The HAMR Project

NDIA
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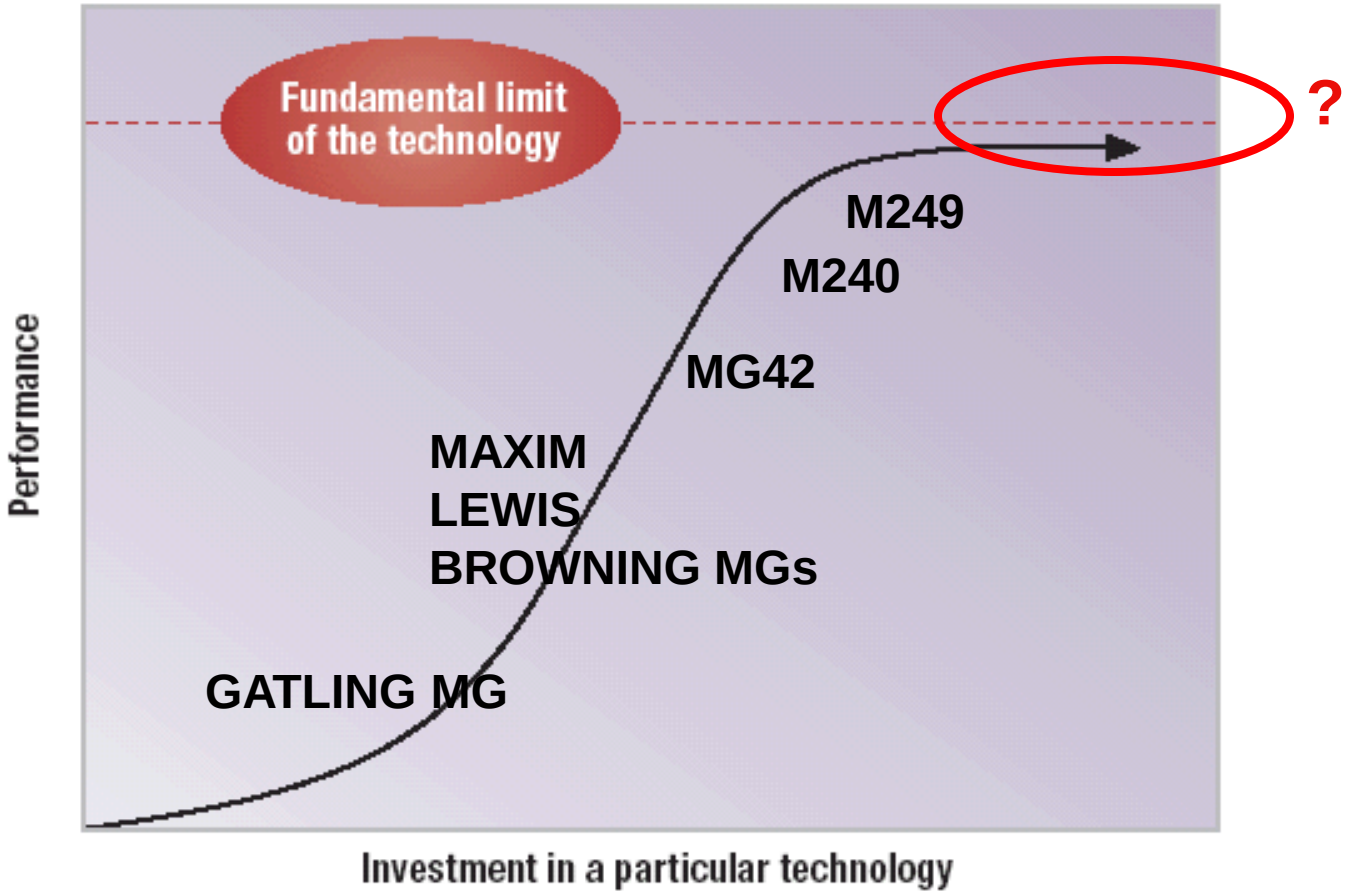
Firearms Tradition
& Technological Innovation

FN HERSTAL

Question in FN Herstal : what's the next LMG after the M249 ?



