Martin-Baker Aircraft Co Ltd

Evolution of MBA Crashworthy Seating

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M Hughes, Project Manager

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AGENDA

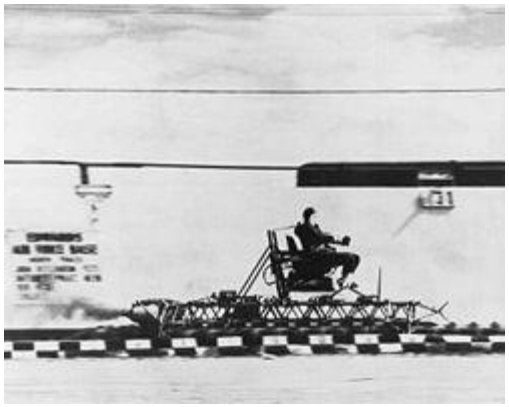
- MBA – Company Overview
- Crashworthy Seats – History
- Evolution of MBA Crashworthy Seats
- MBA Specialist Crashworthy Seat Technologies

MBA – Company Overview

- MBA
  - Company founded in 1929
  - HQ based in Higher Denham, UK
    - Manufacturing locations in France, Italy & USA
    - Worldwide support network
  - Over 60 years of experience in aircrew protection
    - First life saved by ejection 1949
  - To date:
    - 71,000+ ejection seats produced
    - 7,274 aircrew lives saved
    - …. 10,000+ crashworthy seats produced

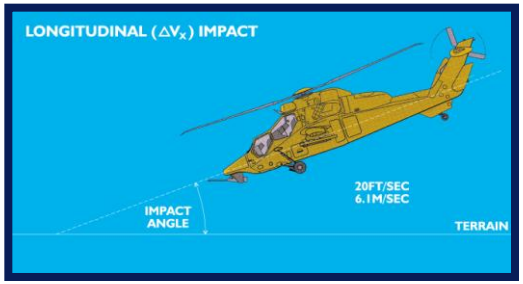
Crashworthy Seating - Research

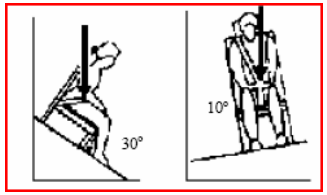
- 1940-1960's
  - Research into human physiological limitations
    - Col J Stapp, US Army
      - Investigated human tolerance to deceleration
      - Prior to these experiments assumed human resistance to deceleration was 18g
      - First rocket sled run 1947
      - 70+ human trials by 1951
      - Demonstrated human body can withstand >32g
      - Stapp later demonstrated survival can be achieved up to 45g when properly restrained
- Derived documents include
  - MIL-STD-1290(AV)
  - USARTL-TR-79-22D (1977)
  - Car industry crash test requirements
  - FAA civilian aircraft seat requirements
- Ongoing release and investigation of civil and military seat requirements
  - i.e. FAA side facing seats



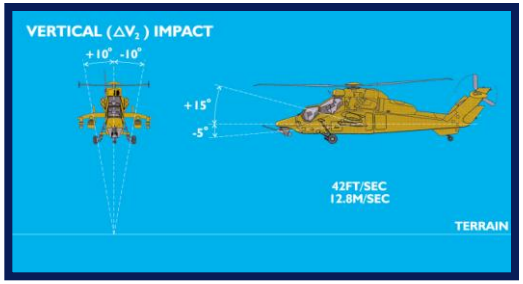
Crashworthy Seating – Test Types

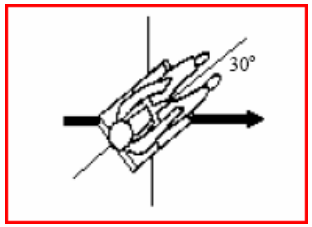
- Examples - Military Standards
  - MIL-S-85510(AS)
  - MIL-S-58095A(AV)
  - JSSG-2010-7 (Design Guide)
- Examples - Civilian Standards
  - FAR23/25/29
    - ETSO/TSO C127a
    - ETSO C39b / TSO C39c
- Flight Critical Tests
  - Static loads
  - Dynamic impact
  - Flammability
- Other
  - Environmental tests



