimation of evacuation time and taking into account the parameters that can affect the course of evacuation.

The phenomenon of "herding behavior" of people during evacuation is taking under consideration. Evacuation time is prolonged if the greater number of passengers are choosing the same path and direction of escape. Such situations are not rare, because people tend to behave collectively, willingly choose further direction on the basis of observing the actions of fellow passengers. Therefore, situations may occur when the most passengers evacuate by only one exit and block it, even though other exits are available. This phenomenon delays the evacuation and could create the panic.

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2. PSYHOLOGICAL ASPECT OF HERDING BEHAVIOUR

The phenomenon of “herding behavior” is often the subject of analysis. In [4] it is analyzed the influence of the fire for people behavior during evacuation. Especially during a poor visibility, people sometimes lose control resulting in the omission of emergency exits and optimal escape routes. People who tend to follow the crowd are susceptible to environmental influences. The study of this type of phenomenon may be helpful in the use of the positive and avoid negative effects. The second phenomenon is the tendency to crowding during the emergency.

Behavior of crowds in emergency situations is also described in [3]. Existing theories about crowd behavior can be divided into the following categories: panic, making decisions and the level of risk. The theory of "panic" focuses primarily on factors that may cause the danger of it. The main idea is that when people see the danger, conscious action is replaced by the unconscious action, which can lead to irrational behavior. The theory of "making decision” says that even a person in danger is capable of making rational decisions. In such situations, cooperation with others (eg fire fighting) may be beneficial for the whole group. The theory of "risk level" implies that the emergence of congestion depends on the type and level of danger. The risk of congestions is the grater the urgent need to leave the room.
There are three critical factors that lead to congestion:

- consequences that may be incurred in the event staying in the room ,
- time available to leave the room,
- the size of the group

In view of the fact that the crowd is a team of individuals to understand the behavior of the crowd the behavior of individuals must be first examined. From the standpoint of psychology, behavior of individuals is the result of the decision making process. In [3], individual decision-making process can be divided into the following groups:

- follow the instinct (the instinct is associated with an inherited pattern of behavior to specific external stimuli);
- follow the experience (relying on experience in decision making, one of the observed phenomena is the tendency to leave endangered places by known exit and thus does not use an alternate);
- bounded rational decision-making (not all solutions are known, and not all consequences are possible to estimate).

Man does not always have time for rational decision-making in danger, acts instinctively, or on the basis of past experience. As a result, there is a risk of irrational behavior.

Human behavior in a large group differs significantly from that when he is alone or in small groups. The decision making process is dependent on social role. On the interaction between individuals also influence social support. Examples of social support in an emergency situation is herding behavior or lake of action until someone else perform the first step.

3. PROBLEM OF PANIC DURING THE EVACUATION

The problem of panic is discussed among others in [1]. Following typical characteristics for this phenomenon were chosen:

- individuals have a tendency to act blindly in case panic escape,
- people are trying to move much faster than usual,
- people are starting to push the other, the interactions between them are starting to have a physical character,
- movement, in particular, pass through the restrictions begins to be uncoordinated,
- congestions are created at the exits, jerking and mutual interference are observed
- escape slows down as tipping or injured people can constitute an obstacle,
- people have a tendency to collective behavior, doing what others
- alternative exits are often overlooked and not used in full.

The analogy with the movement of people to gas flow when the density of people is low and they can move freely is observed. With medium or high density of the crowd analogies to the liquid or granular can be shown . In [1] it is described the results carried out over several years observing the movement of people using video cameras. In the seemingly chaotic movement of people some rules were found:

- people avoid going against the crowd, and usually choose easier path than shorter,
- people prefer to go with their own individual speeds as long as possible,
- people keep some distance between themselves and potential obstacles.

4. INFLUENCE OF EVACUATION DIRECTION CHOISE AND CONGESTION PRESENCE FOR EVACUATION TIME ON SELECTED EXAMPLE

Using the method of genetic algorithms, respectively, encoding the geometry of the routes of escape and matching genetic operators to the problem being solved by the method in [2] an analysis of evacuation time was performed , depending on the following parameters:

- initial distribution of passengers,
- choice of the direction of escape by passengers.

