MS ANTWERPEN:
Emergency management training for low-risk environments

Stefan Strohschneider
Jürgen Gerdes
Otto-Friedrich-Universität, Bamberg, Germany

Emergency management training programs have been developed mostly for trainees from high-risk environments such as aviation or the chemical industry. This article describes a training program for staff members from low-risk environments such as hospitals or hotels, where the awareness of potential dangers is usually low and emergency plans are often outdated or missing. The goal is to equip members of such organizations with some basic competencies necessary for effective functioning in the context of an emergency management team. The training is based on learning by doing, guided reflection, and instruction. The main training tool is a dynamic and interactive computer simulation of a passenger cruiser called MS ANTWERPEN. Participants enact different roles of this ship’s leading crew and are confronted with a number of crises and emergencies. Results of a pilot evaluation study with staff members from a large hospital confirm the expectations regarding the effectiveness of the approach.

KEYWORDS: complex problem solving; computer simulation; emergency management; low-risk environment; team; training

Decision making in highly dynamic, complex, and opaque situations is difficult. The literature on complex problem solving and natural decision making provides interesting insights into human error tendencies and has pointed to numerous traps and pitfalls we are likely to stumble into (Dörner, 1996a; Dörner & Schaub, 1994; Frensch & Funke, 1995; Klein, 1996, 1997; Strohschneider & Güss, 1999). If we translate “complex problem solving” into “management of crises and emergencies” (see, e.g., Danielsson & Ohlsson, 1997), it has become quite obvious that training and education are mandatory. After all, emergencies and crises are among those situations where deficient problem solving is dangerous and can become extremely costly on different dimensions.

During the past two or three decades, the design of training programs appears to have undergone considerable change. Basically, it was learned that many of the classical “hard skills” that are required for operational personnel need to be supplemented...
with what has been called “soft skills” when it comes to emergency management “staff work” that focuses on planning, coordinating, and monitoring operative procedures (Helmreich & Foushee, 1993; Helmreich, Merritt, & Wilhelm, 1999; Orasanu & Backer, 1996). One reason behind this development is the increasing importance of communication and coordination within and between emergency management teams (Schaafstal, Johnston, & Oser, 2001). Staff work in this area poses quite different requirements than those faced by the operational personnel directly facing the emergency. Another reason behind this development is the growing insight that crises and emergencies have the tendency not to behave as they were conceived during emergency planning. In the actual situation, concrete emergency plans often are of limited help, and nonspecific problem-solving abilities become important.

Training programs therefore follow the rationale that it is necessary to prepare people who are likely to encounter such situations with the resources and competencies necessary to meet the typical requirements of critical situations:

The aim of [training manipulations] is not to teach teams new task knowledge or skills. Instead teams [need] strategies that enable them to better manage the increases in coordination and information overhead that result from increases in workload and stress. (Entin & Serfaty, 1999, p. 316)

Quite naturally, work in this area has concentrated on high-risk environments where all sorts of nonnormal states of operation, crises, and outright emergencies have to be calculated. Typical examples include civil and military aviation (Oser, Salas, Merket, & Bowers, 2001), medical decision making (Davies, 2001), or offshore oil drilling (Flin & O’Connor, 2001; Flin, Slaven, & Stewart, 1996). In these fields, there is a general awareness of the dangers involved and the staff usually are equipped with knowledge about emergency procedures.

In contrast, the training approach that is developed in this article is aimed at people working in low-risk environments such as hospitals or hotels. Here, the awareness of potential dangers is generally low. Emergency plans are rarely updated, and even mandatory emergency procedures are treated in quite “stepmotherly” ways. Although there may be well-trained operational forces (such as security personnel or in-house fire brigades), the integration and coordination of operational measures (firefighting, evacuations, etc.) with administrative tasks and information management remains wanting. These requirements of successful emergency management are usually the task of staff that in low-risk environments is often ad hoc, ill defined, and with very limited knowledge about appropriate emergency management procedures. Because low-risk environment does not mean no-risk environment, such organizations are often overtaxed when the unthinkable happens.

Our training is an attempt to develop a learning environment that equips persons working in low-risk environments with the knowledge and skills necessary to act as members of such a staff and deal with unforeseen crises and emergencies.
Emergency management teams in low-risk environments

As reality repeatedly shows, emergencies also happen in environments that are apparently low risk. Whether these emergencies are due to a coincidence of rare events, to structural problems within the organization, or to technology changes is of secondary importance for the present purpose. However, such instances demonstrate that within these organizations sometimes even the most rudimentary concepts of emergency management are lacking.

