Transitional attack

1 Rue Général Leman

On December 7th of 2010 the fire department of Moeskroen was dispatched to a house fire. The initial call mentioned a petroleum fueled stove had exploded. The structure is a row house in the Rue Général Leman. The fire service of Moeskroen responds by sending an engine with 6 career firefighter. The engine is heading for the fire scene together with a command vehicle driven by the station's fire chief. At the same time volunteer firefighters are being paged along with the battalion chief on call.

1.1 The residence

The fire scene is a row house in the Rue Général Leman. Row housing like this is found throughout cities all across Belgium. The front is only 5 to 6m wide. In the front is a large window and also the front door. The building is made up of two levels.

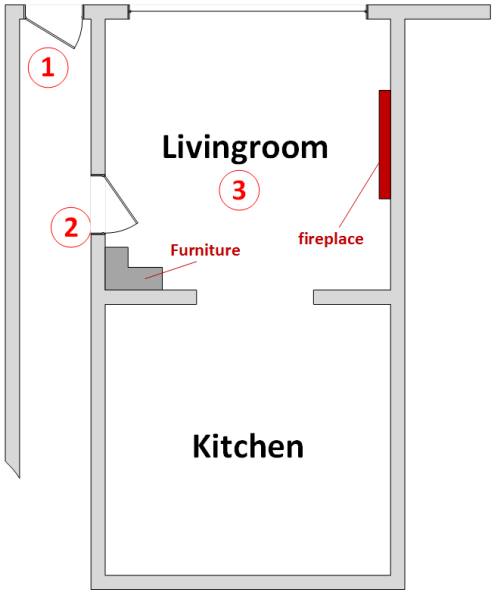

Figure 1 Schematic of the layout of the ground floor. During the fire attack the crew was cooling smoke gas in the hallway (1). At the door leading into the living room, a massive attack was executed (2). In the living room itself the fire was extinguished further using pulsing-pencilling and painting (3). *(Graph: Bart Noyens)*

Figure 2 On scene firefighters find a fully developed fire exiting through the window. *(Photo: Fire Dept. Moeskroen)*

On arrival the fire chief is confronted with a fully developed fire. Flames are exiting through the ground floor window on the front side and thick smoke is rising above the street (see Figure 2). The chief gathers information from the people in the street. There are no victims still inside but there are cylinders containing gas in the building.

Firefighters are clearly facing a fully developed fire in the room at the front. At this point they don't know the exact layout of the house. Is the front room connected to the back? Therefore they also have no idea how the fire is progressing in the room at the back. Is the fire fully developed as well here and are flames exiting out the rear windows? Or is the back side room only now filling up with hot smoke? Maybe the fire's expanding and fire crews are facing a fully developed fire in the front side room, while the same fire is still in growth phase at the back? All of these unanswered questions are part of the difficulties of each and every fire scene.

1.3 The strategy

Figure 3 The attack crew is entering the structure. The picture shows the nozzle man is cooling smoke gas by pulsing into it. *(Photo: Fire Dept. Moeksroen)*

The first engine arrives on scene and is placed just beyond the burning building. The fire service of Moeskroen is a very progressive service and had already implemented the use of attack lines in coils (cfr. "the Cleveland hoselay") in 2010. The decision is made to deploy an attack line Ø 45 in coils. Since the crew is well trained in the procedure, the attack is started in less than 2 minutes upon arrival. The choice is made to perform an interior attack. After all water directed onto the fire from the outside might push the fire into the adjacent room. The attack crew, made up of two firefighters, enters the house through the front door (see Figure 3). The hallway has filled up with hot smoke and the crew has to work its way through to get to the burning room. In order to do so safely they cool smoke using the 3D technique. They used the following method for advancing: every time they advanced, smoke was being cooled by pulsing into it. After one minute the attack crew has reached the door to the fire room (see Figure 1).