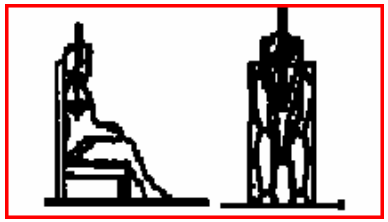


Test 1. Combined





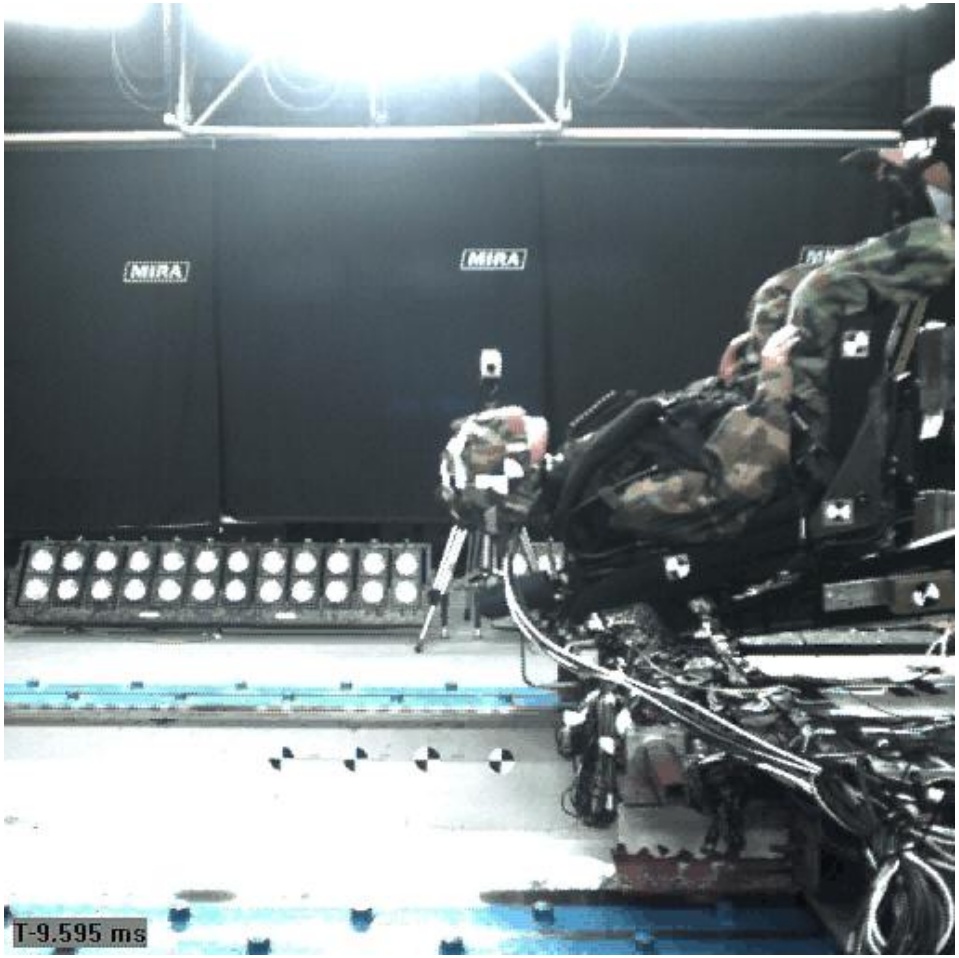
Test 2. Structural



Tests 3 & 4. Attenuation

Crashworthy Seating – Test Types

- 28g Dynamic Attenuation Test - Military



Test 2. Structural

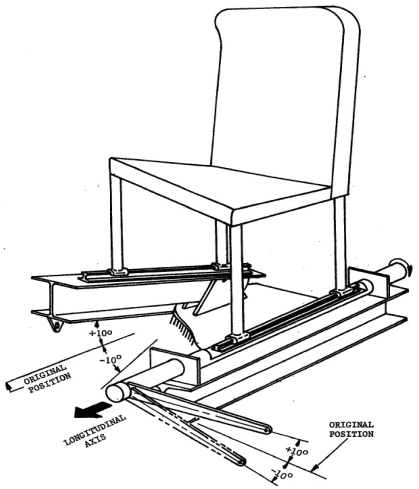
Tests 3 & 4. Attenuation

Crashworthy Seating – Test Types

- TSO C127a Structural Test (18.4g)