A good example (that, by the way, triggered the work presented in this article) was a fire in the university hospital of Aachen, Germany. This 13-story hospital covers 33,600 square meters and houses about 1,500 patients, up to 6,000 personnel, and an unknown number of visitors. Within this huge building the electrical supplies are distributed through 24 vertical pits. In 1995 April, during renovation work, one of these pits caught fire. Due to a number of peculiar circumstances, it turned out to be extremely difficult to extinguish this fire and for about 2 hours it was, in fact, out of control (see Klimpe, 2001, for the details). Although in the end, any loss of life was avoided, the emergency management capacities of this organization can at best be characterized as “muddling through.” To give just a few impressions:

By pure chance the administrative, technical, and medical directors were having a meeting at the time the fire started. There was, however, no general information of an imminent crisis. One person after the other received a phone call that called him to some urgent business, with the administrative and technical directors being the last to be informed. Nevertheless, there was an emergency management staff room in the building, equipped with emergency communication technology and other necessary items. All this was locked away in solid cupboards. The keys, however, were with the house’s fire brigade, which at that time was heavily engaged in firefighting. Also, there was no clear understanding of who was to be member of the emergency management team, and in some instances, people looking competent were just grabbed from the corridors. Finally, the available emergency plan worked well for activities that were routine in character but proved insufficient as a guideline for many nonroutine activities such as organization of emergency release procedures for hundreds of patients, organization of transportation facilities, emergency operation and bedding facilities for several hundred severely ill patients that could not be released, controlling hundreds of relatives that had learned of the fire on the radio and entered the building to rescue their loved ones, or the handling of several camera teams from local stations that were roaming the house in search of thrilling pictures of flames and screaming patients.

Based on experiences like this one, it was decided to develop a program for a generally applicable emergency management training for the higher ranks of the technical, medical, and administrative sectors. Within the general framework presented above, both the literature on emergency management training (see, e.g., Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Prince & Salas, 1993, 2000) and the literature on the improvement of complex problem solving (see, e.g., Dörner & Schaub, 1992; Funke, 1995; Keys, Fulmer, & Stumpf, 1996) point to several important dimensions
that need to be dealt with. Prominent among these is teamwork, which includes communication, group decision making, leadership and team management, maintenance of interpersonal relations, and shared situational awareness. Another dimension would be the development of general emergency skills (Skriver & Flin, 1997) such as goal and task analysis, assertiveness and background control, strategic and tactical adaptability and flexibility, and performance and feedback monitoring (Ramnarayan, Strohschneider, & Schaub, 1997). Other authors stress “adaptive coordination” as a central requirement in critical situations (Dörner, 1996b; Entin & Serfaty, 1999; Serfaty & Entin, 1997) and suggest strategies to increase adaptive coordination such as preplanning, use of idle periods, favoring information transmission over action/task coordination, anticipation of information needs, and dynamic redistribution of workload among team members. Stout, Cannon-Bowers, Salas, and Milanovich (1999) argue for the critical importance of the development of shared mental models in emergency decision making. Evaluation studies (Entin & Serfaty, 1999; Salas, Fowlkes, Stout, Milanovich, & Prince, 1999; Stout et al., 1999), although still rare, have generally supported the claims with respect to the effectiveness of training programs that are based on this framework.

Regardless of whether these listings of training contents are exhaustive, it is interesting to note that they all agree on the need for emergency management teams to be trained on the teamwork- and strategy-level rather than the concrete, operational task-work level. Combining this perspective with practical considerations, the training program was to meet the following requirements:

- The training should be general, in the sense that it should be applicable not only to Aachen hospital but also to other institutions facing similar problems.
- Due to the diversity of potential trainees, it should require no special skills or knowledge—either with respect to technical background or organizational procedures.
- The general philosophy underlying the training was not to teach specific “correct” behaviors. Rather, it should aim at improving general competencies and strategies as well as insights into the necessary flexibility required by the dynamics of typical emergencies.
- The training, therefore, should focus on both team competencies and on strategic approaches to dealing with uncertainty, time pressure, and dynamic developments, as well as problems of handling and processing of information in stressful situations, as described in the literature on complex problem solving.
- The training should combine elements of experiential learning, reflexive learning, and knowledge inputs (see below), because this combination was hoped to yield the highest efficiency in training results.
- In light of organizational considerations, the time frame for the training was fixed at 2 days.

