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ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Launching Indirect Fire Weapons Into the 21st Century With Digital Fire Control

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Outline

- Fire Control Definition
- Brief History/Evolution of Fire Control
- The Need for Fire Control
- Application of Technologies
- Integrated Fire Control Systems
- The Future

What is Fire Control?

- Acquisition of the target and the implementation of the functions necessary to maximize the effects on target
- The functions
  - Target Acquisition
  - Sensing the environment
  - Computation
  - Gun / Launcher / Sight Control
  - Munitions Interface / Tracking / Data Link
  - Network Interface

The Fire Control Functions are Universal

Functions are the same for all weapon systems - their implementation varies as a function of sophistication and automation through the application of technology.

In a basic engagement:

- The human performs all functions
- But is
  - Limited in range capability
  - Limited in low light and poor weather conditions
- And is
  - Stress dependent

The Early Years

Pre – 1800s

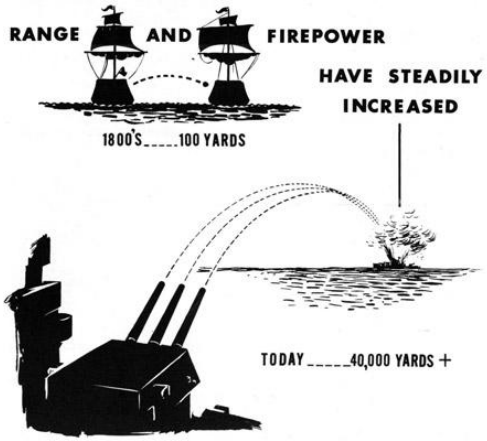
- Line of sight engagements
- Gunner's quadrant invented
- Primitive optical aiming aids
- Adjustment after fire
- Some crude mechanical aids

1801 - 1900

- No fire control inventions at the system level
- Trend toward automation extended to naval gunnery
- Telescopic Rifle Sights introduced

1901 - 2000

- Firing Table development (WW I)
- Introduction of mechanical computers in ships 1915
- Causes for errors began to be studied
- System addressed as a whole – error budgets
- Significant application of technology in last half 0f century



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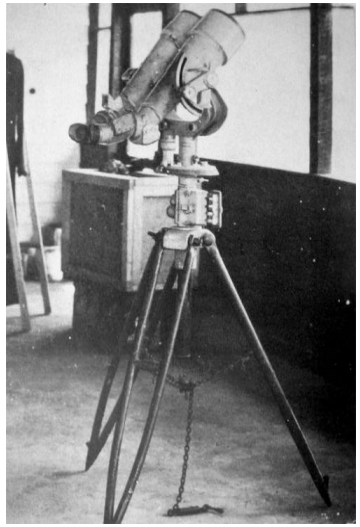
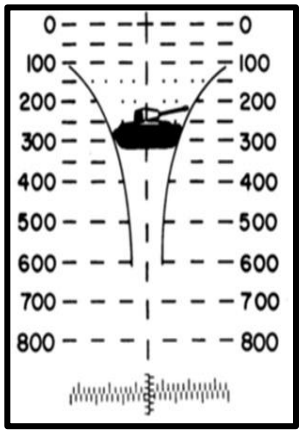
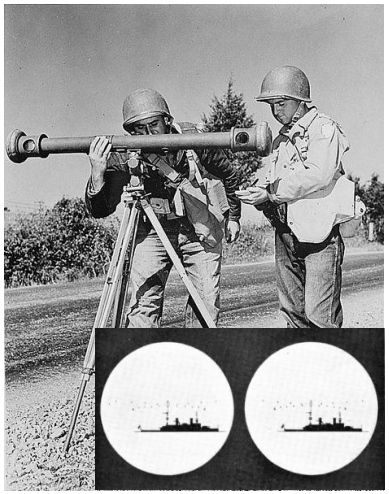
Target Acquisition & Ranging

- Human Senses (Eye, Ears, Nose)
- Technologies
  - Daylight Optics
  - IR Active & Passive
  - Radar & Acoustics
  - Thermal (1960s; Army Common Modules 1970s;)







Active Infrared light source and viewing telescope

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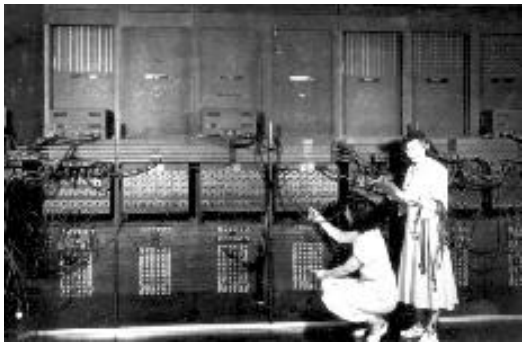
Computation of Ballistics



