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Small Arms Replacement

Components – Systems - Collective

NDIA
National Defense Industrial Association

Joint Armaments Conference
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TNO Defence, Security and Safety

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Contents

- Introduction
  - Context
  - TNO
- Small Arms Modeling
  - From component to system to the performance of the collective
    - *Integration of functions, less components, improvement of weapon parts and the effect on both the Weapon System and Performance of the Weapon mixes (collective).*
- Concluding Remarks

Introduction

- Context
  - The Dutch MoD is currently in a definition phase for the replacement of a large group of its Small Arm Weapon systems .
- TNO
  - TNO founded by law (1932), non governmental organisation and has no share holders.
  - TNO will support the MoD in this replacement program.


Dutch Small Arms Replacement Program

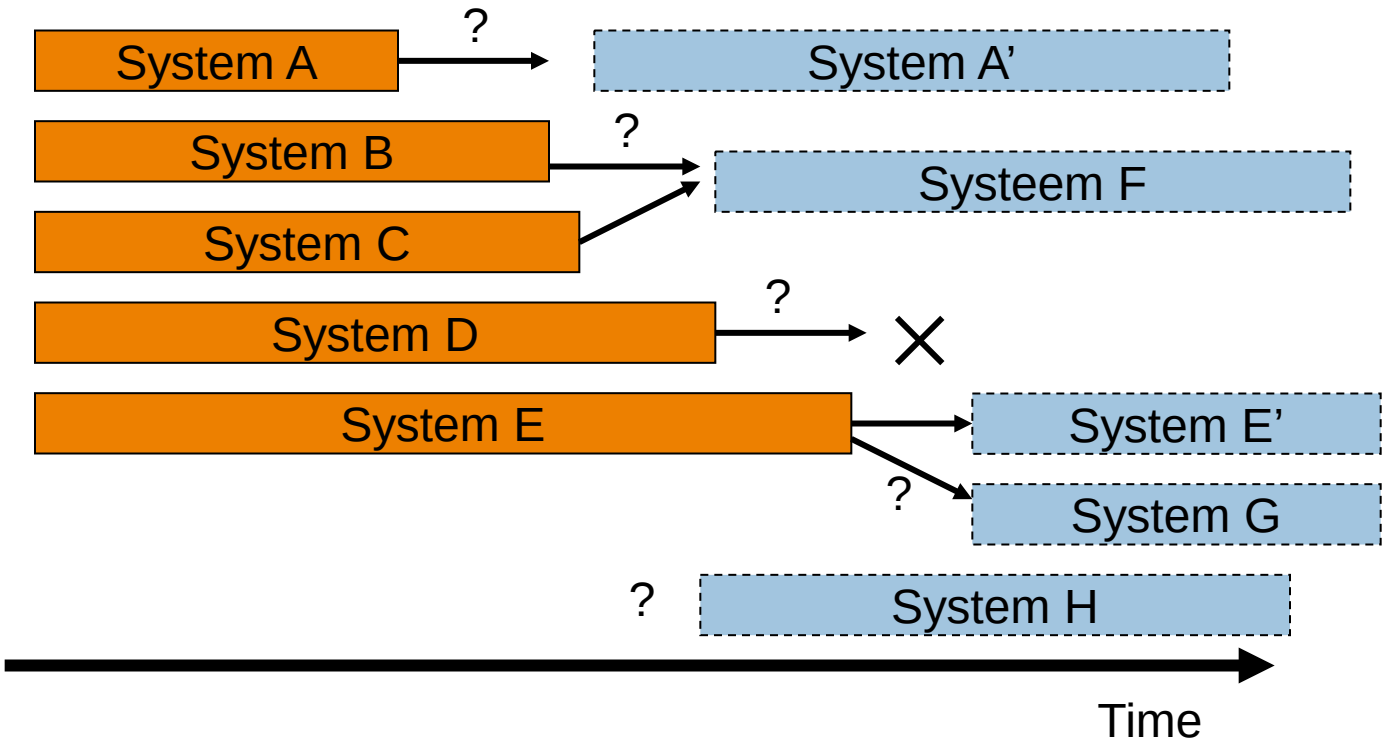
- Replacement / upgrade Small Caliber Weapons

- **Operational**
  - Need for more (different) effects
  - Overgrowth of small caliber (weapons, munitions, peripherals)
- **Technical**
  - New Technologies are emerging
  - Increasing integration of weapon functions
- **Financial**
  - Increasing pressure to reduce lifetime cost

Can we do more (effects) with less (weapon systems)?

Military context

- Phased acquisition of the small- calibre systems
- Make the right decision at every milestone in the acquisition phase

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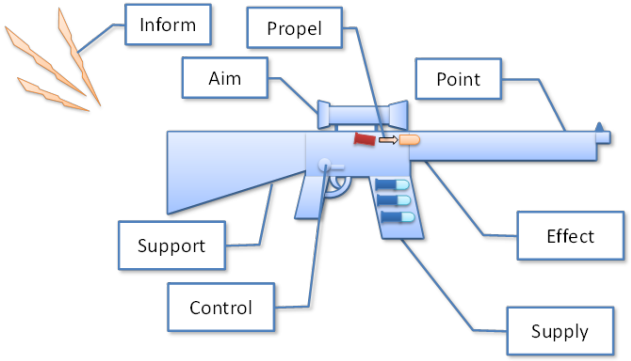
TNO Research Program:
Next generation small arms systems

