Ref: MEMS Aerospace Applications (NATO).
Relevant figures shown as ppt in class

MEMS Aerospace applications Date 21/3/2015

Safety and Arming System:

- The safety and arming (S&A) system ensures the safety in handling transportation and storage, and reliable unlock with the launch overload.

The basic requirements for an S&A system are:
- It must sense the environments to determine the weapon launch
- It must compute when safe separation between the weapon and launch platform has been acheived.
- It must "arm" the warhead when the first two requirements are met.
- It must provide a means to detonate the warhead at an appropriate time
- Finally it should provide a visual indicati[on] that the device is armed.

The figure shows the S&A chip:

How does it work:- By using a small amount of explos[ive] (detonator) to ignite a large quantity of explosive (booster) that in turn ignites a third charge (bulk charge). For this a modified exploding foil initiation (EFI) (slapper) system has been designed. An EFI begins with a copper strip with a reduced cross-section. Under the reduced cross-section is an insulator over a barrel. Located at the end of the barrel is a secondary explosive. A large current is passed down the copper strip. At the reduced cross-section the current density increasing causing heat. The heat converts the copper to plasma. The plasma shears a pellet/flyer out of the insulator and launches down the barrel and onto the explosive located at the other end.

The flyer strikes the explosive with large kinetic energy to create an explosion. Now the barrel has been designed in such a way that it can be mechanically open and closed i.e. the mechanical moving structure it can be locked in a safe or armed position.

In the first generation of S&A. there were three sensors
(1). The first sensor was an accelerometer that sensed launch acceleration and withdrew the locking pin from the slider/barrel.
(2). The hydrostat - a pressure sensor that directly moves a lever. A thin diaphragm was made in the silicon wafer by the bulk micro machining process. Using LIGA process a torsion beam was fabricated over the diaphragm. The movable end of the beam rested in a notch in the spring-loaded slider that formed the barrel of the EFI. When the underside of the silicon wafer is subjected to water pressure, the diaphragm would deflect upward pushing the beam upward and releasing the second lock. The third lock is a repackaged commercial differential pressure sensor. Water flowing over the surface created a static and dynamic pressure where the difference is related to the speed via shear profile function.

Output of the sensor is connected to a thermal bent beam actuator. When heated by electric current the beam elongates, bends and releases the final lock. The devices and the spring barrel were fabricated on a single Si chip. The chip when combined with high voltage initiation system, microprocessor, discrete logic and secondary explosive pellet form the S/A system.

MEMS in Microdisplays:

MEMS will play an important role in shaping the future of display technologies. In general, the applications can be classified as follows:-

* Embedded Direct View Systems:- where the image on the display is directly viewed by the observer.
    - Cell/Mobile phones
    - Computer games.
* Front Projection and Rear Projection Systems:- where a real image is projected onto a screen and viewed from front or rear side
    - Presentation System: (Conference)
    - Home TV/theatre and entertainment
    - Move houses/cinemas
    - Automotive (future)

    } Front Projection

    - PC's and Computer desktops
    - Avionics/cockpit applications

    } Rear end projections
* Near Eye Applications - where a virtual image is projected internally within the eye.
    - Camcorders
    - Digital cameras
    - Head/helmet mounted displays

The technologies for Microdisplays

* Micro-mirror arrays:- are monolithically integrated MEMS structures fabricated over a CMOS control circuit. The MEMS structure consists of a silicon array of aluminized mirrors which can be rotated between two angles (±10°). When the mirror is in its on-state, light from a projection source is directed towards a projection lens to appear as a pixel on projection screen. In the off-position, the light is

directed away from the lens and the pixel appears dark (see fig)

(2) Grating light valve:

- The technology invented at Stanford University.
- Grating Light Valve pixel consists of an array of small ribbons, which can be moved up or down over a small distance by electrostatic forces. The ribbons are fabricated by surface micromachining techniques. These ribbons are arranged such that each element can either reflect or diffract light, hence, a beam of light can be switched between two directions at very high speed. At present, only linear arrays are availble. A microdisplay consisting of a grating light valve will require an additional linear scanner. The principle relies on the availability of cheap laser sources.

Liquid crystals on Silicon