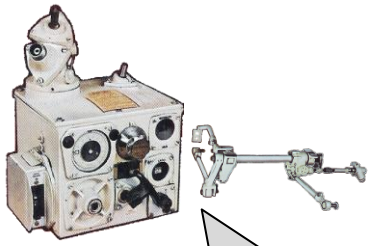
- Exclusive use of Firing Tables 1900 -1935
- Initial use of computers for FT 1930s – WW II
- ENIAC & EDVAC for FT generation – WW II
- Computers in a field environment – 1970s to present
  - Modified Point Mass Solution (1960s), NABK (1990s) NATO BK (2000-present)

M23, Mortar Ballistic Computer & LHMBC

Advanced Field Artillery Tactical Data System (AFATDS)

Mortar Fire Control System Computers

Net Warrior Smart Phone



M13 Mechanical Computer & Linkage

Field Artillery Digital Automatic Computer

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Advantages of Digital Systems

Enhanced Responsiveness
Accuracy
Survivability

- Digital Communication
  - Call-for-Fire, Met data, Situation Awareness
- On-board Ballistic Computation with sensor inputs
- GPS for on-board navigation and location systems
- Gun Orientation
  - Automated Weapon Control
  - User display
  - Self alignment
  - Sensors

	ACT	DELTA
DEF	3104	10
QE	1000	244

User Displays

Inertial Sensors

Modern Indirect Fire Control System

Power Conditioning & Distribution

Digital Messaging & Communication

Embedded Training,BIT

Weapon Position and Control

Power Dist Assy

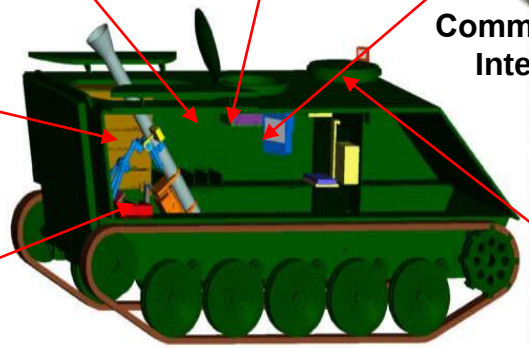
SINCGARS Radios

Fire Control Processing

Commander's Interface

Gunner's Display

Armament System Control



Weapon Pointing and POS/NAV

Pointing/Navigation

Driver's Display

Position & Navigation Information

Application Software

Digitizing the M1064 with Mortar Fire Control System – M95

Evolution of Digital FC

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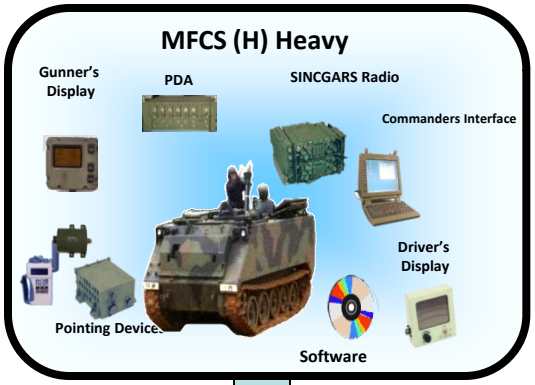
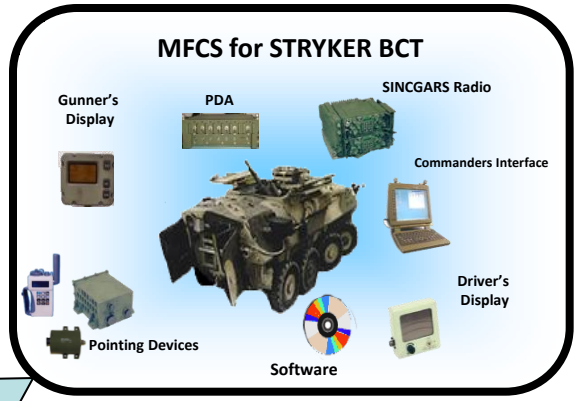
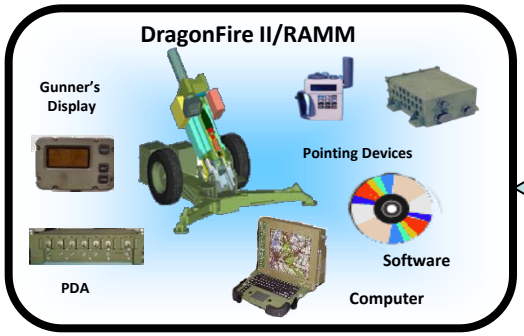
$9.59M/36mo avoided