- *In 2011 TNO was awarded a research program "Next Generation Small Arms Systems" (V1135) to support the acquisition effort.*

- *The purpose of the research program is to support the armed forces by combining and analyzing key performance indicators in order to compose the best possible and procurable set of future small arms systems.*

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TNO Research Program:
Next generation small arms systems

Small Arms Wiki database

HAGAR

IWARS

HALVAR

ODIN

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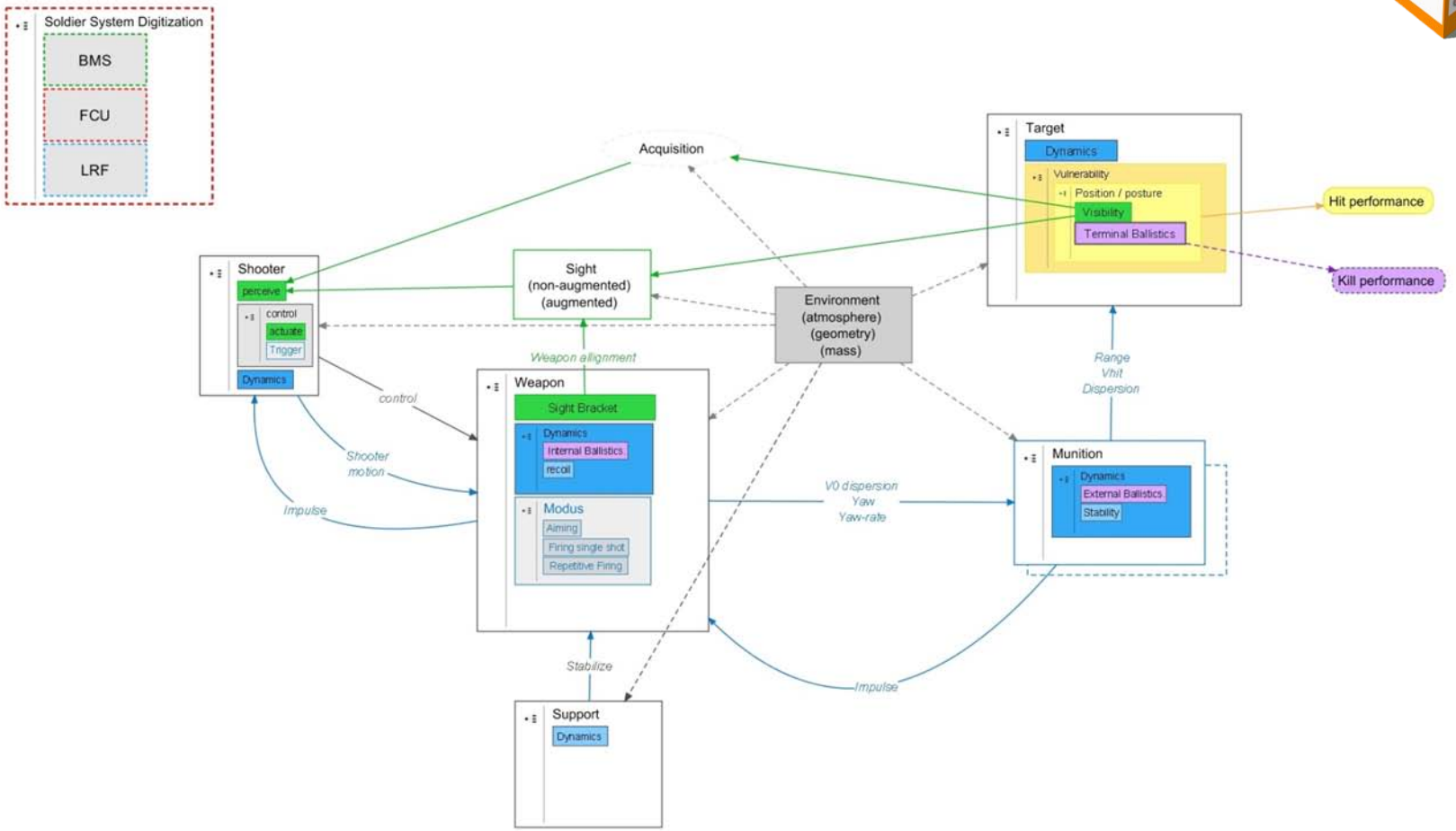
The HALVAR Weapon model