When arriving at the door, the flow rate of the nozzle is set to maximum. Next a massive attack is performed while using a flow rate of 500 liters per minute. The nozzle man forms two "O's" and one "Z" (see Figure 4). The fire is knocked down. A massive attack is a powerful weapon for fighting these kinds of fires. (Note: this technique is described as "indirect attack" in several parts of the world.) In three minutes time, the fire service of Moeskroen had an attack line deployed, had a crew advancing safely through a smoke filled hallway and had the fire knocked down.

Overhaul is started and gas cylinders are being brought outside. During overhaul the second engine arrives on scene and firefighters from the second engine assist their colleagues. The initial attack crew can now take a moment to recuperate.

1.4 Evaluation

If we evaluate the actions taken by the fire service of Moeskroen, it can be concluded that this was a fantastic performance. The colleagues of Moeskroen showed that they were able to get sufficient recourses quickly on scene (2 engines). Aside from that these resourses were adequate. The chief officer in charge made the wise decision to deploy a Ø 45 attack line. This procedure had been extensively trained and practiced, otherwise it would not have been this easy to set up the system.

After the attack line had been set up, the attack was started. Deploying the coiled line went smoothly. This also hints to elaborate exercise being done beforehand. In the hallway, the necessary attention was given to cooling hot smoke. When done properly, this leads to a safer working environment. Using this technique while advancing the hose line, limits the risks of the interior attack.

The moment the firefighters reach the door of the fire room, a massive attack is used. The nozzle man selects the maximum flow rate on the nozzle (500 lpm) and draws two O's and one Z. This was enough to knock the fire down in a few seconds. Again this testifies to having trained extensively on interior attack scenarios. After all this technique doesn't work with high pressure booster lines using low flow rates. Aside from that, it also requires a certain calm from the firefighter when he finds himself in such a situation. None of these difficulties proved to be problematic for the attack crew. The fact that the fire service of Moeskroen had invested in live fire training during the years before this intervention, helped produce such a result.

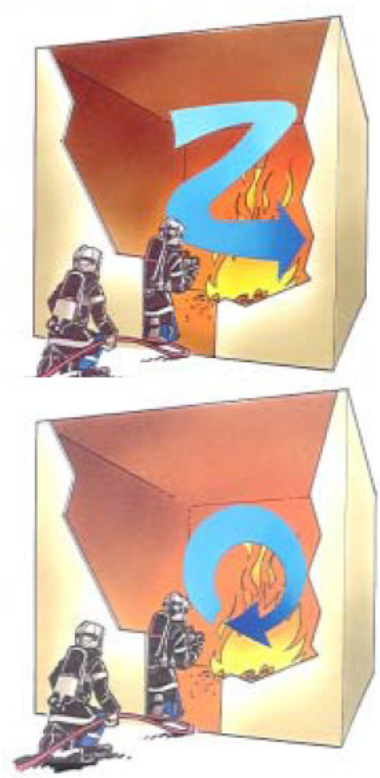

Figure 4 The massive attack: the "Z" and the "O". (*Drawing: see [5]*)

2 Research Governer's Island

2.1 Wind Driven Fires

In 2009 NIST conducted experiments to study the influence of wind on fire development. This was done following a series of fatal accidents that had occurred in the US. The research institute NIST was hereby assisted by the fire departments of New York (FDNY) and Chicago (CFD). After performing lab experiments, tests were also done on Governer's Island. This site had numerous vacant buildings available for live fire testing. The research that followed led to the discovery of the mechanism behind wind driven fires (WDF). More on this subject can be found in the third article of this series which was published in the September 2010 edition of "De Brandweerman".

Figure 5 Use of the floor below nozzle in order to flow water into the burning apartment under wind driven conditions. *(Photo: NIST)*

After it had been established that an interior attack on a wind driven fire is impossible, the search for alternative solutions was started. Someone proposed to break the rule that said "No water may be directed into the interior from the outside". It had long been common practice to fight fires from the inside out and flowing water in from outside was not done. This experiment led to the development of a successful tactic for fighting WDF. The "floor below nozzle" is a special nozzle that is positioned through a window one floor below the fire floor (see Figure 5). This nozzle allows water to be flowed inward through the window of the fire room. It quickly became clear that this method of operation diminished the danger.