To summarize, the training should improve participants’ team competencies and knowledge about different functions of a team and their decision-making behavior in complex and dynamic situations as well as their abilities to avoid typical errors in emergency management situations (see also Salas, Prince, et al., 1999). To meet these goals, a “playground” was needed that would provide the opportunities for experiential learning (Kolb, Boyatzis, & Mainemelis, 2001). Structurally, this playground needed to be similar to the participants’ professional background in order to promote...
transfer from training to reality. On the other hand, the playground needed to include sufficient elements of novelty and unexpectedness, of dangers and emotional involvement, in order to make the training environment sufficiently realistic (Fowlkes, Dwyer, Oser, & Salas, 1998). It was decided that a passenger ship would be an ideal candidate to combine these two conflicting requirements. A passenger ship, like a hospital, is a complicated spatial structure combined with a complex technical system. There is a distinction between caregivers and caretakers, and there are different functions that need to be fulfilled on the side of the caregivers. Finally, both types of organization operate in relative isolation from their surrounding environment. Therefore, we developed a low-fidelity, interactive computer simulation (Prince & Jentsch, 2001) of a passenger ship, which was subsequently baptized the MS Antwerpen. In the following section, the ship and the rationale underlying its construction are elaborated.

The training environment: MS ANTWERPEN

MS ANTWERPEN is the simulation of a relatively old passenger cruising vessel with a length of 149.7 meters and two engines that allow for a cruising speed of 17.5 knots. It has seven decks and room for 300 passengers and 193 crew. It was built in 1947 and, after a series of ownership changes and reconstructions and renovations, it is now owned by a Panama-based line that runs it as a cruiser for passengers from the east and southeast European countries. The ship is not completely modern but generally well equipped for its purpose. For the passengers, there are restaurants, lounges, bars, and many other facilities. In terms of technical equipment, the ship has, besides the two main engines, two auxiliary engines and an emergency diesel aggregate, all the necessary pumps, and supply aggregates. The navigation and safety equipment is complete, including eight lifeboats, large numbers of life rafts and life vests, and waterproof bulkheads. Although MS ANTWERPEN is a fictitious ship, in its structure, technical equipment, building history, and so on it is a combination of several passenger cruisers that in fact existed and are described in the maritime literature.

Although we have introduced the simulation as “low fidelity,” it is in fact quite complex. All the structural and the major technical aspects of this cruising ship were included, matching the real conditions as closely as possible. The same is true for the ship’s environment (sea, weather, and wind conditions, traffic). Most important, however, all 300 passengers are simulated individually, using a coarse human-factor model (see Figure 1). Each passenger belongs to one of several role categories that determines the pattern of his or her activities on board. Beyond this role level, each passenger is described by his gender, age, current position on board and intended destination, his physical status, and his degree of worry or fear. The latter variables are dependent on the environmental conditions (passengers get seasick), the ship’s technical status, and any crises and emergencies. The passengers, therefore, are autonomous agents, and their behavior reflects the crew’s control over the ship. In case of danger, for instance, passengers tend to leave their cabins and cluster in the higher and more backward sections of the vessel; in a severe crisis they may even panic, mount lifeboats or
jump overboard. If any passenger’s physical status drops below a certain threshold, he or she becomes unable to move, does not follow any commands, and, in case of, for example, a fire, has to be salvaged by crew members.

It is the participants’ task to safely navigate their vessel through a stormy night in the north Atlantic Ocean, heading south from a position near the southern rim of the Grand Banks, some 320 nautical miles off Halifax, Nova Scotia. Due to the adverse conditions and because the ship is old and it is the end of a long season, the crew has to deal with different passenger-related problems and several technical failures that in the end may result in an outright state of emergency.

The simulation is designed for a group of 5 to 7 participants who take command of the ship. Each participant plays a specified role within the typical functions of a
passenger vessel’s leadership, namely, the captain, the first officer, the first engineer, the chief steward, the ship’s doctor, the navigation officer, and the first machinist. Each participant is given an introductory note that describes the general features of the ship, the current situation, and the group’s task. Additionally, each participant is given specific materials that contain the information needed for his or her role. There is, for instance, general nautical information, a detailed description of the ship’s technical features and functions, crew and passenger roles, and safety regulations. The captain has, of course, direct access to all information. Also, there are a number of maps as well as technical and structural blueprints available for the participants.

The participants are given sufficient time to read through their materials and clarify questions before the simulation is started. The simulation program is handled by a facilitator, and most of the communication between the crew and the ship is done by printouts that constantly provide the standard information that would be available an a ship’s bridge (course, speed, wind and weather conditions, radar, smoke detectors, etc.). These data are printed every real minute. Additionally, a complete overview of the ship’s technical status is printed every 7:30 minutes (the simulation compresses time; 1 minute real time equals 2 minutes ship time).

For the participants, this means that they have to deal with a considerable amount of distributed information of initially unclear relevance. Of course, they can also request all information they might need directly from the facilitator. For additional stress induction, we use an old line printer that is almost constantly producing disturbing noise. The printing facility is also used for incoming cables (from, e.g., the shipping company, Radio Halifax, and other vessels in the vicinity) as well as messages from within the ship (technical information, passenger complaints, crew information, alarms). There are prefabricated messages of all sorts, which can be sent to the printer at any time during the simulation. To further increase the feeling of realism, one can have the sounds of wind and seas coming from a compact disc player.

