Problems and possibilities with advanced fuzing

Saab Bofors Dynamics AB

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Scope

- AT4CS AST - System background
- Designing the fuze
- Smart Fuzing – the impact on the entire system

AT4CS AST

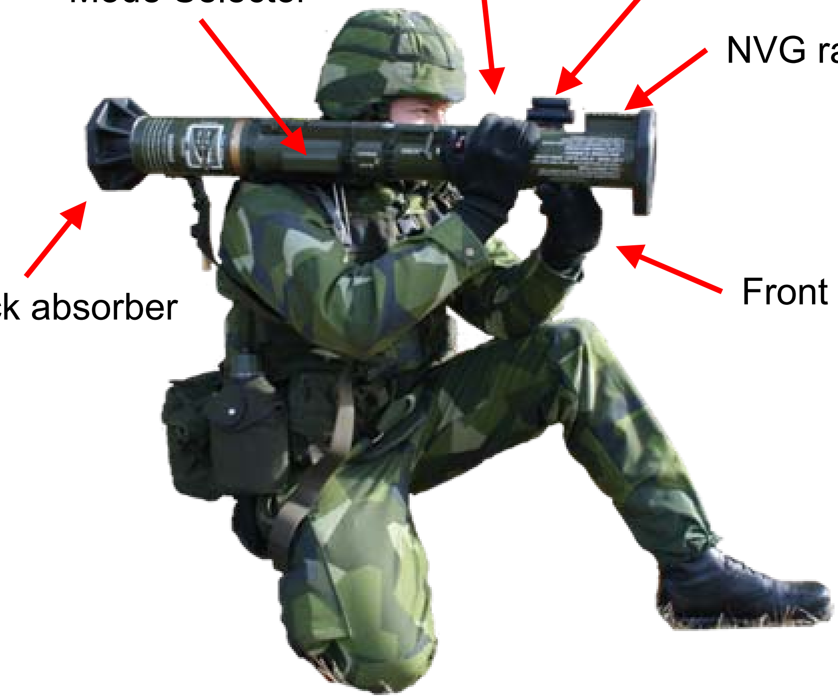
More information…

“Technology for a changing world”
51st Annual Fuze Conference, Nashville
http://www.dtic.mil/ndia/2007fuze/SessionIIIA/sundvall1540.pdf

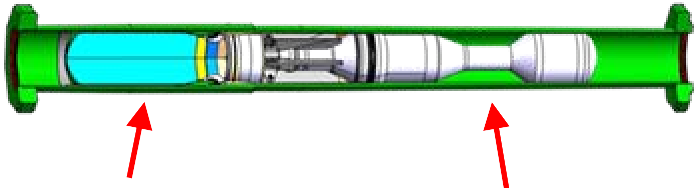
Future Weapons, Discovery Channel
http://www.youtube.com/watch?v=Lm0azEG0CPY

SAAB

AT4CS AST
- Inside/outside



Optical sight



AT4CS AST

<u>Data</u>

Total weight	<9 kg
Length	<1000 mm
Muzzle velocity	approx. 205 m/s
Effective range	200 m
Blast mode and	Double reinforced concrete
Mouse hole mode	Tripple brick wall and
	Light Armoured Vehicles

Objective

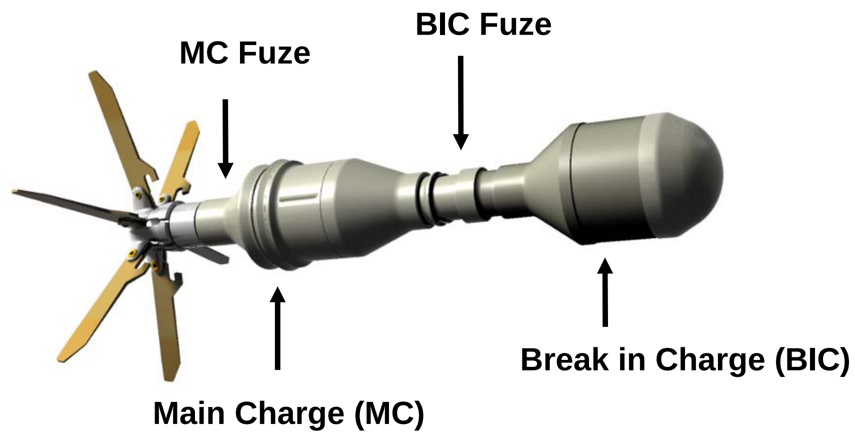
Provide the individual dismounted soldier with a light weight weapon system to achieve fire-power superiority in the complex terrain of urban close quarter combat.

