Crew Resource Management

1 Introduction

The Fire Department is an extraordinary employer. In the past 18 years I've had the feeling of constantly living an adventure. We are involved in a variety of unexpected situations. We save people's lives! What we do has really an important impact in society. Yet this was not what I wanted to do as a child. I wanted to become a fighter pilot, just like many other boys. The movie "Top Gun" served as an inspiration. The world of aviation is a total different world compared to the world of firefighting. Still we can learn certain things from aviation to use in firefighting. Crew Resource Management is such a topic which is worth our attention.

A commercial aircraft is being piloted by a number of people. The captain is responsible for the airplane. Next to the captain there is a first officer, or the P2 (Second-In-Command) and sometimes even a flight engineer. The captain has the absolute command over the airplane. In earlier times, there was a very strict hierarchical relation between the captain and the other crewmembers. Some captains even insisted on the application of the principle of "*Don't speak unless spoken to"*. Because of this concept, all went right or wrong with the competence and insight of the captain.

On December 28th 1978, a DC-8 from United Airlines was on its way to Portland in Oregon piloted by a very experienced crew. The Captain already had 27.600 flight hours on his count, followed by the first officer with 5.200 hours and the flight engineer with 3.900 hours. The aircraft had just made a stop in Denver. It was a relative short flight with an estimated flight time of 2 hours and 26 minutes. To be able to complete this flight, about 14.500 kilograms of fuel is needed. Because there is always a safety margin, the plane had a total of



Figure 1 A Douglas DC-8 at the apron. (*Picture: Rutger Beyen*)

21.200 kilograms of fuel on board. This so called "Reserve Fuel" was almost 50% of the total fuel load in this case. This was due to a law which described there had to be for at least 45 minutes extra air time of fuel in the planes' fuel tanks.

There were 189 souls on board, divided in 8 crewmembers and 181 passengers. The flight continued flawlessly up to the moment the approach for Portland Airport was initiated. In the cockpit, three green lights indicate when the landing gear is fully down and locked. While extending the landing gear, the crew noticed an abnormal vibration. With that, the green indicators of the landing gear did not illuminate. They were for sure in trouble. The captain decided to go around and make a holding pattern. During that extra time, they performed a troubleshooting and tried to find a solution.



Eventually, United Airlines 173 would remain in the holding pattern for another hour while attempting to lower the landing gear. The pilot and flight engineer worked together as good and bad as they could with the captain to get the airplane safely to the ground. Around 17h46 the first officer asked the flight engineer how much fuel they still had left on board. Two minutes later he asked that exact question to the captain. The first officer becomes concerned about the fuel load of the airplane. A couple of minutes later a conversation takes place between the captain and the flight engineer. The latter indicates that the content of the fuel tanks could become very low.

At 17h56 the first officer asks the flight engineer again about the amount of fuel left in the tanks. At 18h02, the flight engineer makes another statement about the continuous dropping fuel levels.

At 18h06, one of the four engines stops running. Shortly after, a second one follows. The captain does not understand why that is happening and the flight engineer explains there is no fuel left in the tanks. At 18h13, all engines have stopped working due to a lack of fuel. Two minutes later, flight 173 crashes at a distance of 11 kilometers of the airport. It was in its final approach fase at that very moment. They were almost there...

Ten people died in the impact. Another 25 sustained severe injuries. A heavy human toll.

Air crash investigation established there was an issue with the landing gear, causing it to extend faster than normally should have been. As a result, the switch controlling the green indicator in the cockpit was damaged. The landing gear itself however was fully down and locked (and thus perfectly usable), but the green indicator remained off. The airplane flew that whole time with a landing gear which was actually fully ready for touchdown.

Bluntly, one can state that the plane went down because the crew did not succeed in solving a rather small issue. They focused that much on the little malfunction, causing them losing *the big picture*. Eventually, all fuel was burnt. Researchers noticed, while listening to the recordings of the voice recorded installed in the cockpit, that the first officer and the flight engineer were aware of the fuel becoming an item at that moment. They did however fail to make this clear to the captain and so make him change his focus from the small issue with the landing gear to the worsening problem with the fuel load.

The captain showed a very bad situational awareness. He was totally unaware of the evolution of a small issue to a disastrous situation until it was far too late. Their way of working caused his colleagues not to be able to make this clear to him.

The crash of flight 173 is sometimes being called the most important incident in aviation history. This crash led to the insight that technical competence of the crew cannot make up for all possible problems. After all, the crew was very competent and experienced. They also have to be able to work together in a good way. The conclusion was made that the captain can neither see nor know everything. During an emergency situation in mid-air, there are numerous details to be kept an eye on. The plane has to be controlled. All this while the crew is observing the problem and thinking about a solution for it. It is very difficult for one person to manage this all at the same time. There are certain limitations to what a person's brain can do.