To sail the ship and handle the upcoming events, the participants have a wide variety of action possibilities. They can, of course, steer the ship, and they have complete control over the technical facilities, including maintenance and repairs. They can also influence the members of the crew (working and not working), and they can give all kinds of orders relating to the passengers (including, e.g., sending drunken ones to their cabins, closing sections of the ship for passengers, or having them man the life rafts and lifeboats). However, participants are not provided with a list of possible actions but have to develop them among themselves and find out about necessary prerequisites, lead times, and side effects.

The participants, therefore, find themselves in a dynamically developing situation of high uncertainty, informational overload, and a vague anticipation of dangers. They have to try to understand and steer the ship, deal with unforeseen events, and organize the work among themselves—all at the same time. In terms of psychological demands, this situation is quite similar to the situation they would face in managing a real emergency.
Structure of the emergency management team training

The complete 2-day training program was designed to meet the goals described above. It basically follows a five-step structure. In Step 1, participants collect first experiences with emergency management during a trip on the MS ANTWERPEN. Following an extended guided reflection (Step 2), participants are instructed about the basic elements of successful emergency management (Step 3). Then, there is a second trip on the MS ANTWERPEN (Step 4), and the training is rounded up by a guided reflection on this trip (Step 5). In the following sections we elaborate on these steps.

Emergency management on the MS ANTWERPEN, first trip

Because participants often have only very coarse (and sometimes wrong) preconceptions about emergency management, the first trip on the MS ANTWERPEN is designed to provide some preliminary experiences in emergency management, the basic requirements and the various difficulties teams are facing. It is important in this opening phase to make it clear to the participants that effective emergency management does not come naturally but has to be learned and trained.

The duration of the first trip is roughly 3 hours. The scenario starts with a rather tame and quiet first hour, intended to give participants the opportunity to make themselves acquainted with the ship, information and data flow, and action possibilities. Then, participants are confronted with a sequence of events that gradually increase in frequency, importance, and gravity. Some of these events are failures of technical systems, others are related to passenger complaints or passenger misbehavior, and still others have to do with nautical problems and traffic en route of the vessel. Finally, a fire starts in the printing shop on one of the lower decks, which, due to simultaneous technical malfunctions, is extremely difficult to extinguish and usually requires evacuation and abandonment of the ship with loss of (simulated) lives.

Guided reflection of the first session

After this opening session, several failures and shortcomings of their “unarmed” teamwork are usually obvious to the participants, and some time is needed to evaluate and digest this experience. In the reflective process, participants are asked to discuss their experiences with respect to the structure of the emergency management team, the procedures developed in the course of the process, communication, and soft factors (such as strategic approach, general mind-set of the team, reactions to stress and failures). The rationale underlying this second step is twofold. First, it is critical that the participants understand why they could not save the ship and what they could have done better. And second, any knowledge and insight generated from within the group conveys an increased sense of competence. The questions guiding this reflective process are designed in a way that helps participants to find an appropriate level of analysis and not, for instance, to engage in scapegoat hunting.
Knowledge input: Basic elements of successful emergency management

During this seminar-like third step, the results of Step 2 are collected and summarized. Additionally, participants are instructed about the basic do’s and don’ts of emergency management. Special emphasis is given to transferring the most relevant topics from high-risk-environment trainings (team structure, distribution of workload and communication, development of shared mental models, development of proactive strategies) to the participants’ low-risk background. During this step, it is certainly not possible to transform participants into emergency management experts. It should, however, achieve an increase in the participants’ sense of competence toward critical situations; it should increase their feeling that a real crisis would not render them completely helpless.

Bringing new insights to work: The second trip on the MS ANTWERPEN

This second trip is somewhat shorter than the first one; it is designed in a way that allows the participants to try out and practice the knowledge and procedures they have learned during the first phases. The ship and the general setup is identical to Step 1; the scenario, however, differs. The sequence of events participants have to deal with starts earlier and the events are of different character. Besides the typical technical problems, passenger-related problems require more attention. For instance, one passenger suffers a severe heart attack that cannot be handled onboard the ship. Therefore, a decision has to be made whether to stay on course or turn west to meet a search-and-rescue helicopter off Halifax. There are many more incoming cables and the general workload is higher. Again, there is a final fire, which is, however, easier to handle than the one in the first trip. The idea is to give participants a fair chance to end this trip with a positive experience of success, which should make it easier for them to accept the contents of the training program.

Guided reflection of the second trip, transfer discussion

This reflexive phase concentrates on the changes between the first and second trips. Participants are asked to formulate their personal views of the key issues involved and discuss how these could be used or implemented in their organization in order to improve the organization’s reaction to a possible emergency.