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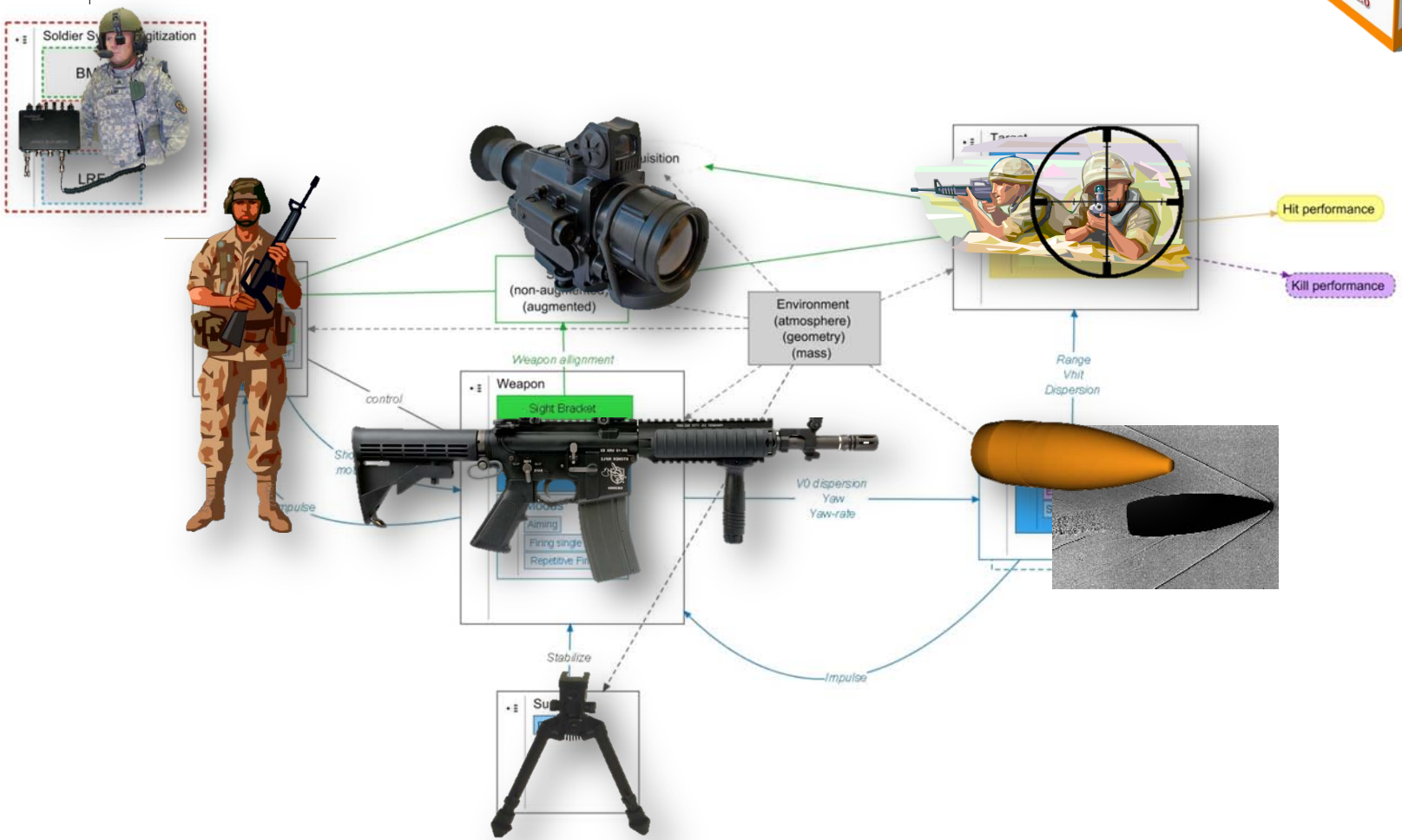
The HALVAR Weapon model



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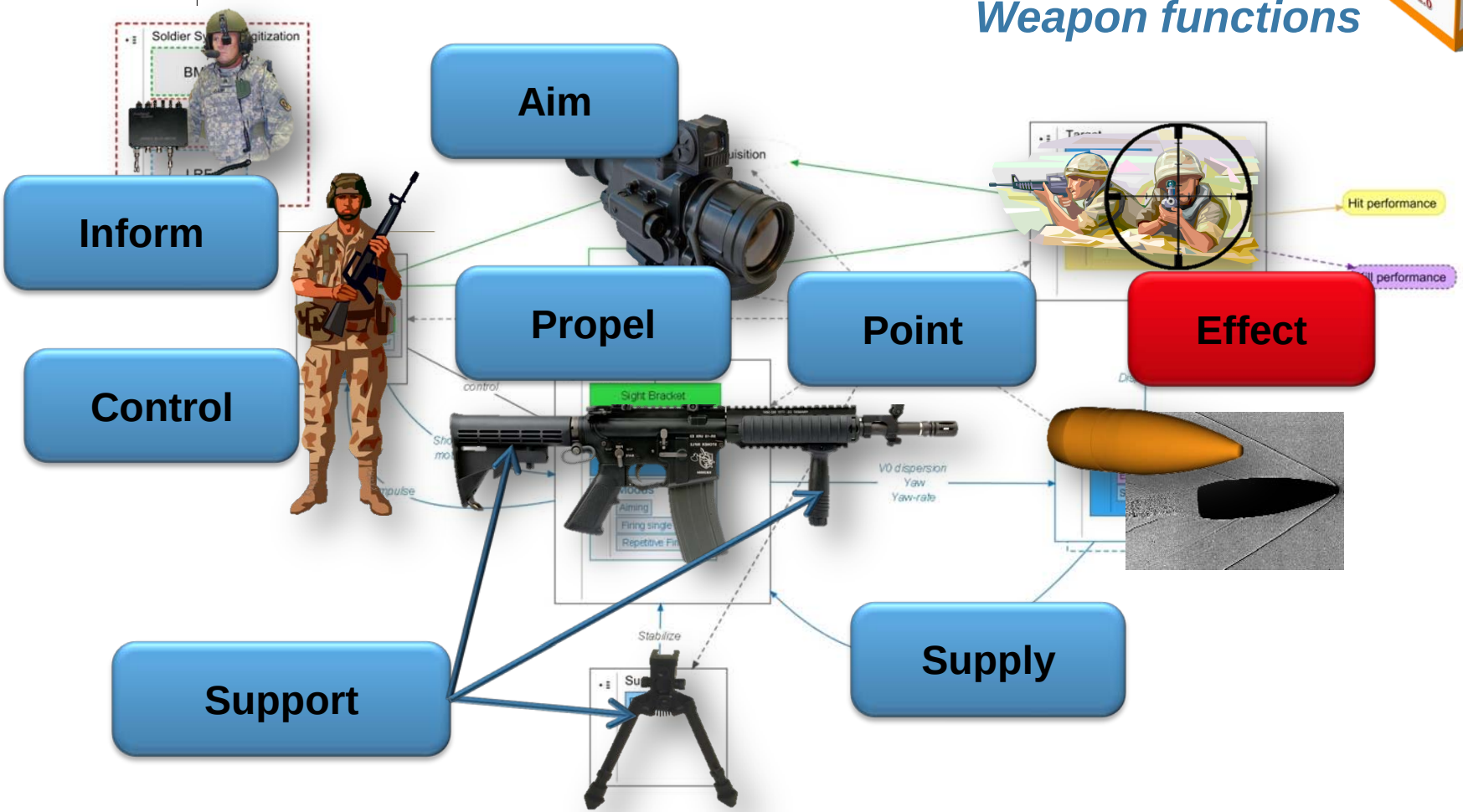
The HALVAR Weapon model