In the case of a possibility of choice of two evacuation routes, passengers are not distributed in proportion to the width of the escape route, but their number is selected randomly.

The analysis is performed for an example of a passenger ship, the geometry of the escape routes is written schematically as in fig 1. Typical passenger ship was matched for the analysis. It is equipped with two staircases, on which passengers follow the assembly station and the lifeboat embarkation.

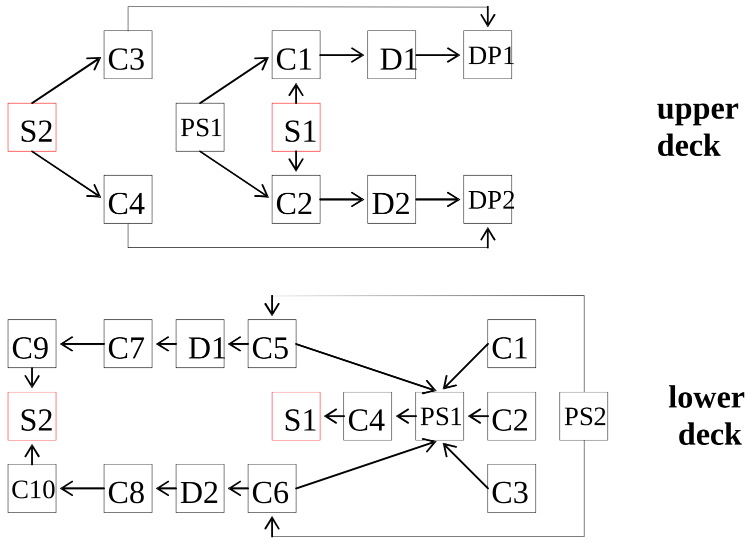

Figure 1 Schema of catamaran escape routes;
C-corridor, D-door, PS-public space, S-stairs, DP-destination point

The vessel has two decks, where 442 people reside. At the start of the evacuation the passengers are guided to the upper deck where is lifeboat embarkation

In the initial generation (the first iteration of a genetic algorithm) for different distribution of passengers and their evacuation direction choice, evacuation time varied within 529 - 829 seconds. In subsequent generations evacuation time increases. In the seventh generation the evacuation time comes to 895 seconds. In further iterations of the algorithm obtains better results in order to achieve convergence in 20 generation. Maximum evacuation time was obtained 950 seconds.

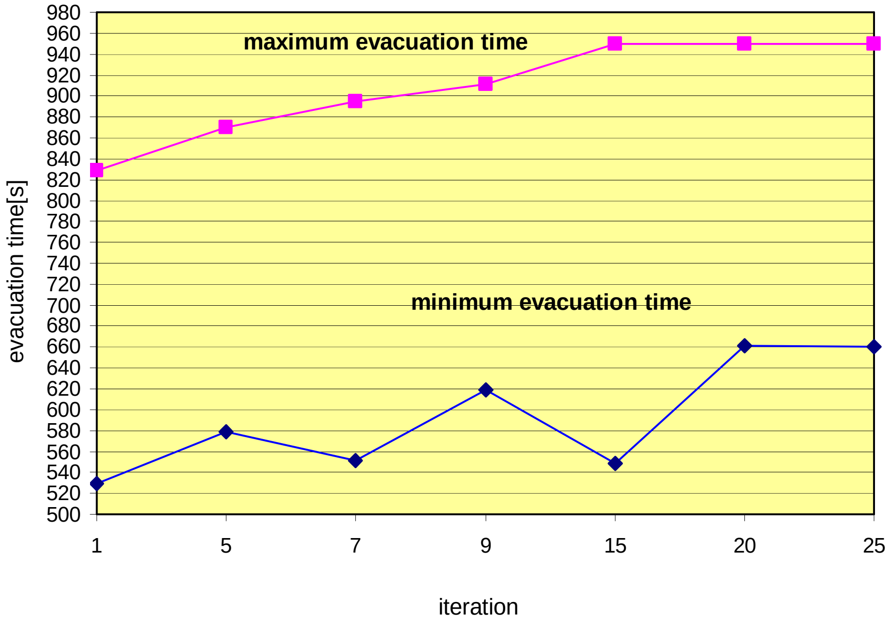

Figure 2 Minimum and maximum evacuation time for different generations

The minimum and maximum time of evacuation in the various iterations are shown at figure 2.