Evaluation of the training program: First results

Design

Because the feedback that was informally collected during the development of the training program was positive, it was considered appropriate to evaluate the training program in a more systematic and controlled manner (Holt, Boehm-Davis, &
Beaubien, 2001; Salas, Burke, Bowers, & Wilson, 2001). The design of this study utilizes the structure of the training program. It is based on a comparison of the participants’ behavior in the first and second trip with the MS ANTWERPEN. If the training was indeed effective in the intended direction, there should be visible effects on several levels: There should be (a) a better coordination of activities within the team, with faster reactions to crises and less decisional slack or decisional friction losses, (b) improved communication patterns, resulting in (c) an increase in control over the ship and less severe consequences of technical problems, failures of all kinds, and fires.

To be able to observe these effects, two groups of participants completed the full training program as described above. The two sessions with the MS ANTWERPEN were videotaped with two cameras; these videos were later transcribed and evaluated. The scenarios were the ones described above, and the sequence of events was identical for all groups. All system data from the ship were stored. Participants in these two training groups belonged to the higher levels of the administrative, technical, and nursing staff of the Aachen University Hospital and thus represented the clientele the training was originally developed for. Both groups consisted of 7 participants (men and women), each of whom participated voluntarily. The age range was 26 through 50 years, and most of the participants had an academic education.

To be able to control for the effects of increased gaming experience, a third group was formed. This control group completed both trips in 1 day, with an extended lunch break in between. This group received no training and there was no guided reflection after the first trip (there was, however, an extended debriefing following the second trip). Therefore, any behavioral changes in this group’s crisis management can be attributed to their improved competencies in riding the ship and controlling the simulation. Because one can expect these gaming effects to be strongest among younger people with a solid computer gaming background, the control group was made up of psychology students from Bamberg University.

The results are presented in three groups, namely, (a) a descriptive comparison of critical phases during the process, (b) results from the interaction analysis, and (c) simulation data.

**Descriptive analysis of critical phases during the trip**

To get an overall impression of the changes in the participants’ emergency management behavior, we prepared free descriptions based on the videotapes and the computer protocols, using the interpretive framework provided by the crisis management theory mentioned earlier. Because there are certain phases that are relatively similar in both trips (such as the initial orientation, technical crises en route, and the final fire), descriptions of parallel phases can be compared directly. We prepared several (rather lengthy) descriptions for each group and for several phases in the course of the simulated journeys. Due to limitations of space, it is impossible to present the complete material here. Nevertheless, we found the differences interesting enough to present two such descriptions, using two similar phases from the first and the second trips from Training Group 1:
First trip: The small fire. The situation: After 70 minutes of playing time (140 simulation minutes), while the crew is busy with some minor technical problems, a smoke detector indicates that there is a fire in a passenger cabin, caused by a passenger smoking in his bed (this fire gets extinguished quickly by the automatic sprinkling system). A few minutes later MS Ariadne, a fishing vessel in the vicinity, radios that her radar equipment is down and asks all ships for course and speed information.

The reaction: The captain tries to act quickly and decisively. He informs the other crew members about the smoke detector alarm, gathers additional information, and gives orders. His orders, however, are so global that nobody knows who is supposed to do what. The first engineer loses precious time in collecting information the captain already has. The captain apparently perceives the situation as dangerous and threatening; his tone toward the other participants becomes harsh. The MS Ariadne problem distracts the group's attention from the fire and it is the first officer who, after a couple of minutes, reminds the group of its existence. Upon this intervention, it is detected that nobody has actually sent crew down to the cabin to check on and extinguish the fire because it was unclear who was responsible for that order. Before the captain finally gives the appropriate commands, he spends considerable time defending himself before the group. He appears extremely stressed, and nobody thinks about, for example, informing passengers, controlling whether passengers need to be evacuated, or monitoring neighboring cabins for a spread of fire. Another message coming in (some passenger complaint) again distracts the group's attention. Two minutes later, after a message has been issued regarding the complaint, everybody is returning to his routine responsibilities although the smoke detector is still on. Only the captain seems to still at least think about the fire, but because the group ignores it, he is not giving any additional orders, and after the smoke detector goes off a few minutes later, the passenger causing the fire is offered free drinks in one of the bars.

Second trip: The small fire. The situation: After about 90 minutes into the second trip (178 simulation minutes), a similar fire happens in another passenger cabin. During this period, the crew has to deal with a heavy workload due to different (minor) problems and duties. There are, however, no distractions.