The article "*Situational Awareness"* that was published in de "*Brandweer M/V*" in January 2018 (article 40 in this series) provides more information about this topic. The founder of the use of situational awareness in the fire service is Dr. Richard Gasaway. After a long career with the fire department, he studied numerous accidents with firefighters. He wrote some books about situational awareness. "*Situational awareness for emergency response"* is a true recommendation for everyone in a leading role with the fire department.

There was an evolution in the perception of the role of the captain. He or she remained fully responsible and so kept full authority. That authority however was now expected to be used to make sure every voice was heard. He or she has the responsibility of the crew to work together as efficient as possible to manage a potential crisis. Crew Resource Management (CRM) was born.



Figure 2 Book by Dr.Rich Gasaway about situational awareness.

Above all, if at 17h46 the first officer had stated clearly to the captain that they had to initiate the landing at that very moment because crashing was far worse than touching down with a landing gear of which they were not 100% sure of its functioning, 10 people would not have died that day.

2 Application to the fire department

That being said, what does this story mean for the fire department? In the history of aviation, a lot of airplanes crashed because their captains refused to listen to the rest of their crew. Nickolas Means calls them "Stubborn Captains" in his presentation.

The fire department is often active in emergency situations. In aviation, the emergency situation is rather the exception. With the fire department, the emergency situation is the cause of our intervention. The situation is often dynamic and unclear. All this makes it for the fire department a challenge to have a good situational awareness.

The fire department often works under time pressure. There is not much time to wait with making decisions or taking actions. While time goes by, the situation (or the condition of a victim) worsens. In an emergency situation on an airplane there is a big time pressure as well. There is only a limited amount of fuel available. Because the time is limited, it is not possible to analyze all possible options thoroughly. Because of this it is possible that the man or woman in charge (or the captain) accidentally skips an important option.

During major interventions, a chief officer is in charge. During smaller interventions the command is most of the time in hands of a non-commissioned officer (or company officer). These people sometimes have to lead a group of firemen in very difficult situations. Different than in the cockpit, all these people are not close to one another. Often, the officer doesn't even have visual contact with his or her collaborators which are closest to the danger.



This is for example the case during an interior attack. Sometimes a non-commissioned officer has to split up his team because two different tasks need to be conducted at two different places. It is impossible for him or her to be at two locations at the same time.

Identically to aviation, the fire department handles a very strong hierarchy. The men or women in charge are "the boss" during the intervention. This is a difficult balance. It is important that everyone is on the same page. The action plan of the (non-commissioned) officer has to be carried out. Every leader has his own style. He or she has to make sure the whole team works together. Often, there is no time for consultation. When a group of firefighters arrives at an apartment fire where people are being stuck on the floors situated above the fire, there is no time to organize a democratic consultation. A more direct command is advised (supported by SOP's and an extensive, good training).

Just like in aviation, leaders within the fire department can be confronted with (fast) changing circumstances which are not fully comprehended. Because of this, it is important that every team member communicates effectively with the leader about topics which are crucial for the safe and effective fulfillment of the tasks.

The fire department too has examples of tragedies in which inefficient communication has played a role.

2.1 A negligible fire in a shed

May 3rd 1999, the Wognum Fire Department in The Netherlands is being dispatched to a small fire in a shed. Wognum is a rural municipality with 7 800 inhabitants at that time. Two fire stations with a total 34 volunteer firefighters are responsible for the protection of the village.

Two fire engines are being dispatched. En route to the fire they already notice a large black smoke column. Upon arrival of the first fire engine, the firefighters determined that there are two sheds and a house (as seen on figure 3). They hear the screaming of the pigs and popping of the roof sheets that consist of asbestos. One minute later than the fire engine, the second-in-command of the fire department arrives. He is surprised by the situation since he only came for a small fire. He exchanges some brief words with the company officer of the first fire engine and they both continue their tasks.

The two sheds have a collective separating wall without doors or openings. Both sheds have two parts. The frontsides of the sheds serve as stable. About 80 pigs are housed in them. De backside is used as workshop and storage.

The shed located at the Bravo side is the one which burns. The sheds have brick walls but a roof structure made of wood. In the roof, combustible isolation is applied and that is what caught fire.





Figure 3 Aerial image of the situation. The gable roof on each of the sheds is clearly visible. The shed on the right hand side (within the yellow rectangle) on this image is the one which burnt. (*Image: Google Maps*)

The company officer of the first fire engine commanded a low pressure deployment and learnt from the farmer that the pigs can only exit through the main entrance at the alpha side of the shed. However, this door can only be opened from the inside. Then he takes a secondary entrance, accompanied by two firefighters to open the main entrance. They all wear SCBA and have a high pressure booster line with them. They see the isolation is almost completely burnt away and the fire is almost out. What is left of it is quickly being extinguished with the high pressure nozzle.

