New Solutions for S&A and Firing Functions in Modern Fuzes

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"Collaboration for Fuzing Challenges"

Newark, NJ Max Perrin
Outline

- Fuze and S&A Devices – Requirements evolution
- New Needs – New Functionalities
- Technical solutions
- Focus on new solutions for:
  - Electro-mechanical S&A Devices
  - Electronic S&A Devices
A leader in the field of ammunition fuzes and S&A Devices for missiles and munitions

Complete range of fuzes for all types of munitions

Key competences in Fuzing technologies, Micro-technologies and Ammunition electronics
Main Types of SAD

**Current use**

**Mechanical SAD**
- All type of munitions and missile

**Electromechanical SAD**
- Missile and aerial bombs, some munitions

**Electronic SAD**
- High value missile

**New trend**

**Mechanical SAD**
- Mainly tube launched munitions

**Electromechanical SAD**
- All type of munitions, small missiles

**Electronic SAD**
- Aerial bombs, small missiles, smart munitions
New Requirements directly impacting the Fuze and SAD Evolution

Better Operational Flexibility
Multi-modes / Mode Selection

Terminal Effect Improvement
+ Collateral Damage Reduction

Conventional Safety Requirements

New Safety Requirements
New Requirements – New Trends

- New Generation of Conventional Munitions
- "Smart" Munitions
- Guided Munitions
- Missiles

Key Focus Areas:

- Safety & Arming
- Fuze
- Operational Flexibility
- Terminal Effect

Munition - Weapon System
New Requirements – New Trends

**Safety**
- IM (Insensitive Munitions)
- STANAG 4187 (2nd Safety Feature)
- Self-Destruct Feature
- Overflight Safety
- Mission Abort
- Back-to-Safe
- Fail-Safe Design
- STANAG 4368 – Motor ISD

**Operational Flexibility**
- Multi-mode / Multi-missions
- Mode Selection
- Before Flight / In-Flight

**Terminal Effect**
- Tailorable / Scalable Effects
- Tunable / Aimable Warhead
- Collateral Damage Reduction
- Hard Target Fuzing

**Safety & Arming & Firing Unit**
- Fuze
- Munition -Weapon System

**Modularity**
- Miniaturization
- Shock hardening
New Requirements – New Trends

**Need for a Safety, Arming and Firing Function with**

- New Functionalities
- More Flexibility
- More Control

**Modularity**

- Multi-mode / Multi-missions
  - Mode Selection
  - Before Flight / In-Flight

**Miniaturization**

- Hard Target Fuzing

**Shock hardening**

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New Functionalities

- Control of the arming sequence
- Activation / de-activation
- Arming / de-arming
- Programming / Control of arming delay
- Control of several initiation points - Timing Sequence
- Processing & Management of safety signals delivered by the weapon / munition
- Communication with the other modules from the fuze, munition or weapon system

Needs
Electronic Control of the Safety & Arming Function
Need for control of the safe & arm functions: Electronic command of the SAD

Two S&A Device technologies are suitable to achieve this function:

**Electromechanical SAD**

- Detonator (Primary explosive)
- Lead Charge and Booster (Secondary explosive)
- Safety features

**Electronic SAD**

- EFI
- Booster
- Safety features
- U > 500V Secondary explosive

**In-line S&A Device**
Electromechanical & Electronic SAD – Product Trends

**Electromechanical SAD**
- **Now**: Missile and aerial bombs, some munitions
- **Trend**: All type of munitions

**Electronic SAD**
- **Now**: High value missiles, Aerial bomb
- **Trend**: Aerial bombs, small missiles, smart munitions
The 2 technologies EMSAD and ESAD evolve and develop together, even in different ways.