The reaction: The captain, upon learning about a smoke detector signal, immediately asks the group for assistance. Together with the chief engineer and the first officer, he quickly locates the room on the blueprints and a number of decisions are made in quick succession, including the evacuation of the neighboring cabins and the setting up of a fire watch in these rooms. The captain asks the chief steward (who is comparatively free of other chores at this moment) to join the group and appoints him the person to pass on all orders concerning this fire. Following a suggestion from the chief engineer, the air conditioning is switched off in order to stop the inflow of oxygen into the critical area. After these initial steps, the captain (who appears to be comparatively calm) informs the rest of the team about the situation and their decisions. Then they redistribute responsibilities. The chief engineer is responsible for the direct firefighting, the chief steward passes on all orders, and the captain surveys all activities and incoming information. After the fire in the cabin gets extinguished, the captain
calls a meeting for the full team. During this meeting, additional preventive decisions are made, including the continuous monitoring of the affected area and attempts to find out the reasons for this fire in order to be able to fight other possible fires more efficiently.

From a comparison of the behavior of the same team during two similar emergencies, it is obvious that in the second instance the group’s crisis management is much more swift and effective. This effect may be partly explainable by the greater familiarity with the situation, but it appears also to be due to a more analytic approach, improved communication, organization of work, information of other team members, and proactive decision making. The reflections on the first trip and the development of appropriate crisis management procedures seem to have strengthened the feeling of efficacy of the team members, which in turn helps to maintain a positive group climate and a sense of mutual assistance.

**Interaction analysis**

The interaction process in the groups was analyzed using the KatKomP category system for complex problem solving behavior (Badke-Schaub & Stempfle, 2001). All verbal behavior was coded as either belonging to “content,” “process,” “relationship,” or “rest”; with each of these broad categories divided into a number of more precise subcategories. The authors report interrater reliabilities of .87 for the broad categories and between .66 and .68 for the subcategories.

According to Fisch (1994), who analyses the interaction of discussion groups, effective group behavior should consist of about 25% to 30% of process-oriented interactions, 40% to 60% of content-oriented interactions, and up to 20% relationship management. Badke-Schaub and Stempfle (2001) argue that in groups engaged in dynamic problem solving, the distribution should be roughly two thirds content-oriented interaction and one third process-oriented interaction, with only a very small percentage of relationship management. This latter proposition is certainly valid for teams in emergency management where relationship-oriented communication should usually be postponed until after the emergency. Table 1 shows the relative frequencies of these basic categories for all three groups and both trips.

**Table 1:** Interaction Analysis for Two Training Groups and One Control Group: Comparison of the Distribution of Verbal Behavior Categories (percentages) During the First and the Second Simulation

<table>
<thead>
<tr>
<th></th>
<th>Content</th>
<th>Process</th>
<th>Relationship</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Training Group 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip</td>
<td>70.9</td>
<td>23.6</td>
<td>4.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Second trip</td>
<td>64.4</td>
<td>31.8</td>
<td>2.9</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Training Group 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip</td>
<td>65.3</td>
<td>28.0</td>
<td>5.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Second trip</td>
<td>56.8</td>
<td>36.0</td>
<td>6.9</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip</td>
<td>68.4</td>
<td>24.0</td>
<td>7.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Second trip</td>
<td>62.5</td>
<td>19.1</td>
<td>16.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>
In both training groups there is a clear difference between the first and second trips: The frequency of content-oriented interaction decreases, whereas the frequency of process-oriented interaction increases. In the second trip, both groups come close to meeting the Badke-Schaub and Stempfle criterion, an indication that the teams as such are better integrated. Also, in both training teams relationship-oriented communication is comparatively rare—in most instances it is simple gossip and kidding in phases following tense work.

For the control group, the picture is different. During the first trip, the relative frequencies of these four categories are comparable to the training teams. During the second trip, the control group also has a slight decrease in content-oriented interaction. There is, however, also a decrease in process-oriented interactions, compensated by a sharp increase in relationship-oriented communication. This pattern is typical for teams that function at low levels of integration.

It is also interesting to look at the communication patterns from the perspective of distribution of information. In a functioning team, specific information should be distributed among the team members according to their role, whereas important information should be shared among the whole team to enable team members to develop a shared mental model (Stout et al., 1999). We therefore analyzed how often each person was addressed by the other team members. Figures 2 and 3 show this distribution for the two training teams.
For Team 1, we notice a very uneven distribution during the first trip. Three individuals (1, 2, and 3) are addressed in more than 55% of all instances and one person is pretty much sidelined. Only 9% of all utterances are addressed to the whole group. During the second trip, the picture changes. Participant 6, who was dissatisfied with his role in the first trip, became captain, and now he is the person who is addressed in roughly 20% of all instances. The rest of the discussion, however, is much more evenly distributed, and the information given to the whole group rises to 13.3%.