Weapon functions



One function can be divided over different components

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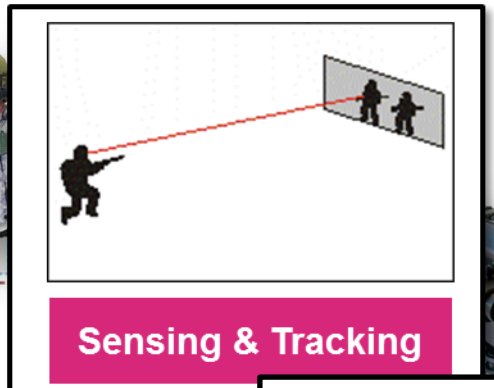
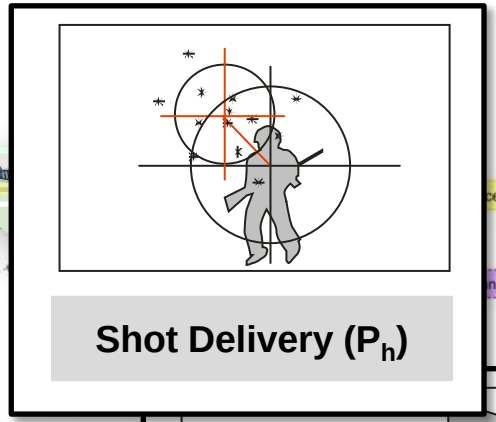
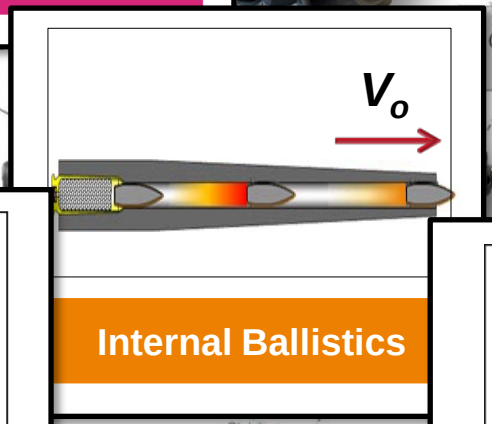
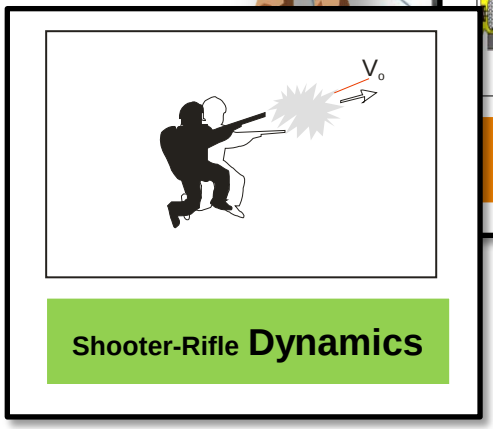
The HALVAR Weapon model