Requirements

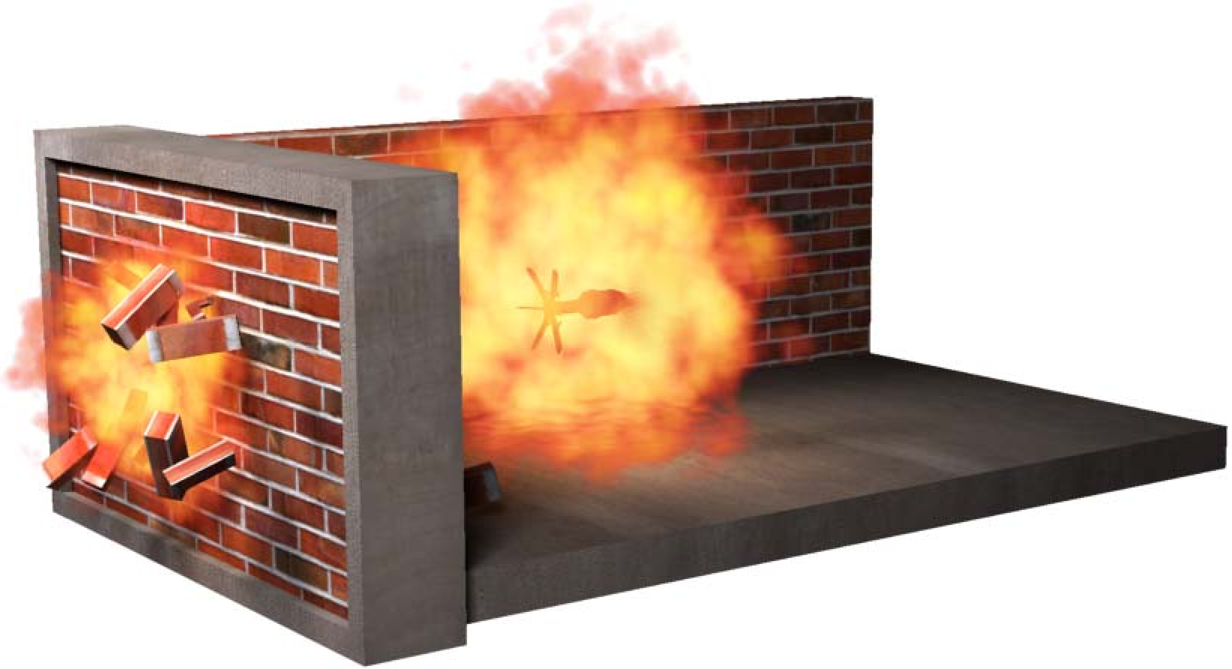
This means the system must be able to effectively defeat the wide range of targets present in the urban environment, as well as take advantage of the tactical opportunities of a urban environment.

- Defeat enemies behind walls
- Create new points of entrance in buildings
- Structure demolition
- Defeat Light Armoured Vehicles
- Possibility to deploy the weapon from confined spaces

AT4CS AST



Delay Mode



Delay Mode

In Delay mode, the delay time between the two warheads are long, giving the main charge enough time to travel past the wall and inside the room.
This is a very effective way of defeating threats hidden inside buildings, bunkers or fortifications

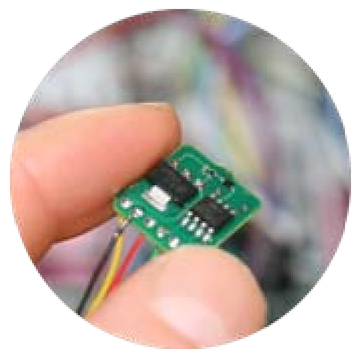
Breach Mode

Breach Mode

A short delay time between the two warheads makes the main charge detonate will still inside the wall. This generates a breach hole – a man sized hole in the wall that can be used as an entry point to the building.