The HAMR (Heat Adaptive Modular Rifle) project

Initially launched as a larger project in 2004

A combined concept and technology study focused on improving the efficiency of the Dismounted Soldier to perform his mission

Trying to fill the gap : assault rifle / light machine gun (GPMGs)

Partially reorganized in 2005 to provide, in a 1st generation, an answer to the USMC IAR program

1. Current fielded concepts

Assault Rifle

Pro

- Point target capability
- First round firing probability
- Less sensitive to the environment
- Ease of maintenance

Cons

- Magazine capacity for sustained fire

Light Machine Gun

Pro

- Suppressive fire capability
- Best weight as a system (weapon+ammo)
- Most designs prevent cook-off using an open bolt architecture

Cons

- Heavier that the Assault Rifle (LMG itself)
- Need for a more extensive training
- Most products designed as GPMG

2. The original concept : keep the best of both worlds

From the Assault Rifle

- Keep Closed Bolt operation
- Keep Semi-auto / Full auto

From the Light Machine Gun

- Keep Open Bolt operation
- Keep use of linked ammunitions

Combine those features in a redesigned architecture

- Making it more user-friendly and easy to operate
- Improving performance in harsh environments
- Keeping closed bolt design, switching to open bolt when required

3. The first HAMR Generation

Designed to provide a solution for the USMC IAR

- Magazine fed (30 rounds)
- Semi-auto / Full auto
- Improving mobility compared to the M249
- Accurate
- Cook-off resistant

As a side project, investigation of H/C magazine designs

- Avoiding moving complexity from the weapon to the magazine
- Trying to minimize weight and volume

1. Original USMC IAR performance specification

Most significant performance parameters

Rate of fire : (T) 800 rounds in 20 min

(O) Offensive 510 rounds in 9 min 32 sec

Defensive 705 rounds in 12 min

Accuracy : Semi-auto : (T) 7 MOA , (O) 4.5 MOA

Automatic : (T) 11 MOA , (O) 6 MOA

Probability of First Round Ignition : (T) 99.8 %

Weight : (T) 12.1 pounds, (O) 10.5 pounds

2. Preliminary tests

Performed on a Heavy Barrel SCAR

Rate of fire : (T) **MET** (**NOT MET** at +54°C)

(O) Offensive **NOT MET**

Defensive **NOT MET**

Accuracy : Semi-auto : (T) **MET** , (O) **MET**

Automatic : (T) **MET** , (O) **MET**

Probability of First Round Ignition : MET

Weight : (T) 12.1 pounds **MET** , (O) 10.5 pounds **MET**

3. Search for design alternatives

Tool Boxes for the designer at FN HERSTAL

” TRIZ approach ”

- Look at the 40 principles to trigger ideas
- Try to reformulate your problem (what’s available for what to do)

” Everything has been invented ” (and try to avoid frustration)

- Visit the firearm museum (> 120 years of design efforts)
- Explore Patent Databases (> 36.500 US patents in F41 Classification)
- « Be curious » (someone may have solved your problem !)

4. Selected solution

From the TRIZ approach :

- Significant amount of heat is available

→ Principle 37 : Use thermal expansion

Rejected (does not provide travel AND effort)

→ Principle 36 : Use phase transition

Selected for further investigation

- Electronic is now everywhere

→ Principle 28 : Replacement of Mechanical System

Rejected (safety relying on electrical power availability ?)