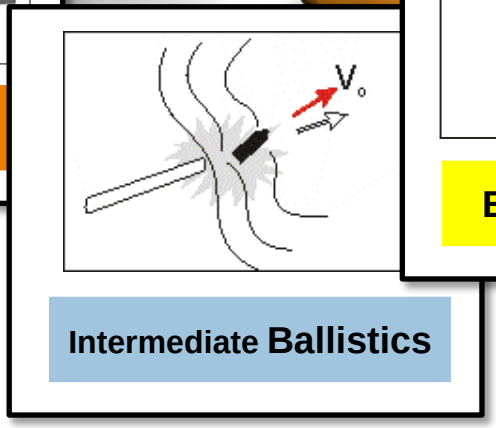
Multi Aspect modeling

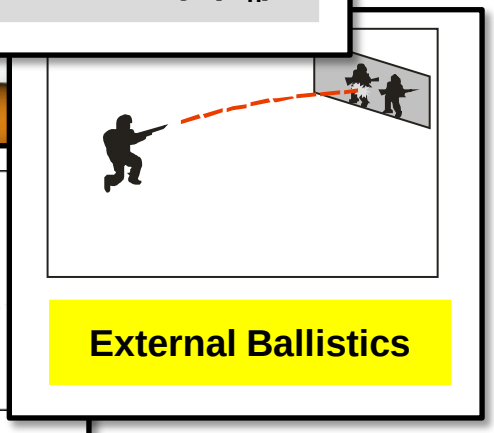


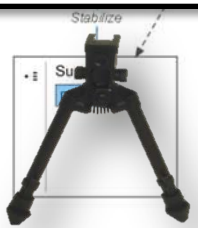










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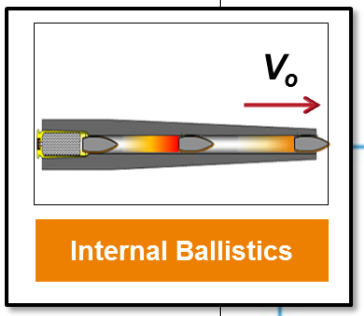
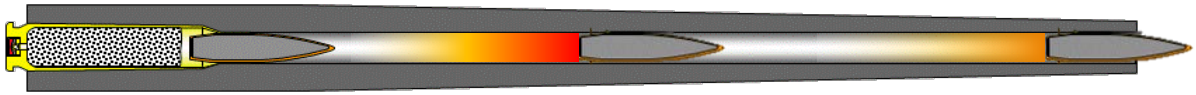
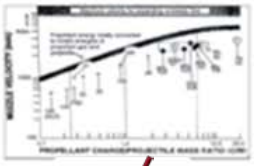
Multi-Resolution modeling

First Order → Higher Resolution modelling

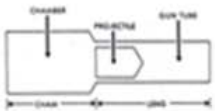




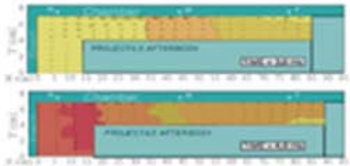
Emperical

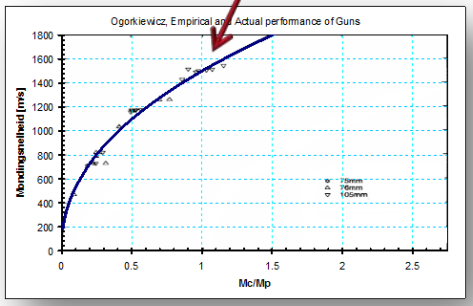


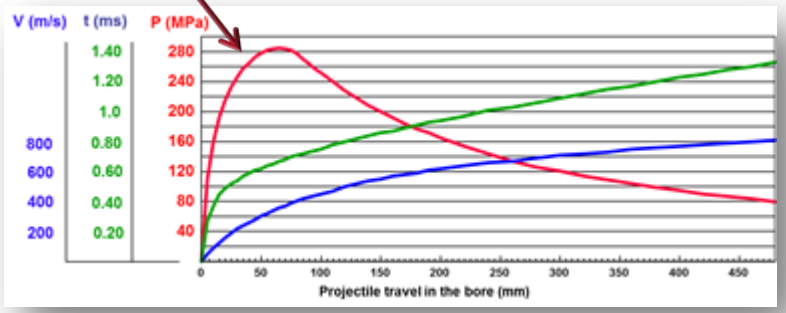
Lumped Thermodynamic (Bear Frankle, TiBalCo en IBHVG2)



CFD (Computational Fluid Dynamics)







$$v_m = 1500 \cdot m/s \cdot \left(\frac{m_c}{m_p}\right)^{0.45}$$

Result Internal ballistic calculation
(Bear Frankle)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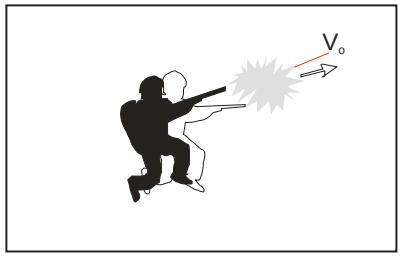
Example implemented aspect models



Shooter-Rifle Dynamics

3DOF

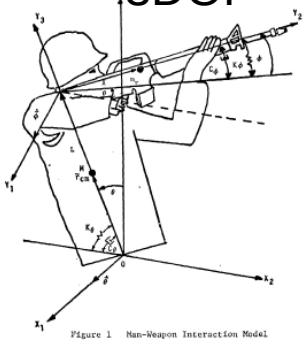
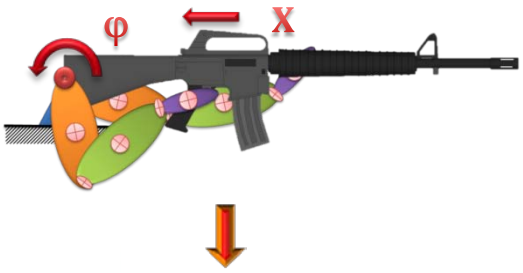
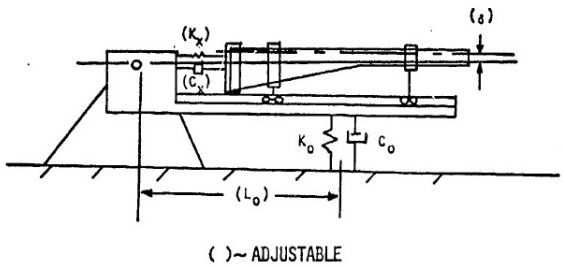