Crashworthy Seating – Survival Solutions

- Survival Solutions
  - Ejection Seat
    - Escape from aircraft during mission / flight
    - Relies on having time to eject
  - Crashworthy Seat
    - Remain with aircraft, relying on aircraft structural strength
      - Now a more realistic solution with increased aircraft cabin strength
      - Seats supplement the crashworthiness of the aircraft fuselage and landing gear
    - For high impact levels an attenuation system is integrated into the seat
      - Reduces spinal compression load
      - Reduces acceleration endured by occupant
    - Safely restrains the occupant during survivable impact
      - Designed to perform even with severe floor or bulkhead deformation
      - MBA select the worst case combination when testing



MBA – First Rotorcraft Project

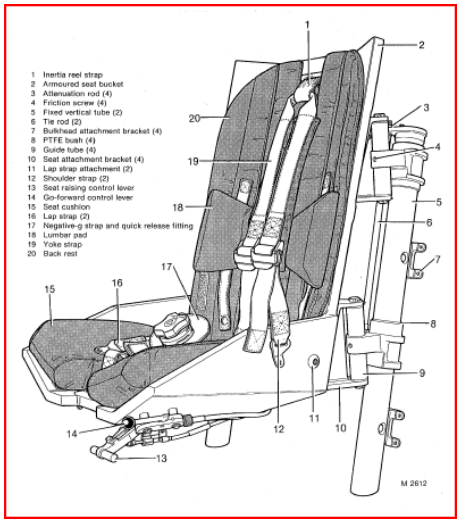
- Late 1960's
  - Design patent filed for sideward firing ejection seat for Westland Wessex
  - Separate system required to remove blades
    - Risk to other aircraft / personnel in vicinity
  - High cost and weight penalty

Rotorcraft Ejection Seats

- Small number of rotorcraft are fitted with ejection seats
  - V22 Osprey demonstrator (MBA SJU-5 Mk10 seats)
  - Ka-50 / 52 Black Shark / Alligator
  - NASA RSRA X Wing technology demonstrator
- Benefits
  - Escape during flight
  - Normally used where risk is greater than would normally be expected
    - i.e. flight demonstrators, extreme attack helicopters
- Disadvantages
  - High mass
  - Purchase and maintenance cost
  - Not practical for transport craft
  - Require complex integrated sub-systems
    - Canopy fracturing / removal
    - Disposal of rotor blades
    - Systems require time to operate
  - Not principally designed to offer crash protection

MBA Crashworthy Seats

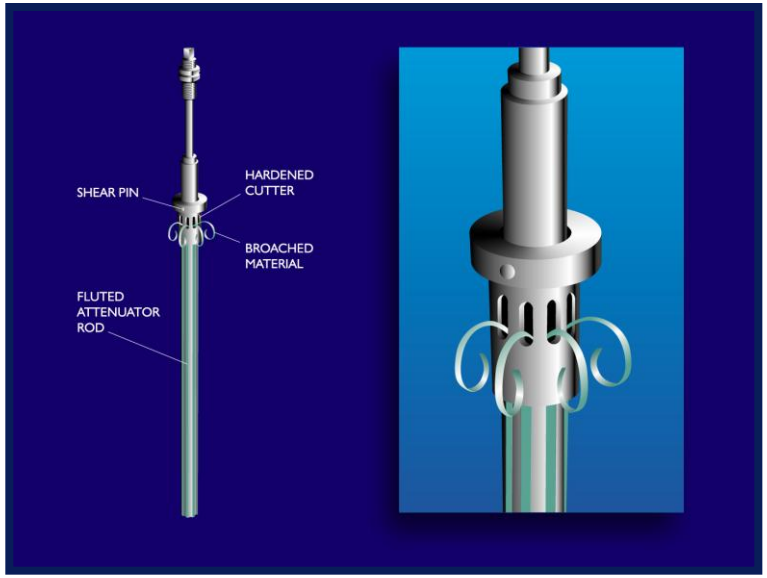
- **MBA Crashworthy seats - the beginning…**
  - Mid 1980's
    - Agusta request quotation for A129 Mangusta armoured ejection seat
      - Ejection seat solution not practical
    - MBA engineered armoured crashworthy crew seat to meet Agusta requirements
      - Based on ejection seat design principles
      - Ballistic armour protection
    - First generation attenuation system
      - Rod and die system
      - Energy absorbed by passing tube through machined die