4. Selected solution (2)

From « Be Curious » approach:

- MEMS is an extremely innovative technological area
  - having heat as a source of energy
  - searching to provide mechanical work (actuators)
    - → using phase change
- From this point, a search for phase change actuators brought the technical concept

Use the heat generated by the high firing schedule to activate a closed bolt / open bolt mechanism through a phase change thermal actuator

1. System architecture

Take advantage of the SCAR platform modularity and :

- Redesign the lower rail to integrate the thermal actuator

- Redesign the trigger frame to integrate a new fire control module

2. Tool boxes for detailed design

Thermal analysis / validation :

- FEA transient thermal analysis
- Temperature measurement on existing prototypes

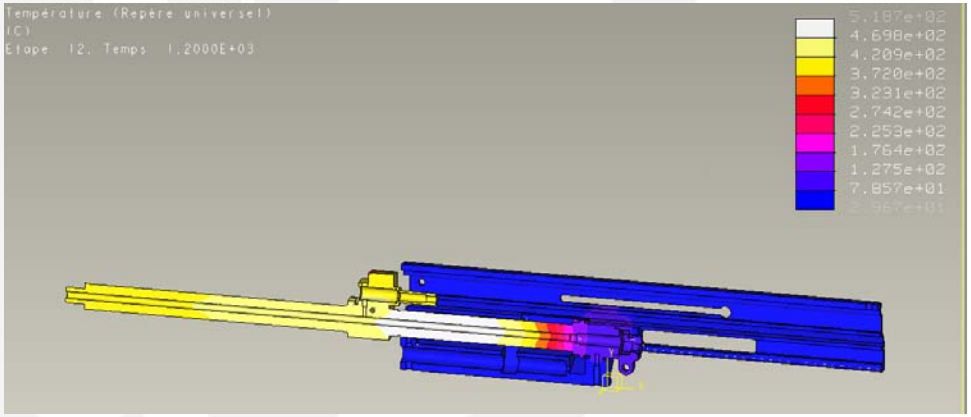
Mechanical design / validation :

- Multi body dynamic simulation (MSC/ADAMS)
- FEA fatigue analysis
- High Speed Video
- Kinematics measurements (Optoelectronics)