Figure 1 Man-Weapon Interaction Model

2DOF





- *Shooter-Rifle dynamics*
  - 2 DOF simplification
  - Validation model with experiments on proof stand

* T.D. Hutchings et al., *Study of Man-Weapon Reaction Forces Applicable to the Fabrication of a Standard Rifle Firing Fixture,* U.S. Army Armament Command Research Directorate, 1975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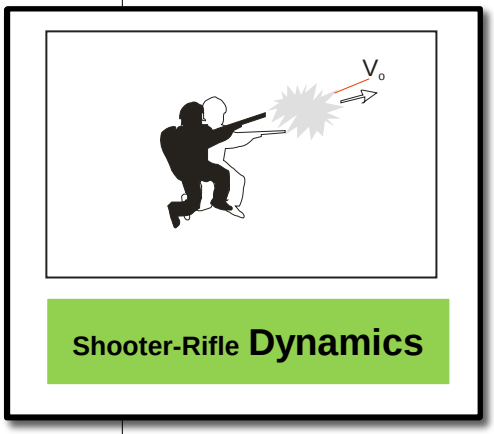
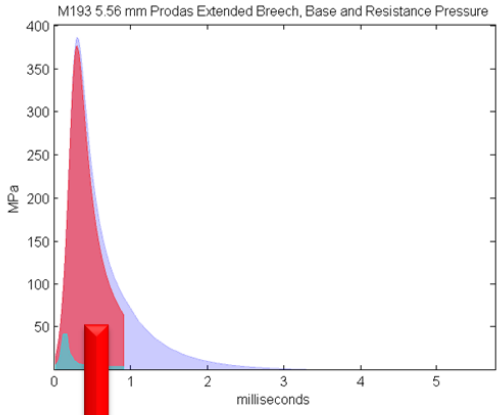
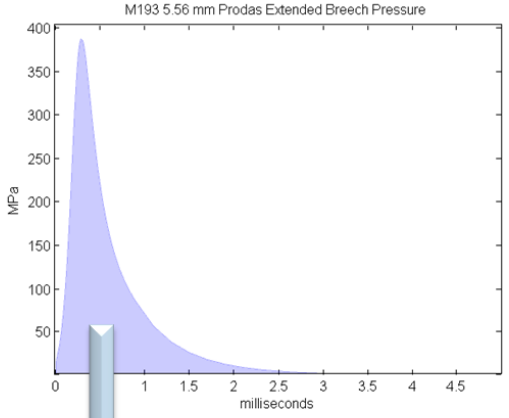
Example implemented aspect models







Projectile Acceleration

Basis for Recoil Force

- *Model Input*
  - *Internal ballistics*
  - Weapon mass and moments of inertia
  - Biomechanics: Properties of the human body (masses, inertia and (spring) stiffness)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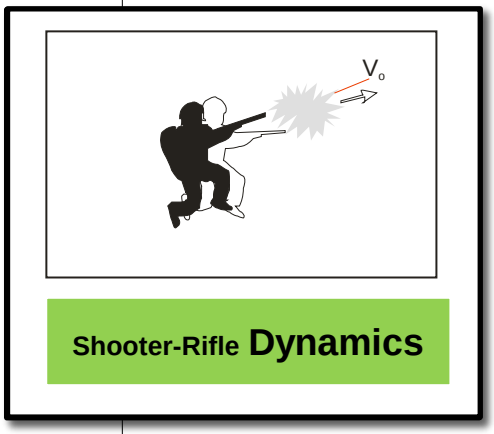
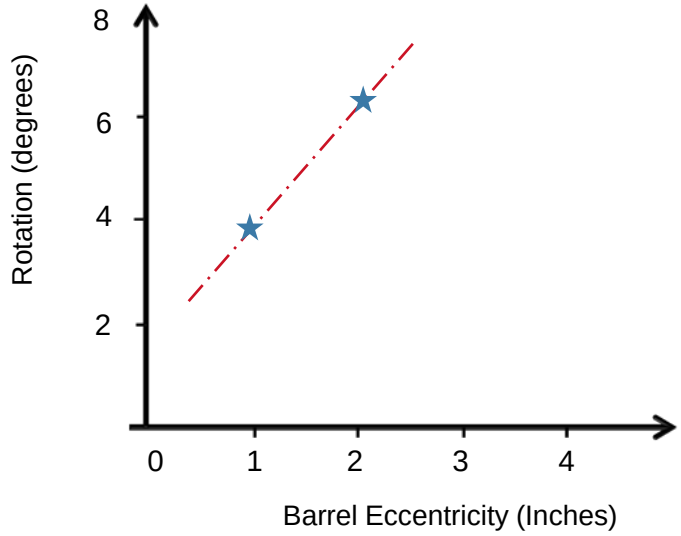
Example implemented aspect models



Eccentricity



- *Model Output*
  - Weapon Rotation as function of:
    - Eccentricity (δ)
    - Rate of Fire
    - Impulse