1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009

MBA Crashworthy Seats

- **Second Generation Attenuation System**
  - Fluted rod and die system
  - Increased level of control
    - Material cut rather than deformed
- Used in
  - Tiger (PAH2) Armoured Crew Seat
  - Rooivalk Armoured Crew Seat



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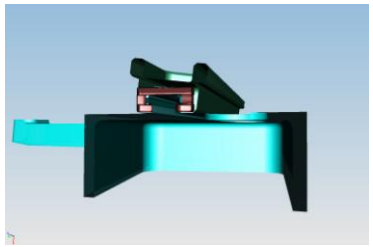
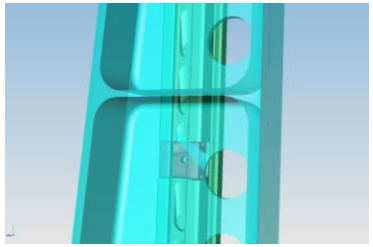
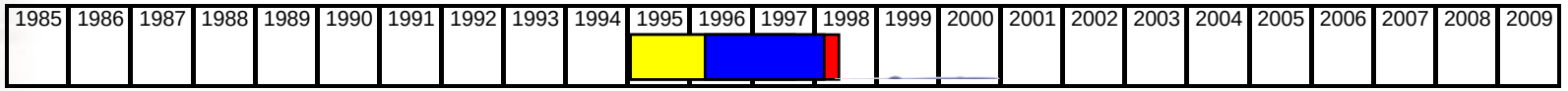
MBA Crashworthy Seats

- **Third Generation Attenuation System**
  - Cutter and strip system
  - Evolution of third generation system
    - Developed to suit mass production
- Uses include:
  - S92 Armoured Crew Seat
  - S92 Crew Seat
  - Rotating and Traversing Seat