In comparison with the simulations described in [2], which does not include the direction of the escape route selection, there is a significant influence of this parameter for the evacuation. Evacuation time is prolonged, the algorithm is faster in the practice of good and very good results. The shortest time of evacuation was 529 s, while the longest 950 seconds, giving a discrepancy of more than 420 seconds. It can be concluded that the impact of the initial distribution of passengers, coupled with the possibilities of choosing the direction of escape has a strong influence on the evacuation. Unfavorable distribution of passengers and making the wrong choice of escape route, leading to a congestion, can lead to almost twice extension of the evacuation time.

The distribution of passengers and the number of people who follow the escape routes for the shortest and longest time are illustrated at figurers 3 and 4.

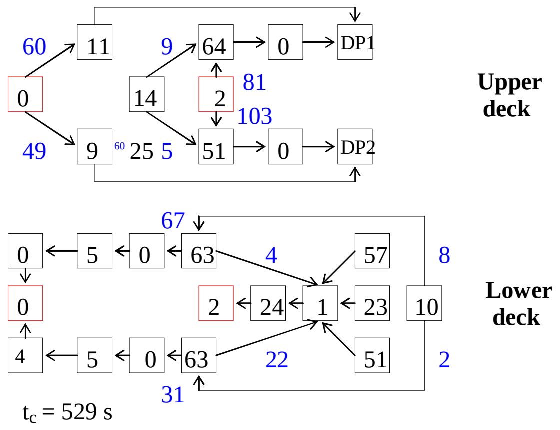

Figure 3 Distribution of passengers and the number of followers using escape routes for the shortest evacuation time.

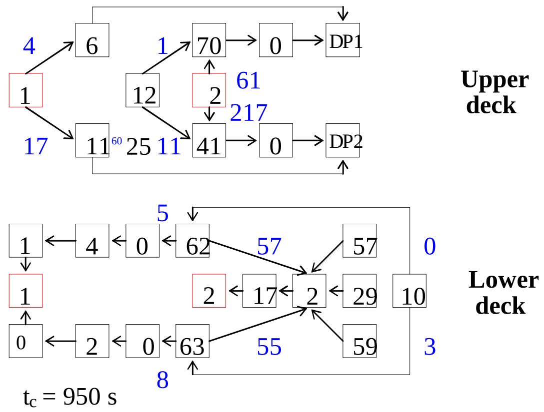

Figure 4 Distribution of passengers and the number of followers using escape routes for the longest evacuation time.

It is very often situation, when we deal with the collective behavior, that people tend to follow "the crowd". Therefore, the situations are not infrequent, when all participants of evacuation shall be guided toward one of the exits, even though other exits are available. It is therefore a significant factor in delaying the evacuation and making the congestions. It also may result in the creation of panic, which practically prevents efficient evacuation. It should be noted that these results are the result of simulation performed on one example. However, it was chosen due to the fact that it is fairly typical. A similar analysis can be performed for each fire zones of large passenger ships, each of which is equipped with at least two staircases, as well as the analyzed example.

5. CONCLUSIONS

Analysis of the possibility of herding behavior and its influence on the evacuation can make proposals how to improve evacuation. First of all, eliminate the factors that could cause panic. It may be clear and understandable messages, and appropriate management of the evacuation by crew members (they should be easily identifiable, adequately trained). The symbolism of escape signs must be matched to human perception, and of course they should be suitable distributed at escape routes. Design of escape routes is also very important. They should be simple to avoid the points where the man is forced to make a decision on the future direction of escape.

6. BIBLIOGRAPHY

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