Fireworks fly with hardly any smoke

There is a fair bit of smoke around in professional fireworks displays. One of the major drawbacks is that it obscures the view and can diminish bright colours in the show. So TNO has developed the 'low smoke lift system' for Clearspark, thereby consigning that undesirable smoke screen to the past, once and for all.

'Firework technology may not be as old as Roman roads but it is beginning to seem like that,' Murk van Rooijen, programme manager at TNO, muses as he explains how professional fireworks are ignited: 'A mortar rack is placed on a fixed or mobile spot, say in a park or on a pontoon off the coast. The mortars are then loaded one by one with a shell – a casing that houses the firework. Black powder is contained in the base of the shell for the launch. The shell is lowered into the mortar by the operator via a quick fuse. The end of the fuse is then taped to an igniter. Once activated, the shell flies rapidly upwards and a delay fuse ensures that the shell explodes at its zenith, giving the public a spectacle to enjoy.'

NITROCELLULOSE GUNPOWDER

To prevent the occurrence of smoke upon launch, Van Rooijen's team replaced the black powder with nitrocellulose powder used by firearms today. 'This gave us a very interesting challenge. If you use black powder, it is gone immediately, combusting very rapidly. Nitrocellulose powder combusts very slowly at low pressure without the rapid generation of gas and force required to propel the shell. So we had to conceive a system that could, as it were, put itself under pressure. And from an economic perspective a system that would fit the existing mortars.'

A feasibility study led to a launching system with openings that would allow an efflux of gases. Van Rooijen: 'The art was to balance the combustion with the efflux. If the gases flow out too quickly, then the pressure will not accumulate. If it is too slow, then the shell will not peak high enough. Eventually we managed to build a research vessel that allowed us to demonstrate convincingly that we could launch fireworks as high as a hundred metres.'

BRAINSTORM SESSION

The next step was system operation. Van Rooijen: 'A two-day brainstorm session enabled us to tap the ideas of the people who work with fireworks on a regular basis as well as their managers. We finally arrived at a prototype launching system after ten detailed concepts and three rapid prototypes. This version must be mounted beneath the mortar. Behind a door in the system the operator first places a cartridge: a launch cartridge containing propellant and electrical igniter in one. He then loads the mortar with the shell. This is similar to the current practice involving two actions but the new system is even more reliable.'

The concept is now with the manufacturer and the system is expected to go into production in 2010. Van Rooijen: 'Our concept cartridge is made of metal but the final version might be made of cardboard. In any case, the final cartridge will be affordable.'

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Hardly any smoke is visible using the new system (above) compared to a conventional launch using blackpowder (under).

Photos: Etienne van Daelen / TNO