*T.D. Hutchings et al., *Study of Man-Weapon Reaction Forces Applicable to the Fabrication of a Standard Rifle Firing Fixture,* U.S. Army Armament Command Research Directorate, 1975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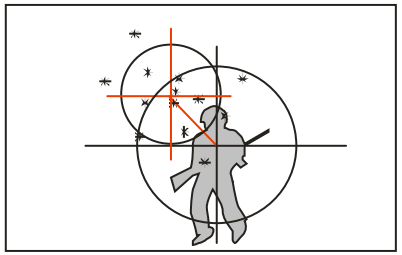
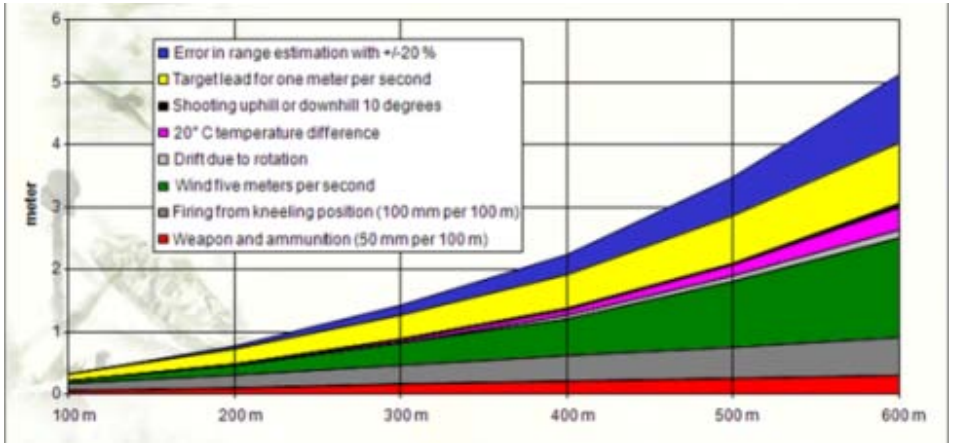
HALVAR Output



Shot Delivery (P_h)



- A important output van HALVAR is, *shot delivery or placement,* as a result of the different small variations in the input parameters (error budget)
  - The shot delivery will be established by Monte Carlo simulations

Per G. Arvidsson *Presentation:*
"Is there a problem with the lethality of the 5.56 NATO caliber? … No", Shrivenham, 2010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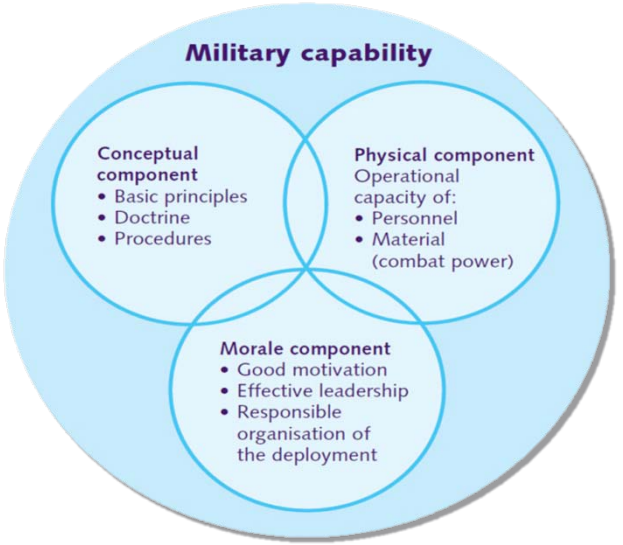
HAGAR

- HAGAR is the environment for modeling the human opponent, and it is a framework by itself.
- HAGAR shall facilitate the linkage between small arms performance and its influence on state and actions of the human opponent.
- The rationale for HAGAR can be found in recent military doctrines.

The appreciation of military success becomes less about 'kinetically' defeating the enemy.
Instead, it is more about producing the right effect in the opponent and turning around an engagement in your favour.

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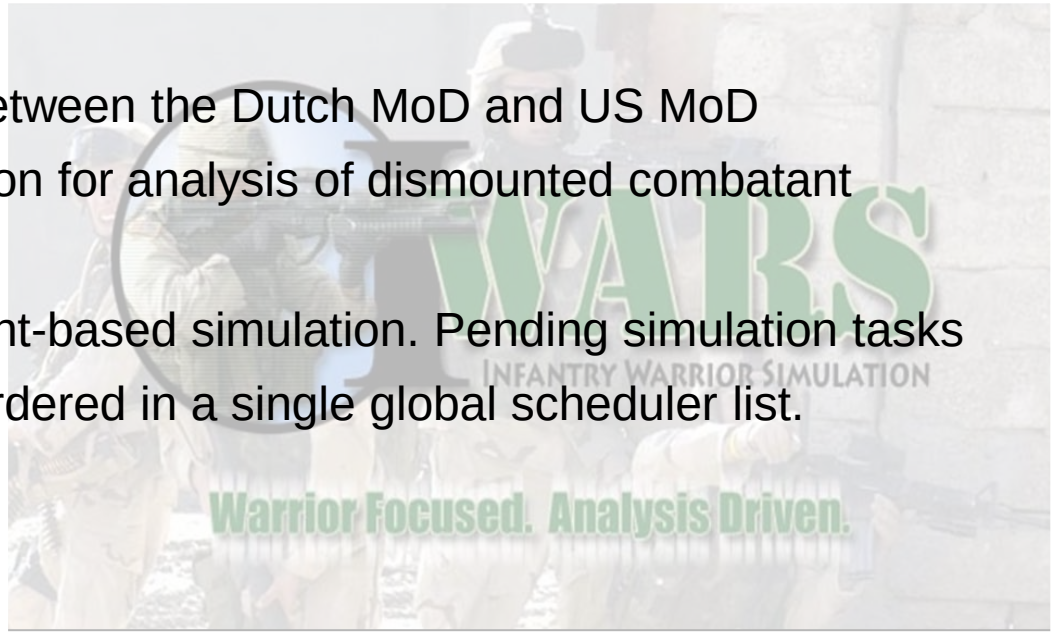
IWARS

- For modeling the weapon collective performance in combat scenarios the simulation tool IWARS is used.
- IWARS:
  - Project Agreement between the Dutch MoD and US MoD
  - Constructive simulation for analysis of dismounted combatant operations.
  - Hybrid time- and event-based simulation. Pending simulation tasks are chronologically ordered in a single global scheduler list.