Within the fire services of the US, this development wasn't received without criticism. In certain circles the interior attack was held onto as the solution to all fires. The special nozzle was even nicknamed "the coward nozzle" because it was believed that the new approach was only for cowards. "A real firefighter attacks from the inside." Also in the fire service (worldwide) it was believed that flowing water from the outside into the building will push the fire further inwards. The fire will spread into the adjacent rooms. Any victims and/or fire crews will perish.

2.2 Further study

The concept of flowing water inwards from the outside was then examined more closely by scientist performing studies on fire development. It was at the least intriguing to find a tactic which was deemed unacceptable, producing such good results.

Soon after the question was posed whether this would work for normal fires as well. The FDNY, NIST and the research institute UL set out together to investigate. On Governor's Island a number of houses was found in which a large number of live fire testing could be done. During these tests, water was flowed inwards in all possible ways and manners. This was contrary to the existing doctrine in the US (and in many other countries as well).

The results made it clear quickly that directing water in from the outside improves interior conditions. However it is very important to put everything in the right context. The first clarification that needs to be made is that this relates to fires that have an opening in the exterior wall available to them. This opening supplies enough oxygen for the fire to reach the fully developed stage. After all firefighters shouldn't go about breaking windows at under ventilated fires and then expect that conditions will improve.

It's equally important to realize that a decrease in temperature from 700 °C to 400 °C after water's been flowed in, means that conditions have improved. This doesn't mean that survivable conditions have been created inside.

One of the research conclusions was: "you can't push fire (with water)". This means that the fire will not spread into adjacent rooms because of an exterior attack. It does not mean that there won't be a mix of hot smoke and steam flowing into the neighboring room.

It's also important to know that the exterior attack is limited in time. US researchers advise to limit the exterior attack to 15 seconds. This is a very short time frame. After that an interior attack still has to be initiated to further extinguish the fire.

2.3 Transitional attack

These new insights have led to the creation of a new firefighting tactic. When the fire service arrives on scene at a fully developed fire, a "transitional attack" can be used. This means that first a brief exterior attack is used to knock down the fire. Afterwards an interior attack is started to prevent the fire from rekindling. This is called "the transition from external to internal attack". Hence the term "transitional attack". Another phrase that's often used in the US is "softening the target". This indicates that the fire is being weakened so that crews will face an easier and less dangerous target going in. In the Netherlands this tactic fits perfectly in the quadrants model. Such a tactic is called "shifting between quadrants".

3 What if?

Let's reexamine the approach for the fire in the Rue Général Leman. In 2010 the way the fire service of Moeskroen dealt with the situation would have been hailed as a text book example on how to tackle such fires. But what if we were to look at the situation with the knowledge that's become available since last year? And what if the house had a slightly different layout?

3.1 Renovated house: longer hallway

3.1.1 Situational view

Suppose the home owner had renovated the house. The door leading into the living room at the front end is walled up. The room at the front side is now a kitchen joined by a double door to the living room at the back. This living room has a large beautiful window overlooking the backyard. Visitors enter through the hallway into the living room. This door is farther from the front side though. During the original fire, the attack crew had to advance about 3 meters to get to the door of the fire room. Now the door leading into the living room is located 8 meters from the front.

One fine summers day a fire starts in the kitchen. Because of the warm weather, the window in the kitchen had been partially opened. Because of this, enough oxygen is available for the fire to develop (just as in reality the fire became fully developed). The door to the living room is partially open. While the fire is growing, hot smoke is being pushed into the living room. A smoke layer is being formed. While the fire in the kitchen reaches the fully developed stage, the temperature of the smoke keeps on rising. Because the door leading into the hallway is also open, the hallway itself gets smoke logged as well.