Designing the Fuze
-and a few associated challenges





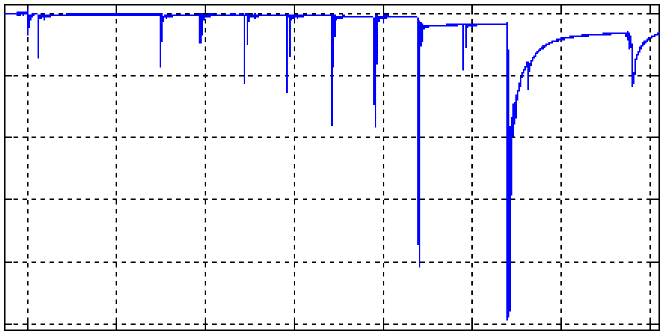
Shockwave induced Problems

The BIC charge detonation and wall penetration is associated with severe shockwaves and very high levels of mechanical stress. The extreme conditions fall outside any component specification and can give rise to problems that are unique to this kind of application.

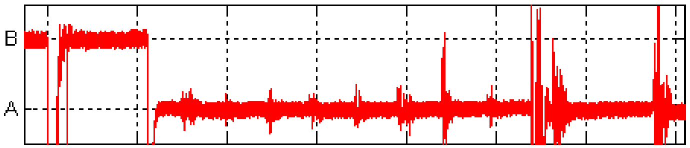
Example of shockwave induced problems that have been encountered

- Bouncing electrical switches
- Cracked glass seal of EED
- Instant detonation of MC on target impact

Impact Sensor



Mechanical Switch



Result from telemetric measurement of a test round with inert MC and live BIC. The round was fired through several different targets and finally into a brick wall where the BIC detonation and wall penetration was measured.

Surface cracks in EED glass seal

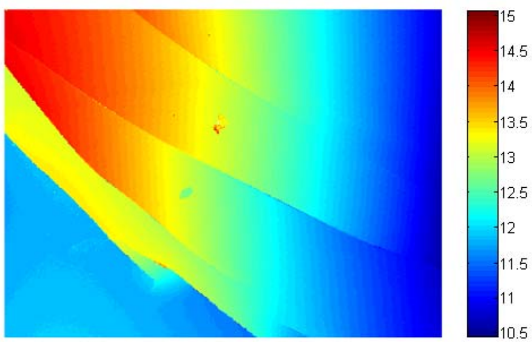
During the development work it was noted that some EEDs sustained cracks in the glass seal during the assembly process. The problem was derived to the interrupter interface that in turn was adjusted in order to avoid further problems.

-However, a question on how the high shockwave from BIC detonation affects the brittle glass seal was raised.

Height data from the surface of a EED glass seal

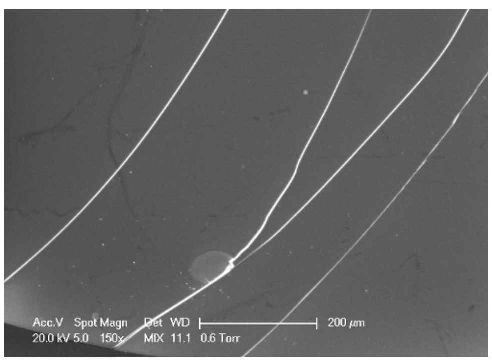
3D surface data created using optical profilometer.

Area: 0.8 x 1.06 mm
Z-diff: 5 μm



Height scan of surface cracks

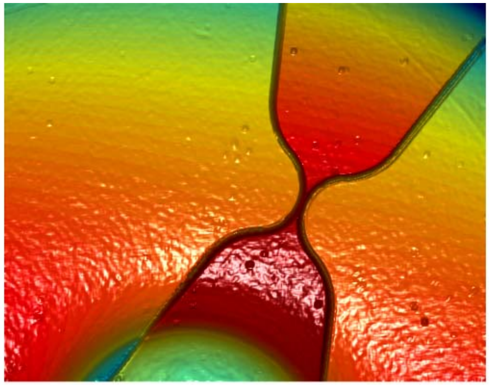
3D representation of the image to the left



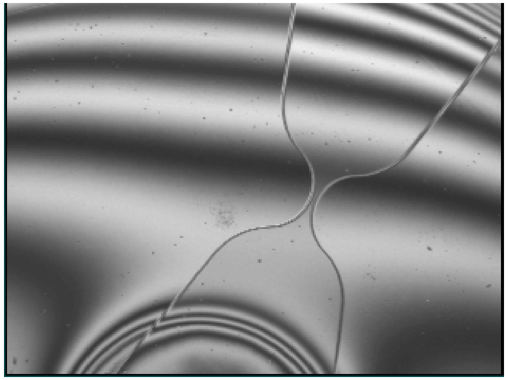
ESEM image of similar cracks in the same area

Surface cracks in EED glass seal

The cracks in the glass surface are in the range of 2-3 μm in height and can, in theory, easily break the thin-film bridge (less than 500nm thick) if they propagates all the way through to the surface.