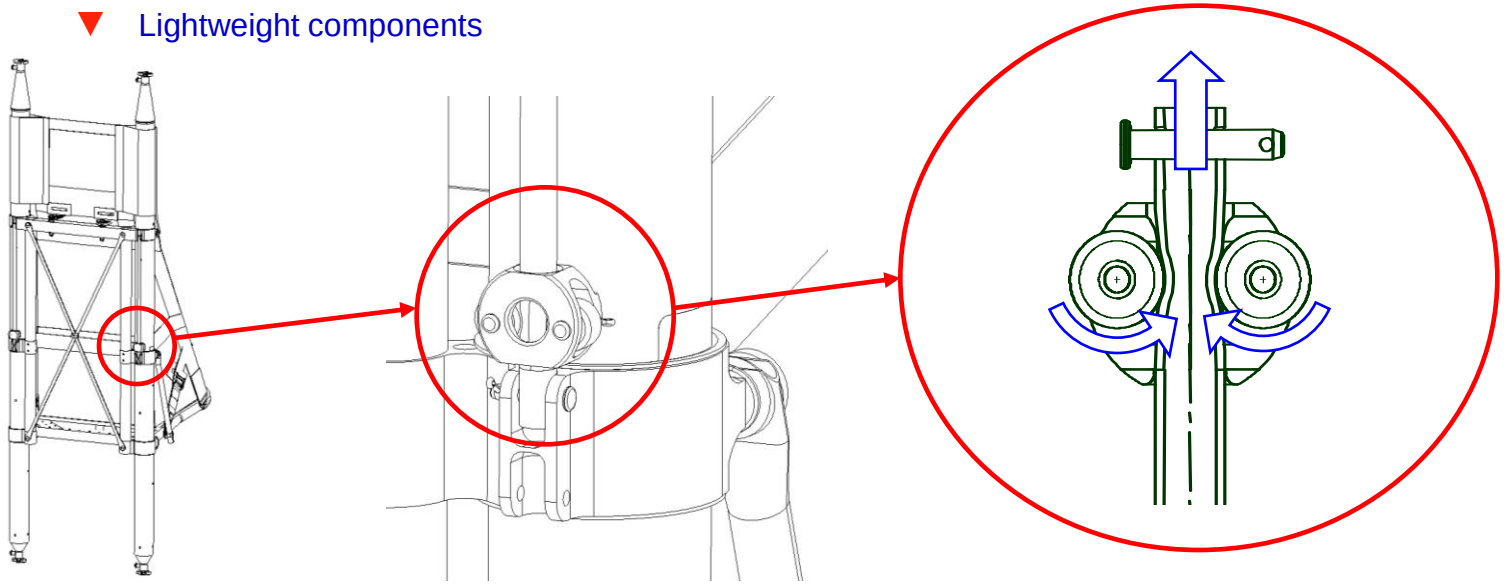






MBA Crashworthy Seats

- **Latest Generation Attenuation System**
  - Tube and roller system
    - Increased adaptability
  - Designed with assistance of bespoke test fixture
    - Allowed for component level dynamic tests with excellent repeatability
    - Data fed back into design model for optimisation
    - Hard / soft start technology developed
      - System can be tuned to suit 5-95th occupant size for each seat model
      - No occupant adjustment required – reduced risk and training requirement
  - Suitable for civilian and military seats
  - No shear pin = simplified maintenance
  - Mechanism controls rebound
  - Lightweight components



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MBA Crashworthy Seats

- **Latest Generation Attenuation System**
  - Uses include
    - CH53E CATSS seat / Utility Seat
    - S92 / EC145 Passenger Seats
    - S92 Enhanced Comfort Crew Seat
    - UH60M Troop and Gunner seats
    - H92 MPACS
    - MFOS

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MBA Crashworthy Seats

- **Non-Attenuating / Fixed Wing Seats**
  - Crashworthy
  - Generally non-attenuating
    - Lower specification requirements than rotorcraft
  - Single or double seat variants
    - Crew, mission and rest applications
  - Uses include
    - Nimrod
    - Jetstream 41
    - P-8A Poseidon
    - KingAir 350








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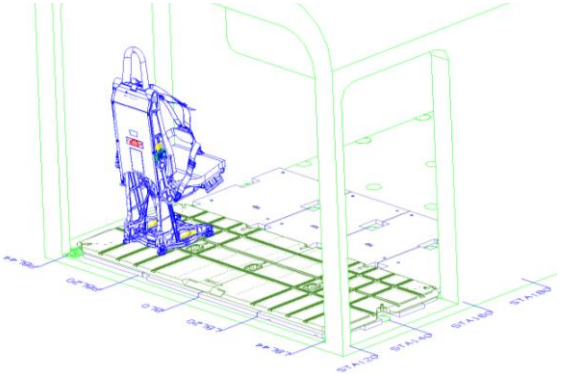
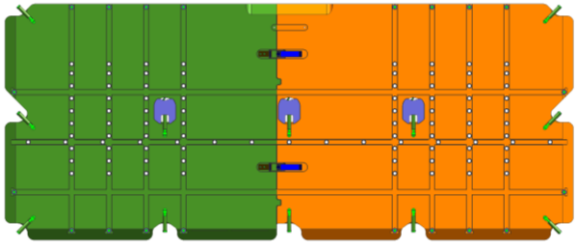
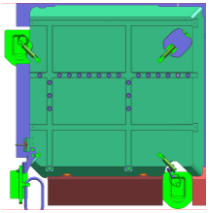
Specialist Solutions