For the second team, the distribution of being addressed is more even than for the first team and, because there were no role changes, similar in both trips. Still, the information given to the team increases from roughly 12% to 18.4%. Overall, these data allow for the tentative conclusion that the communication patterns in both groups improved considerably during the training process and came much closer to what is considered necessary for effective crisis management.

Simulation data

Given the tendencies described so far, it is interesting to take a closer look at what the participants actually did to the ship and its crises and emergencies. During the simulation, all relevant system data are written to a file that allows for a complete reconstruction of the trip, the participants’ questions and decisions, and so on. With respect to evaluative purposes, the following dimensions are of special interest:

- Overall state of the technical system: This variable represents the mean state of all technical equipment on board (engines, machines, pumps, etc.) and is a coarse representation of the participants’ control over the vessel itself.
Worry or fear of the passengers: The worry or fear status of the passengers is dependent on the state of the technical system, the rolling of the ship in wind and weather, the functioning of the public utilities on board, and so on (compare Figure 1) and thus represents the degree to which the main objective—a safe and pleasant journey—is accomplished.

Total number of burned cabins and other rooms: In both scenarios, fires develop. If these are not extinguished fast enough, they can spread and ignite neighboring cabins, halls, staircases, and so on. The number of burned rooms represents the team’s fast emergency management ability and therefore the degree to which the ship could be saved from these fires.

Loss of life: Lives can be lost if passengers or crew are trapped in burning segments, if they are forgotten when the ship is evacuated, or when passengers jump overboard in case of panic. Thus, this variable is an overall success-indicator.

Table 2 presents the results for these variables for both trips with the MS ANTWERPEN for all three groups. For the first two variables, the values of the more difficult second half of each trip are given separately.

Given the starting value of 100, there is some decay in the state of the technical systems for all three groups and both trips. Comparing the first and the second trips, there is a slight improvement, again for all three groups. For this variable, Training Group 2 shows the largest improvement, but also had the largest difficulties in dealing with technical problems during Trip 1. As the data for the second halves show, technical problems usually get worse toward the end of the simulation. During the second trip, this deterioration is largest for the control group.

The differences between the groups in terms of passengers’ worry or fear level are more pronounced. Generally, fear increases during the second half of each trip. For both training groups, the fear level is much lower during the second trip, and the increase during the later phase is only marginal. In contrast, the training group has a higher fear level during all phases of the second trip.

### Table 2: Analysis of Major System Data: Comparison of the First and the Second Simulation; Aggregated Values for Full Sessions and the Second Half of Both Sessions (Only Technical State and Worry or Fear Level)

<table>
<thead>
<tr>
<th></th>
<th>State System (average)</th>
<th>Worry or Fear Level (average)</th>
<th>Rooms Burned (total)</th>
<th>Loss of Life (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip, overall</td>
<td>94.10</td>
<td>39.20</td>
<td>379</td>
<td>89</td>
</tr>
<tr>
<td>First trip, second half</td>
<td>93.83</td>
<td>47.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second trip, overall</td>
<td>94.19</td>
<td>31.70</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Second trip, second half</td>
<td>94.20</td>
<td>32.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training Group 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip, overall</td>
<td>92.46</td>
<td>42.00</td>
<td>376</td>
<td>82</td>
</tr>
<tr>
<td>First trip, second half</td>
<td>91.91</td>
<td>52.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second trip, overall</td>
<td>93.59</td>
<td>32.20</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Second trip, second half</td>
<td>93.37</td>
<td>33.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First trip, overall</td>
<td>93.31</td>
<td>41.60</td>
<td>386</td>
<td>39</td>
</tr>
<tr>
<td>First trip, second half</td>
<td>93.53</td>
<td>51.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second trip, overall</td>
<td>93.38</td>
<td>41.93</td>
<td>373</td>
<td>38</td>
</tr>
</tbody>
</table>
With respect to burned rooms, the final fire is really a final one in the first trip. It destroys almost the complete structure of the ship, and this result is practically identical for all three groups. In the second trip, the final fire is objectively less dangerous and both training groups manage to extinguish it with comparatively little damage done. This is different for the control group, who suffers almost the same fate as in Trip 1. For loss of lives the picture is similar. Both training groups lose considerable numbers of passengers and crew during the first trip and no one during the second. For the control group, this figure is smaller during the first trip and remains identical during the second. This is an interesting result because it is due to the fact that the control group decided in both instances to completely abandon the ship, which in turn indicates this group’s low feeling of control.

Overall, the data indicate that both training groups indeed are able to better manage the crises and emergencies that they encounter on the second trip—not only in comparison to the first trip but also in comparison to the control group. Although there are no differences between training and control groups in the first simulation session, these differences are remarkable in the second one. The training group is not able to improve their emergency management behavior, indicating that the development of both training groups is not attributable solely to gains in gaming competence.