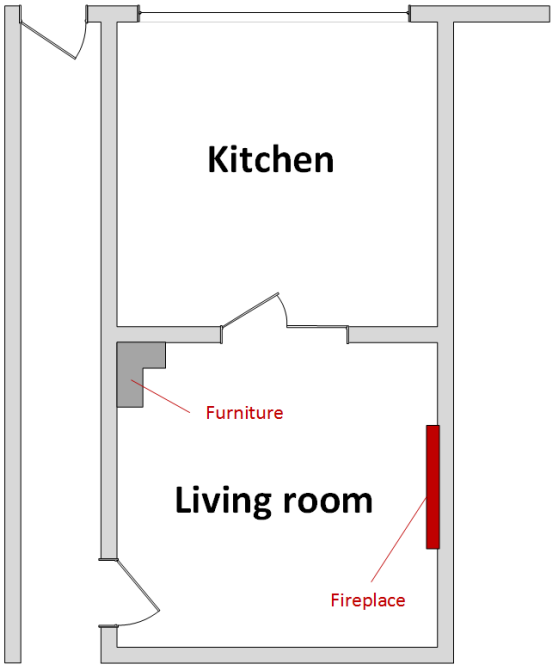

Figure 6 The layout of the house after it has been remodeled. The living room and kitchen have been swapped. Access to the living room is farther down the hall and the living room has to be crossed to get into the kitchen. *(Graph: Bart Noyens)*

When the fire department arrives on scene they're confronted with a similar scenario as in Moeskroen in 2010. Thus the choice is made for the same strategy. The attack crew starts the interior attack. This time the crew needs to advance eight meters instead of three. While they're doing this, the temperature in the living room keeps on rising. Burning smoke is flowing into the living room from the kitchen. The couch (with PUR foam) is pyrolyzing. The furniture is exposed to radiative heat coming from the smoke layer. The couch closest to the kitchen door starts to burn.

By now the attack crew reaches the living room door and enters the room. Again, smoke is being cooled in this room. Because the smoke layer is already very close to the floor they can't immediately see that the couch next to the kitchen door is almost fully engulfed in flame. It's radiating an enormous amount of heat to the couch next to it. When the two firefighters advance three meters into the room, flashover occurs. The crew perishes.

3.1.2 Application of Transitional attack

Granted, the scenario described above has been slightly dramatized. This is done to highlight what the risk can be when things start to go wrong during an interior attack. Up until last year however, this method of operation was considered best practice.

By applying the recently gained knowledge on transitional attack, the risk can be seriously diminished. If the fire crew performs an exterior attack before starting the interior attack, the risk is greatly reduced. The nozzle man could draw 2 O's and 1 Z through the kitchen window. The effect will be similar to that of the massive attack done back in 2010. The difference is that the nozzle man doesn't have to take any risks. By executing a massive attack the fire is knocked down (see Figure 7). This action "buys" time for the attack crew to carry out the interior attack. Because the fire has been knocked down, the flow of hot smoke into the living room decreases. Even more so, steam from the massive attack will end up in the living room. This will make the atmosphere in that room less flammable. The above scenario all of the sudden becomes less likely. The interior attack still needs to be carried out. Smoke will still need to be cooled. The risk for the attack crew has seriously limited by the application of the new concept.

As can be seen on Figure 7, the temperature in the fire compartment will drop considerably. The moment the crew finished the massive attack, a double flowing current

will reappear in the window. Smoke and steam will flow out while fresh air will flow in. The oxygen level inside the room will start to rise again. After some time, the fire will rekindle in several areas. These small fires will continue to grow and if the fire service doesn't react properly, the fire inside the room will progress again into flashover. By using a transitional attack, a time frame of relative safety is created between knock down of the fully developed fire and the second flashover. This time frame needs to be used to execute a safe(r) interior attack.