3D representation of the thin-film bridge



Interference pattern of thin-film bridge

It can not be confirmed, through lab testing or live testing, that any malfunctions have occurred due to cracked glass seals. Neither can it be confirmed that the shockwave itself induces any cracks in undamaged EEDs.

With the adjustments done to the interrupter, together with the results from testing and analysis, <u>cracked EEDs is no longer considered a risk.</u>

Instant detonation of MC

During testing it was discovered that the sharp high G impulse from the BIC detonation caused the MC electronics to malfunction. The shockwave induced a disturbance in the delay circuit that caused it to trigger prematurely.

An investigation was launched and three actions where decided.

- **Redesign of the PCB layout**

  A very careful redesign of the PCB layout was done.

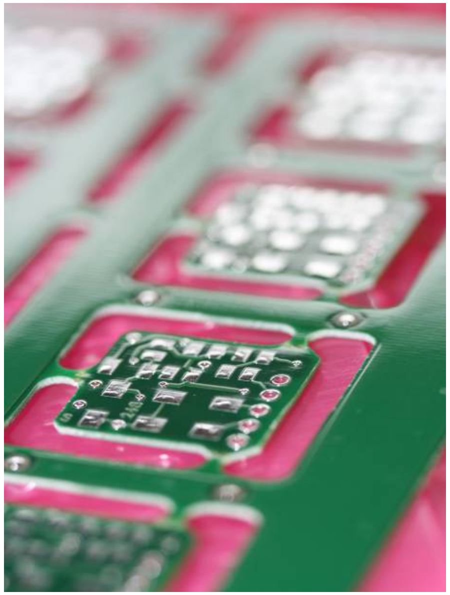
- **Casting**

  As an extra precaution the circuits where casted

  in order to further withstand mechanical stresses.

- **Development of a second circuit solution**

  A new digital circuit was developed



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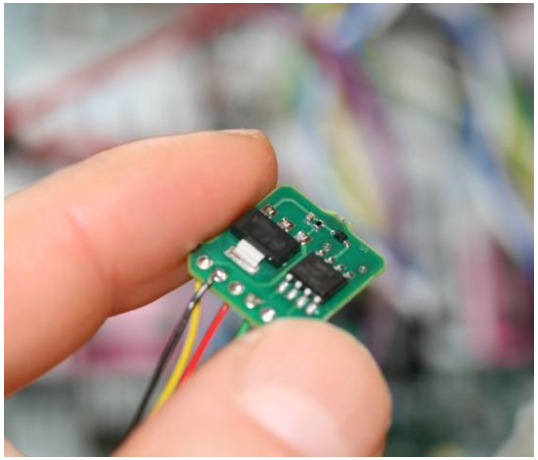
The New Ignition electronics
-Based on a commercial standard processor

- **Fully programmable delay times**
  -Makes it suitable for several applications
- **Capable of signal processing**
  -For example debouncing of mechanical switches
- **Possibility of reading several sensors**
  -Demonstrated with optical sensor, Hall effect sensor
- **Low Cost**
  -Standard components makes the solution cost effective
- **No batteries**
  -The needed energy is produced by a impact triggered generator



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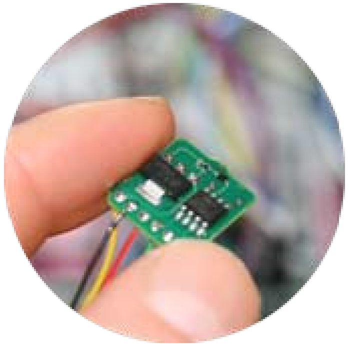
Smart Fuzing
-and the effect on the rest of the system





Smart Fuze or Advanced Fuze?

Advanced Fuze

- Multiple firing modes
- Adjustable delay time
- Time setting (mid-flight detonation)
- Etc.