- **Interface Kits for Retrofit….**
  - MBA have developed and qualified installation kits for applications for which no crashworthy solution was previously available
    - CH47 crewmember
    - CH47 loadmaster
    - KingAir 350
  - Simple attachment, integrates directly with existing equipment
  - Allows for multi-mission capability
    - Design tailored to suit end-user requirements







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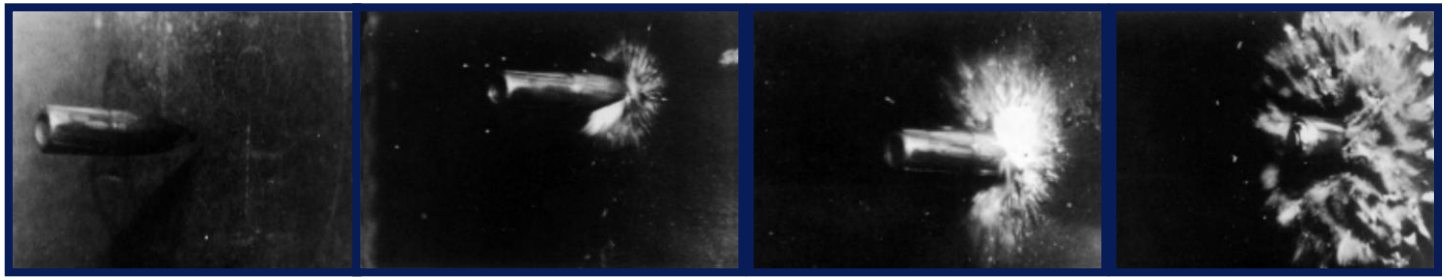
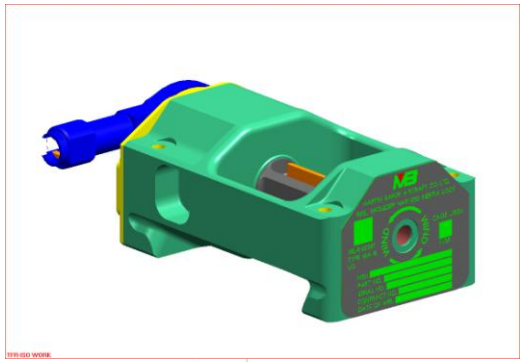
Specialist Solutions

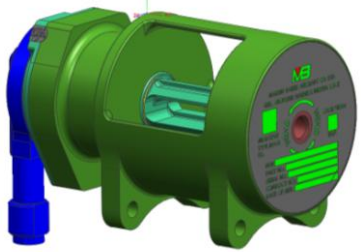
- **Armour Technology….**
  - Fifth generation MBA armoured seat MPACS Safety of Flight qualified
  - Significant experience of armour types
    - Aluminium Oxide
    - Silicon Carbide
    - Boron Carbide
  - Type driven by cost / mass / performance buy-off
  - Current MPACS bucket defeats highest small-arms threat requirement
    - Bucket shape designed to suit customer requirement
    - MPACS bucket structurally qualified to MIL-S-58095A(AV) req’ts
      - 250lb occupant
      - Static tests incl. combined Static Test, 25g fwd, 9g lat + down
      - 28g structural dynamic test
      - 46g combined and attenuation dynamic tests
    - Wing armour options



Specialist Solutions

- **Restraint Technology….**
  - MBA strives to use modern restraint system solutions to maximise crashworthy safety
    - Adequate restraint is key to survival
    - Occupant motion must be minimised to reduce:
      - Body and head acceleration
      - Contact with aircraft interior components
      - Flailing injuries
  - MBA work closely in partnership with restraint system suppliers
    - Developing new solutions to satisfy end-user requirements
    - Recent developments
      - Low mass / high strength harness for H92 MPACS in partnership with Schroth Safety Products / BAE Systems
      - MA16 type inertia reel
        - Crew and gunner versions
        - MBA developed unique ATP fixture
        - New lead-in webbing strap developed
        - US Army AWR approved for Blackhawk
        - Full QPL programme in progress





The Future

- MBA will continue to innovate, evolve and develop crashworthy protection solutions
  - Goals
    - Increased occupant protection
    - Increased mission capability
    - Improved technical performance

60 Years of Saving Lives