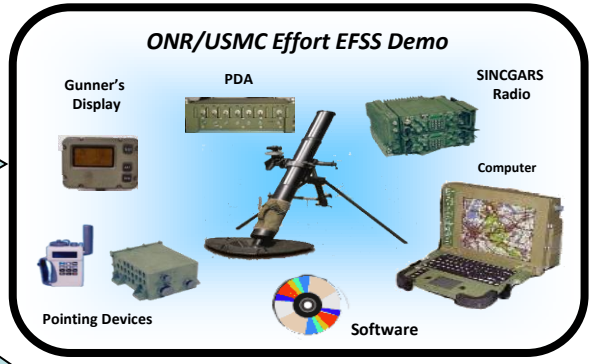


$6M/35 mo avoided



$5.5M/36 mo avoided

MFCS Software & Hardware

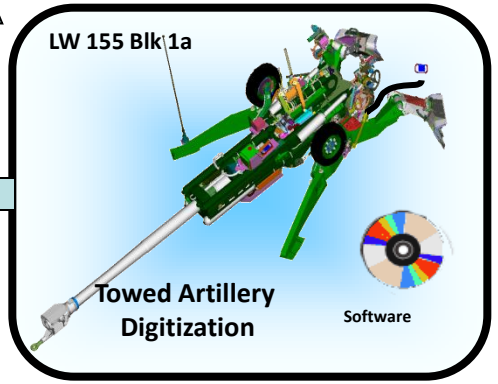


$5.67M/30 mo avoided

$2.2 M/12 mo avoided

$2.4M/18 mo avoided

$6M/31 mo avoided



$2.4M/36 mo avoided

NOTE: SOFTWARE DEVELOPMENT COSTS ONLY

U.S. Artillery & Mortar Digitization

1992 - Paladin Continuous upgrades to present

2003 1064 Mortar Carrier

2004 Stryker Mortar Variant

2007 M777

2007 Portable Excalibur Fire Control

2009 Dismounted 120mm

2013 M119A3 Digital Fire Control

2013 Advanced Mortar Protection System (AMPS)

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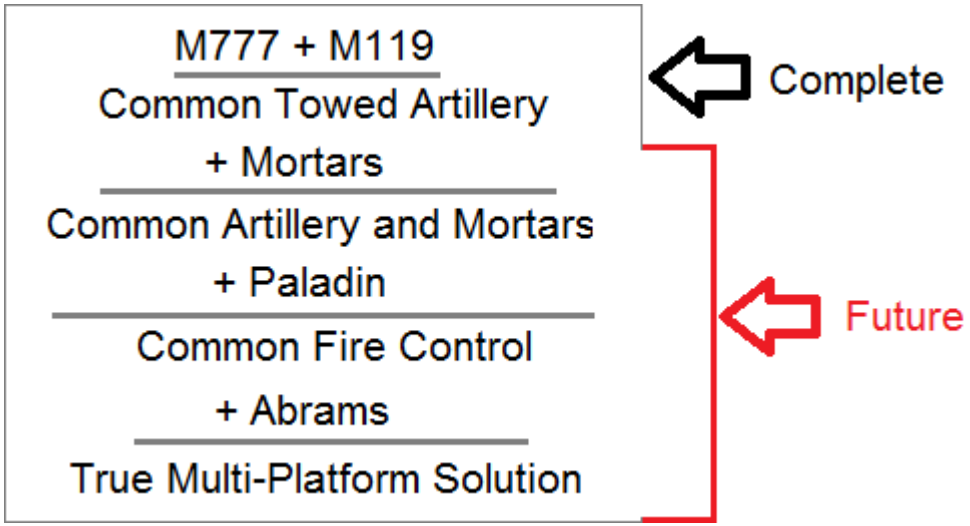
Future Focus Areas

- Network Assisted GPS
  - GPS Denied
- Emphasis on software algorithms/networking
  - Battlefield Decision Aids, Information Fusion, Sensor Fusion
- Increased Mapping Capabilities
- Communication with Smart Munitions
  - Guided (Excalibur, PGK, APMI), Future M119, 81mm mortars & 60mm
- Emphasis on Size, Weight, Power (SWAP)
  - Reduced size, weight and power, *e.g*. MEMs
  - Efficient functional and physical integration
  - Large system capabilities available for dismounted Soldier
  - Wireless LRU's

Common Fire Control

- Modular
- Multiplatform



- Common Software Architecture
  - Digital Comms, Variable Message Format (VMF)
  - Ballistics Kernel Interface
- Tailored User Interface
  - Towed Artillery, Mortars, Self-propelled Artillery, etc.

Questions?

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