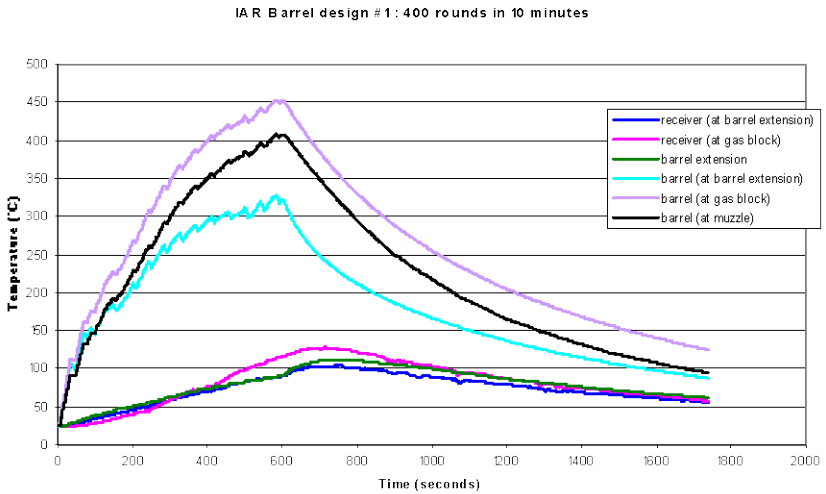
3. Transient thermal analysis

Investigation of temperature profiles

FEA Thermal Analysis

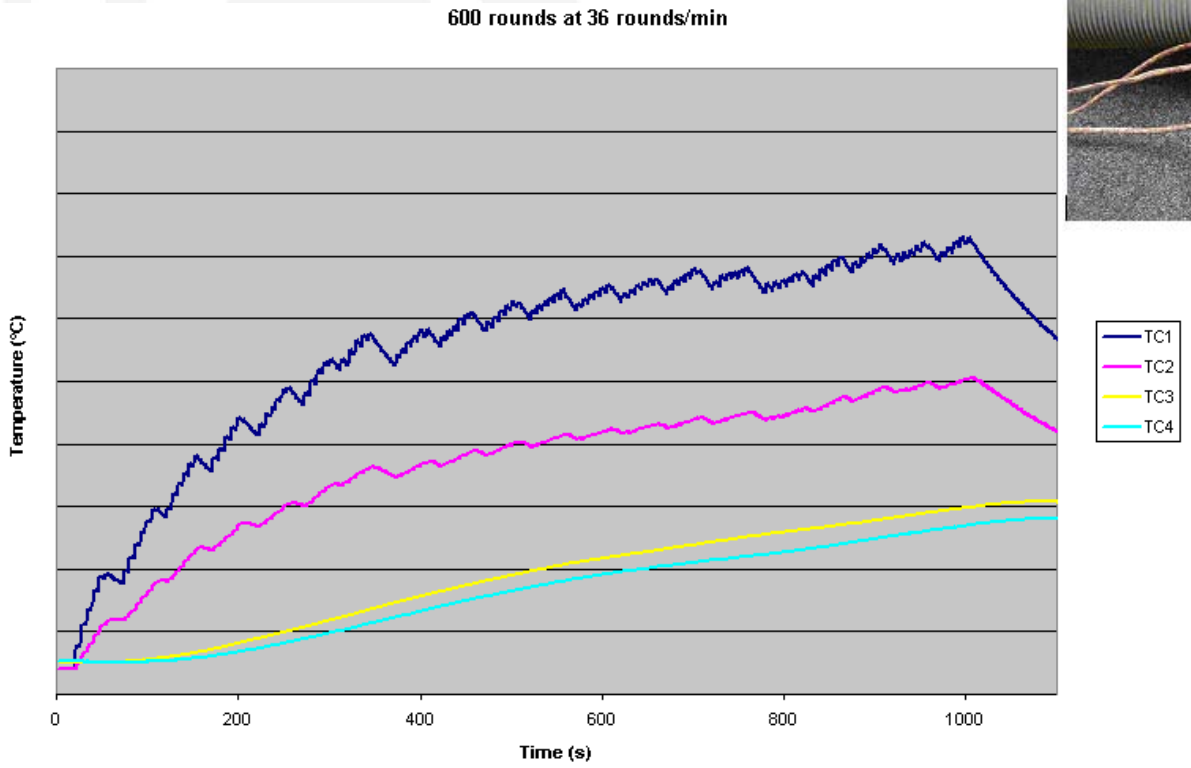


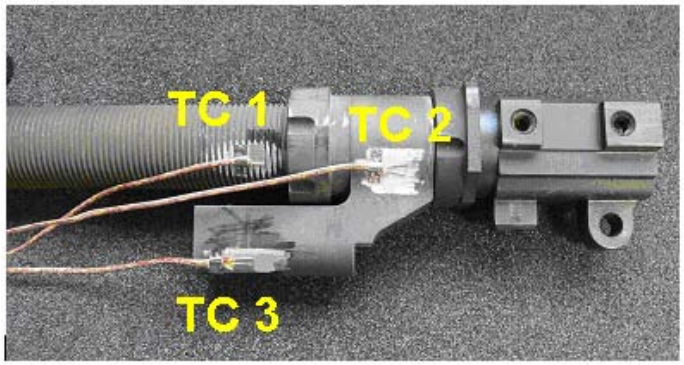
Correlated with Experimentation



3. Transient thermal analysis (2)

Experimental validation





Thermocouples on barrel

4. Thermal actuator advantages

Thermal activation

- performed at a defined and accurate temperature
- independent from external temperature

Mechanical performance when transitioning (changing phase)

- 0.5 inch stroke
- 120 lbs load capability

Small and simple embodiment

- 2 inches length
- 0.5 inch diameter
- 4 components : housing, piston, seal and phase change material