De commander notes that the roof plating contains asbestos. Furthermore, he sees there are still objects burning above the main entrance. It draws his particular attention that there is a large tank resting on wooden beams right above the entrance. He informs about the content and learns it contains water for the pigs. The tank is capable of holding 600 liters. Because it is filled with water, it does not provide any fire hazard. The remaining fire around the tank are being extinguished.

The first company officer communicates the presence of the tank to different colleagues. Afterwards, it became clear that many people had not understood that the tank was mounted on wooden beams. *It could have been on the ground as well.* He also informs the second in command about the tank but not that it might possibly fall down.

Agreements are being made that the crew of the first fire engine will be responsible for the evacuation of the pigs. Several pigs are severely burnt due to falling pieces of burning isolation material. During the evacuation, which requires a significant amount of time, the fire at the frontside rises again from time to time. It is extinguished with the high pressure nozzle every time.



Meanwhile, the second fire engine has arrived on scene. The crew hears their colleagues yell terms like "high pressure", "cool the pigs" and "evacuate the pigs". Promptly, a high pressure line is established and the firefighters start evacuating and cooling the pigs while wearing SCBA. The company officer of the second fire engine enters the building to have a look at the situation.

Both fire engine crews are now involved in the rescue operation of the pigs. Suddenly, a loud crackling sound appears. The beams carrying the tank give way and the tank falls down. It hits three crewmembers of the second engine. One person is only slightly injured. Two others are severely injured and one of them is jammed between the tank and the wall. The company officer of the second fire engine is among the injured. He has a spinal injury.

The other firefighters act fast and free their colleague. The two heavily injured firefighters are being transported to the hospital by ambulance.

Investigation pointed out that the second-in-command and company officer of the second fire engine heard something about the presence of *a tank* before it came down. It was however unclear for them that the tank presented any kind of danger. On the opposite, other firefighters had a clear image of the size and location of the tank. They were particular focused on the contents of the tank. It could have contained a flammable substance as well. Only one person had thought about the risk of the tank falling down but did not communicate this to his superiors.

The situation described above is one in which the necessary knowledge to prevent an accident is present in the group. However, there wasn't – in hindsight – the right culture to share such information. If the firefighter would have shared his concerns about the danger of falling of the tank with the second-in-command or the company officers, the situation might have ended differently.

2.2 Build in moments for CRW



The fire department should execute a change in culture. There is a need for a new balance in which all members are encouraged to share information of which they think it is crucial. The term *balance* is deliberately chosen. During urgent interventions, at which the situation is very dynamic, most firefighters experience one or another form of stress. Because of the urgent and dynamic nature of the intervention, a more hierarchic style is applied. As the situation is more dangerous and/or there is more risk for human lives (civilians or own personal), a style of such kind imposes itself to maintain control over the management of the intervention.

In such a situation, it is not evident as a firefighter to walk up to an officer and point out a risk that he or she might not have noticed. If the fire department wants to use such information to avoid accidents, she will have to build a culture which encourages the sharing of that information, even in the heat of the moment.

2.2.1 Reception of new members

An important moment to set the tone is the reception of new members in the team. When people are new, they will determine for themselves what the (informal) rules are in the environment where they will work now. This is the moment to explain them what crew resource management is. In this moment, there can be referred to a simply story such as the one of United 173. This story illustrates clearly what can happen if important information does not reach the right person in a very simple way. Also, it is the perfect moment to underline the fact that firefighters' work is teamwork. It works indeed with a hierarchical structure but without his or her team the leader means nothing. Every link in the firefighting chain is important!

2.2.2 We are master of the situation

There can be a culture in which people speak up when they notice something dangerous. Often, the triggers to do so are missing. It is important to build in these triggers. The more risk it holds and the more dynamic the intervention is, the more difficult it is to realize so. As the risks and dynamics of the situation increases, so does the chance that something goes wrong. This means that it becomes more important to use CRM to decrease the chance of accidents to the lowest possibility.

During fire interventions, there is this moment when the fire department gets the upper hand over the fire. The fire department is master of the situation. This is often communicated to dispatch. It is also a good idea to communicate this within the radio channel of the intervention itself. "We are master of the situation" means actually that we <u>think</u> we are. We can always be mistaken. When this radio call is made to everyone present at the scene, everyone on scene will be able to react to the call when seeing or hearing something that is not compatible with a "situation that is under control".



Figure 4 A truckdriver-pump operator is often in the ideal position to maintain overview of the situation and warn if something – according to him – goes wrong. (*Picture: Nick Lemahieu*)

Years ago, there was a fire in Brussels, Belgium where teams of firefighters were searching for a fire in an old mansion that was renovated and divided into apartments. Everyone was in his comfort zone since the fire did not seem to mean much. Teams had gained access to the first floor and the third floor. The circumstances they faced reinforced their image about a very small fire. There was only a little smoke visible, there was no buildup of temperature, ... Everything seemed to point in the direction of a small smoldering fire somewhere in the building.