→ **Requires a operator to make the decisions and communicate the settings**

Smart Fuze

For example:
Automatically adjusts the delay time based on:

- Velocity at impact
- Target Hardness

→ **Makes the decisions automatically, for optimized performance**

The Advanced fuze
- an integrated part of the entire system

Fuze capability

Adjustable Delay times
Timed Mid-flight Detonation
More Firing Modes

Functionality already exists in the fuze

Implementing it means the following needs to be considered

The system Today

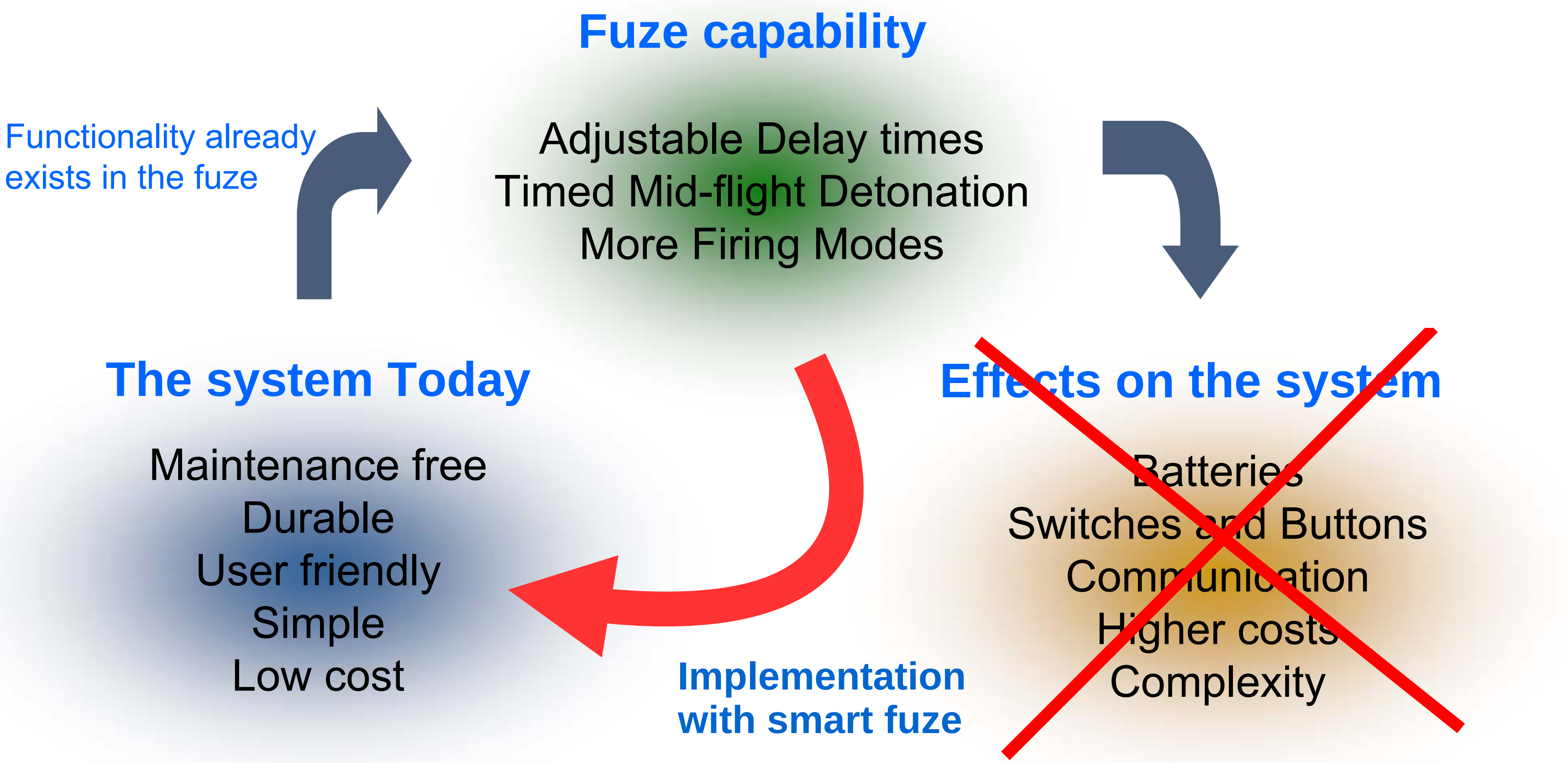
Maintenance free
Durable
User friendly
Simple
Low cost

Effects on the system

Batteries
Switches and Buttons
Communication
Higher costs
Complexity

A advanced fuze is not an isolated subsystem in the same way as the traditional fuzes. Instead it is an integrated part of the entire weapon system, and therefore the whole system will have to be adapted in order to handle the new type of fuze.

The Smart fuze
- advanced fuzing with a simple interface



Implementing it with a independent smart fuze that automatically makes adjustments for maximum performance, makes it possibly to keep a simple design for the rest of the system and allows the operator to focus on the target.

Questions?

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Warhead Design
Mechanical Development
Development and Technology

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