5. Closed bolt / Open bolt mechanism design

Functional analysis

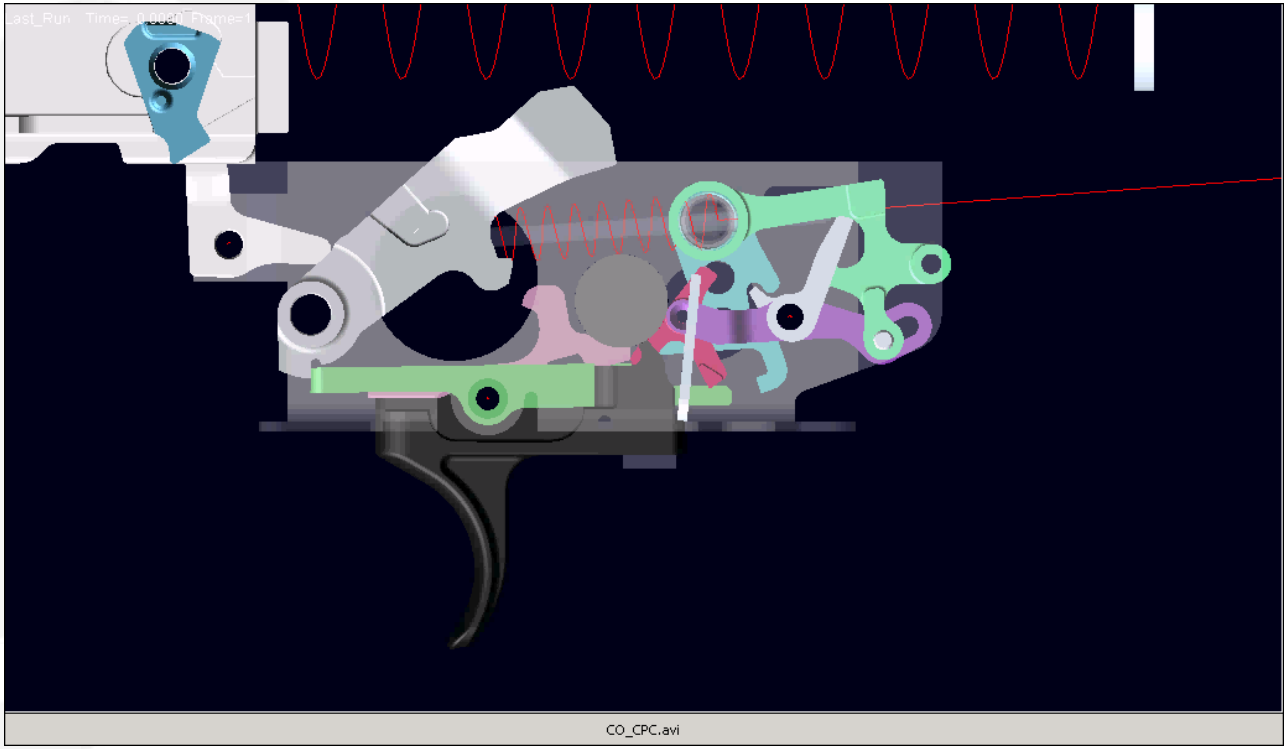
- Closed bolt firing mechanisms
- Open bolt firing mechanisms
- Validation of every function in existing designs

Extensive use of multi body dynamic simulation

- to verify dynamics effects, mechanical efficiency
- to analyze transients, potential failures and their effects
- to analyze robustness of embodiment
    - effect of dust contamination through friction
    - effects of operating group velocity

5. Embodiment

5. Open bolt simulation (semi-auto)



1. First generation HAMR performance

The accuracy of a top class assault rifle

and the firing schedule of a LMG

in a single gun

Accuracy : 2 MOA requirement in semi-auto (M855) demonstrated

Close to 1 MOA when using MK262 ammunition

Firing schedule (600 rounds between cooling):

75 rounds/min for 8 min demonstrated

120 rounds/min for 5 min demonstrated (= LMG firing schedule)

Class III MRBF :

> 20.000 demonstrated

2. First generation HAMR status

- A new, innovative product using mature and robust technologies
- Transparent operation for the user
- One of the major differences between the Assault Rifle and the LMG wiped off

3. Second generation : spiral development

- Main goal : firing 100 rounds before reloading

- Revisit of others functions and concepts of Automatic Rifles and Light Machine guns for making them more efficient for the Dismounted Warfighter

- Potentially significant changes from Spiral 1

4. Conclusion

Questions ?

At FNH USA booth

Further information available

or

Follow on discussions welcome

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