This image was suddenly disturbed by messages transmitted by radio. Everyone had to leave the building immediately! Firefighters came out astonished. *What was all the fuss necessary for?* They were even more wonder-struck when they turned around and concluded that the fire was completely raging at the second floor. A fire at the second floor had suddenly developed extremely fast and passed the flashover phase. Without the call of the team members outside the building (the truckdrivers of the engines, turntable ladder trucks and the chief officer), the situation for the team on the third floor could have become very precarious. After all, such buildings have wooden floors and fire breakthrough with such a heavy fire is not unimaginable.

It was the application of CRM before the term existed. This story illustrates the added value fire truck drivers can offer. They stand outside. Their vision is not limited by a breathing apparatus mask. Their physical labor is in normal circumstances more limited than the one of the teams working inside the building. Because of this, their heart rate is less and that makes it easier for them to think about what they see. Delivering heavy physical performances is hard to combine with thinking. This fact makes that drivers, who have often a good view on the burning building, are perfectly placed to pass crucial information if they think the situation is going wrong.

2.2.3 The bears eat lemons

In the heat of the moment, it isn't always easy for a (company) officer. An overload of information is thrown at him or her. Choices have to be made. That is a difficult job. Missing a piece of important information is quite easy.

Years ago, the fire department was sent out to an apartment where a fire had been reported. Upon arrival they noticed a slight development of smoke but nothing suggestive for a large fire. The company officer chose to make a reconnaissance at the third floor. Probably, there was just a bit more smoke at that floor than at the other floors. At that moment he had no information suggesting any other scenario. They went upstairs together and found no clue for a large fire. Suddenly, the circumstances evolved. Not much later the five firefighters jumped out of the window at the third floor. Several amongst them suffered major injuries. The team ended up right above the fire during their search for it.

Afterwards it became clear that one firefighter, the youngest one onboard the engine, had had a short view on the rear facade while driving. Throughout the small space between two buildings they could shortly see the rear facade of the building they were responding to. That side was on fire over the full height of three floors. That one person thought everyone in the firetruck had seen that. It appeared not to be. Nobody else had looked in that specific direction at that moment. Driving to a fire can be hectic. Especially on a short drive. People are busy fitting their protective gear, the material, ... Radio connection is being



The company officer already passes some instructions to the firefighters in the back of the engine, he is communicating over the radio or he is just exchanging information about the route with the driver, ... There are numerous reasons which explain why the other team members missed that image that was only very shortly available.

Above all, for the youngest member it was not simple to talk about this to the company officer who was 20 years older. *What would have happened if the company officer did get that information? If there would exist a culture in which everyone is encouraged to talk to the commanding (company) officer in such case?*

In a hectic situation it will anyhow be difficult to obtain the officers' attention. He or she is occupied with all hands of tasks. Often, the officer experiences stress. All this makes it hard for him or her to really listen. An American fire station figured out a solution for this. They introduced a code sentence. They chose something absurd: *The bears eat lemons*. This sentence does not fit in the context of a fire department intervention at all. And that's exactly the intention. Hearing this sentence has to take the (company) officer out of his rush for a short moment.

The (company) officers in that fire station know they have to quit everything they are doing when hearing this sentence. Their attention is then needed elsewhere. It means that someone is bringing them a piece of information of which that person thinks it might be crucial for the further safe continuation of the intervention.



Figure 5 Fire in a house. The fire is raging throught the roof. Wooden beams connect the gable with other parts of the building. As time passes, these beams will burn through and the gable might fall in the outside direction. (*Picture: Frank Boelens*)



Image that the fire department intervenes in the event of a fire in an older, solitary house. Upon arrival the fire is already completely through the roof (see figure 5). The chief officer decides to give up the house and orders a defensive strategy. During the intervention, the wooden roof structure burns away completely. At a certain moment, the mayor arrives on scene and the chief officer walks towards him to brief him about the ongoing fire. At that moment a firefighter runs at them. He saw that the gable is no longer held by the roof structure and that the facade start to lean to the outside direction. Two colleagues are extinguishing the fire in the drop shadow of the gable and the firefighter is unable to reach his sergeant. Interrupting the chief officer in his conversation with the mayor is not that simple. He starts his message with "Chief, the bears are eating lemons."...

In one of his amazing lectures about aviation accidents Nickolas Means says: *Don't be the stubborn captain.* This is applicable to all company and chief officers with the fire department. Being with the Fire Department means teamwork. We need each other and even a trainee on his first intervention can notice something what all others, because of circumstances, might have missed.

3 Sources

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