**Electromechanical SAD**
- Miniaturization
- More and more electronics
- New technologies

**Electronic SAD**
- Size reduction
- Cost reduction
- LEEFI based Fireset

**Technology Trends**
- Microtechnologies
- New materials and techniques
- Metal, Plastic Injection
- micro-actuators

**Low Energy EFI**
- HV Components
New Challenges for the Fuze/SAD Designer

- **Introduction of electronics in mechanical / electromechanical SAD design**
  - Power supply issues
  - Low power electronics
  - Low energy initiators
  - Design of safety architecture, Fail-safe
    - Hardware
    - Software

- **Resistance to more and more severe environments**
  - Specific integration techniques (electronics)
  - Potting technologies
  - Shock filtering and absorption solutions
  - Mechanical shielding solutions

- **Miniaturization**
Electro-mechanical S&A Devices

Exemple of current, in-service product

- **Tank Ammunition Fuze DM173** for DM11 round (120mm)

- **Programmable fuze**
  - Impact - Impact Delay
  - Airburst (from 64ms to 12s)
  - Self-destruct

- **SAD operation**
  - Safety criteria: acceleration detection and gas pressure switch
  - Electronic control of the SAD arming with piston actuator

- **In production, in service with the German Army and the US Marine Corps**
Miniaturized Electro-Mechanical SAD

Cylinder diam. 20mm x 22mm includes:

- Safety electronics
- 1st safety event
- Firing train interruption device
- Explosive train
- Piston actuator
- Explosive output

Integration in a mortar multi-function fuze
**Miniaturized Electro-Mechanical SAD**

- **Qualified in tube launched environment (mortar)**
  - 1st safety event: setback acceleration, mechanical switch integrated in the SAD
  - 2nd safety event: provided by the fuze control electronic module (flight detection, electronic)

- **Adaptable to other type of munitions, with suitable external safety event**
  - "Smart" fuze and Guided munitions fuze, artillery, mortar, etc
  - Shoulder-launched weapon
  - Any other warhead S&A devices
**Electronic SAD, EFI-based**

- **ESAD Main Benefits**
  - High level of insensitivity
  - Resistance to EM disturbances
  - Resistance to mechanical stress / shock
  - Flexibility

**Exemple of current, in-service product**

- **FBM21 Aerial Bomb Fuze**
  - Multirole Fuze: General Purpose and Penetration / Hard target capability.
  - Proximity mode (with external sensor)
  - For use with 3" fuze pocket bombs, dumb or guided bombs, Paveway II & III, Enhanced Pw II & III, AASM (Hammer), JDAM
  - Based on JUNGHANS' EFI and fireset design
  - In mass-production since 2009, combat proven

![FBM21 Aerial Bomb Fuze Image]
LEEFI based Fireset and ESAD

- Main benefits provided by LEEFI technology
  - Lower design constraints
  - Smaller size
  - Lower cost
  - Possible use of standard components

- Running programme within JUNGHANS - Objectives:
  - Get a qualified source for LEEFI and key components (HV switch), ready for product development in 2015
  - Rely on plug-in detonator solution, as used in the EFI technology
  - SAD size lower than 40cm³
  - ESAD Modular design (Integration flexibility / Multipoint ignition warhead)
  - Enable the use of ESAD solutions in a broader range of applications, either in munitions or missile domain:
    - Smart munitions, small missiles, multipoint initiation warheads, Motor ISD
The ultimate wish
- Re-use of proven technical solutions/modules: "off-the-shelf" (or nearly OTS) "pin-to-pin" compatible device!

Main issue: Munition or Missile Applications often require:
- Specific interfaces, size, safety events/signals, power supply
- Specific environment and stress resistance (hard target or not)

The realistic view
- Getting a real generic S&A solution is a problem
- A more realistic option is to share and re-use basic design and common technology
  - Common architecture and design
  - for Electromechanical SAD : re-use the interruption train system and electronics
  - for ESAD : re-use the fireset and electronic architecture
Modern S&A and firing devices have to deal with new requirements for munitions and missiles, in terms of performances and safety features.

New microtechnology solutions as well as electronic integration techniques lead to significant improvements in both Electromechnical S&A device and ESAD domains.

- Providing additional functions to S&A Devices, suitable for modern use of munitions
- Enabling the use of these technologies in a broader range of application
Thank you for your attention!