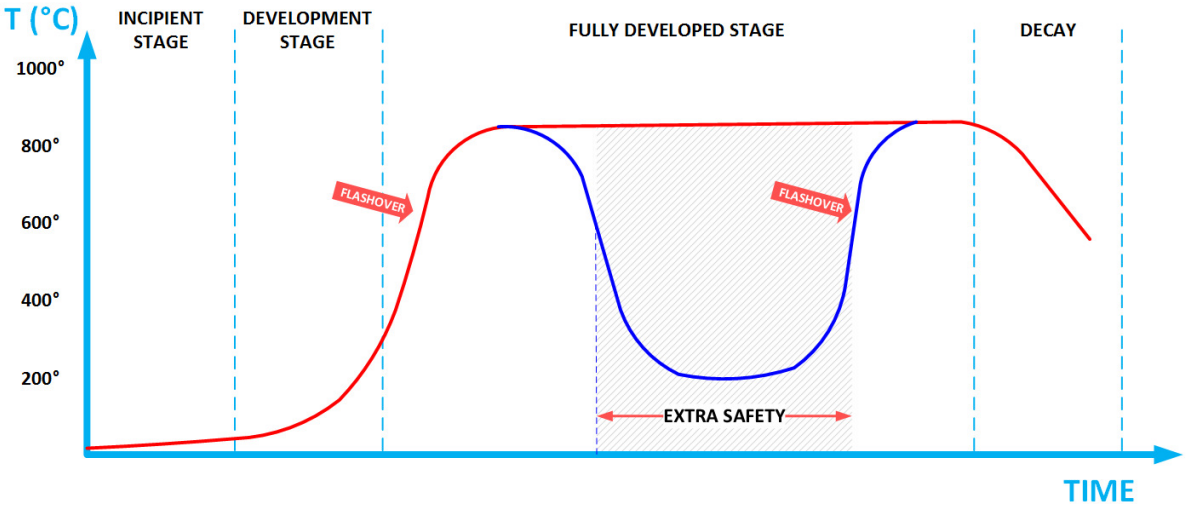

Figure 7 The heat curve for a ventilated compartment fire is indicated by the red line. The effect of the exterior attack is indicated in blue. After the exterior attack, the fire will slowly progress again into flashover. The time frame between knock down and the second flashover can be used to enter and completely extinguish the fire *(Figure: Bart Noyens, Karel Lambert)*

3.2 Single house with a fully developed fire exiting at the back

New tactics bring forth new considerations to be made by the incident commander (IC). The moment the fire department arrives at a single standing house in which a fire is blazing and exiting from the back, the decision can be made to execute a transitional attack instead of a classic interior attack through the front door.

In that case a coiled attack line is deployed up to the window or door from which the flames are exiting. With the use of a massive attack the fire is knocked down. At the moment of the transition from exterior to interior attack, a new decision has to be made. If the exterior attack was done through an open door, the logical choice would be to start the interior attack from there. However if it was done through a window and it isn't immediately possible to enter through a door at that side, the interior attack can be done from the front door. In that case a second attack line should be deployed from the engine to the front door. This will be faster than moving the initial line from the back to the front. A competent IC will anticipate this (if he has enough recourses available). While the first crew is busy setting up the first attack line for the exterior attack, a second crew will deploy the second attack line and if necessary perform forcible entry on the front door. That way they can start the interior attack right after the exterior attack's been finished.

3.3 Single standing house, fire at the back, fenced off.

In the future, higher expectations will be made of our officers. Society's becoming more complex. This is no different for firefighting. Commanding officers need to weigh different options. In the above scenario, the IC has a choice to either start an interior attack or do a transitional attack. But what if there's no direct access to the back of the building? A common situation in which this could occur is when the backyard is sealed off by fencing. If there's no gate that can easily be opened, it might take a while to get an attack line deployed to the back. In such cases it might be better to opt for a classic interior attack. Setting up the exterior attack could quickly take five minutes or more if an obstacle needs to be overcome. This will surely lead to fire spread inside the structure. The choice between the two tactics will need to be made by the IC on scene. Let's hope he's well trained for the job …

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