Summary and discussion

Emergency management is usually performed by experienced and well-trained experts. The rationale behind the training approach that is described in this article is a different setting: Organizations that are considered low risk but that nevertheless run a chance to encounter grave emergencies (such as fires, chemical contaminations, or bomb threats) with the possibility of sizeable numbers of casualties and material damage. Examples for this kind of organization include hospitals and hotels.

The target group for the current training approach is staff members from such organizations who due to their position within the organization are likely to become members of an ad hoc emergency management organization formed to deal with such an instance. In many cases, the emergency plans of such organizations are outdated and way too specific to be of much help in the given situation. Therefore, dynamic decision making in an opaque situation is required from the emergency managers. However, these staff members usually have neither experience with nor knowledge of procedures and structures that would increase the likelihood of successful emergency management.

Following a survey of the relevant literature, a 2-day training program was devised that aims to provide staff members belonging to the target group with some basic knowledge and skills necessary to function effectively and within the context of an emergency management team. The training focuses on emergency management team structures, appropriate procedures within the team, team communication, and the development of a helpful mind-set, including strategic preferences. The training itself is based on a combination of instruction, learning by doing, and learning by reflection.
The tool used for the learning-by-doing part is the interactive and dynamic computer simulation of a passenger cruising vessel called MS ANTWERPEN. Participants steer this ship through a stormy night in the North Atlantic, playing different roles of the commanding crew. During the night, the ship encounters several hassles, crises, and a final severe emergency. This setup is devised in a way that simulates a typical emergency management situation structurally—which means that the requirements in terms of handling information, structuring tasks, communication, and decision making are similar to those of a real, unplanned emergency without being specific only to one type of organization or one type of emergency. At the same time, this process does not require any special technical knowledge.

First attempts were made to evaluate the effectiveness of this training program with staff members of a German hospital that has encountered several such emergencies and has developed awareness of the necessity of improving emergency management skills within the organization. The evaluation basically consisted of a comparison of the groups’ behavior and success during two trips with the MS ANTWERPEN that were run at the beginning and at the end of the training program, realizing different events in different order. Most notably, the groups’ behavior during the first simulation session underlined the necessity of such a training approach. A more formal analysis of different sets of data indicated that the trained teams were able to improve their communication patterns, team structure, and distribution of work, as well as their actual control over the ship. The comparison with a control group that did not receive any training allows for the tentative conclusion that these positive effects are attributable to the training process and not merely a result of improved gaming competence due to the repetition of the simulation.

It is not known how generic the data presented is, as we did not conduct a full-scale evaluation study and the groups observed differed in more than one aspect. Therefore, the available database needs to be increased and the emergency management competencies of trained groups need to be tested outside the seminar room. Because real crises (which would allow for on-the-job observations) are fortunately rare in our focus environment, some relevant outside criterion should be utilized. Currently, we plan such a study using a traditional (paper-based) staff exercise from the public sector as criterion.

It would not be very prudent to try to disentangle the different components of this training approach and ask for their relative contribution toward behavioral changes. Yet, the results presented in this article corroborate other findings about the usefulness of low-fidelity computer simulations for training purposes (Bowers, Salas, Prince, & Brannick, 1992; Jentsch & Bowers, 1998). Low-fidelity training tools such as MS ANTWERPEN appear to be especially applicable for low-risk environments where there are no clear preconceptions about likely crises. As long as the tool contains sufficient structural similarities to the features of the real environment, it can be hoped that this quality even enhances the transferability to a wide range of real-world challenges.
References


Stefan Strohschneider is Privatdozent at the Institute for Theoretical Psychology of the University of Bamberg. His teaching and research interests are in the area of action regulation in complex environments, problem solving, crisis management, and cross-cultural differences in these processes.

Jürgen Gerdes is a theoretical psychologist and software developer at the Institute for Theoretical Psychology of the University of Bamberg. His focus lies on the simulation of complex and dynamic systems both for gaming and theoretical purposes.

ADDRESSES: SS: Institut für Theoretische Psychologie, Otto-Friedrich-Universität Bamberg, Markusplatz 3, D-96045 Bamberg, Germany; telephone: +49 (0)951 - 8631961; fax: +49 (0)951 8631184; e-mail: stefan.strohschneider@ppp.uni-bamberg.de. JG: Institut für Theoretische Psychologie, Otto-Friedrich-Universität Bamberg, Markusplatz 3, D-96045 Bamberg, Germany; telephone: +49 (0)951 - 8631858; fax: +49 (0)951 691511; e-mail: juergen.gerdes@ppp.uni-bamberg.de.