AMSAA Excellence in Analysis

TSE Technology Solutions Experts, Inc.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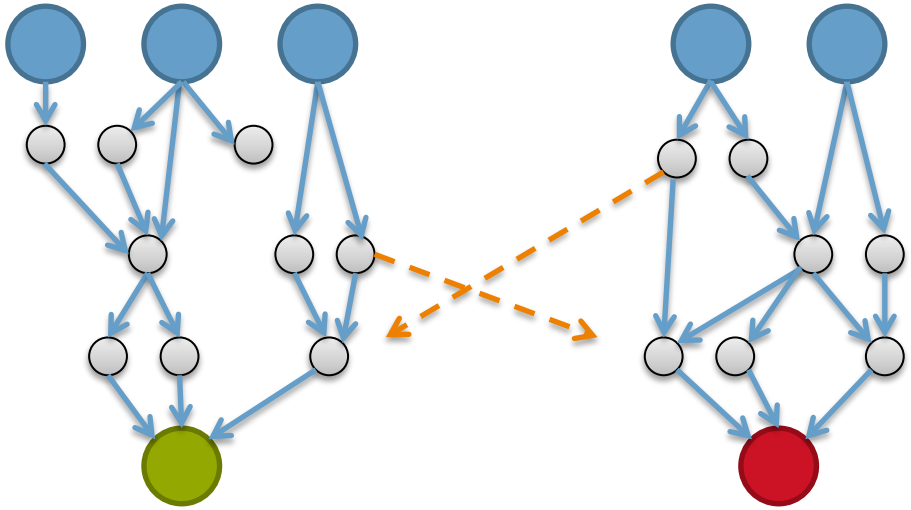
ODIN

- ODIN will be based on the ‘Effect-Based Solver’ developed by TNO
- *To answer questions on the effect the introduction of new weapon systems on aspects like: logistics, maintenance and training (of the collective).*

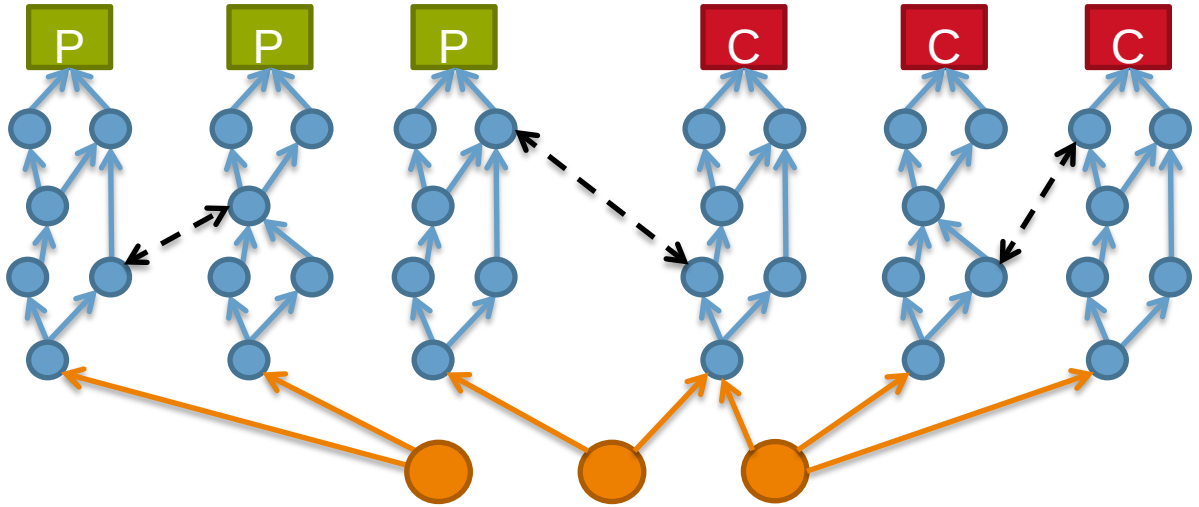


Characteristics weapon collective

Profits versus Costs

ODIN

- ODIN will be based on the ‘Effect-Based Solver’ developed by TNO
- *To answer questions on the effect the introduction of new weapon systems on aspects like: logistics, maintenance and training (of the collective).*
- With ODIN a comparison can be made for the Costs and Profits of different Small Arms Collectives.

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Concluding remarks

- In this presentation a short overview has been presented of the TNO capabilities on Small Arms Modeling and Simulation.
  - From component to system to the performance of the collective of weapon systems.
  - With this toolbox TNO will be able to answer questions like:
    - *What does a new technology bring for the weapon performance*
    - *Can optimal weapon mixes be defined?*
    - *How does the introduction of a new weapon influence the training, maintenance?*

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Questions?

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