



Ammunition and Weapon Effects in UT

Prepared for 2011 - ISB symposium, Miami, US

Theo Verhagen & Martin van de Voorde
TNO – the Netherlands



Ammunition and Weapon Effects in Confined Urban Theatre in the vicinity of own troops

- ▶ Why
- ▶ IST
 - ▶ Experimental program
 - ▶ Understanding
- ▶ Awareness
- ▶ Demands
- ▶ SOLL



Why

Buildings & Fortifications are part of modern operations

Operational units are unfamiliar with:

- the 'quality' of the encountered target;
- the ammunition effects;
- operational risk and safety in confined space;
- (3D) application restraints;
- ...

The available ammunition types

- have to be used;
- are procured within another mindset.

Impact:

- Ammunition consumption
- Logistic support
- \$\$\$\$\$\$

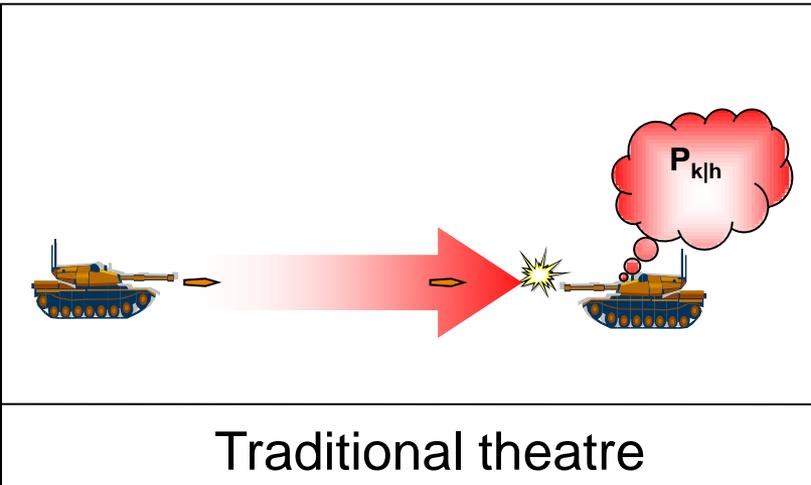
Mid-calibre ammunition

- 100 m distance
- Burst of 3 shots (5 times)
- Centre of target
- Penetration found

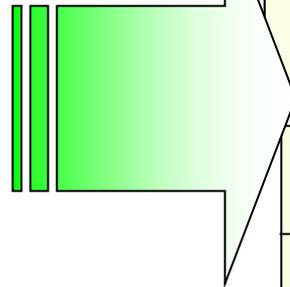
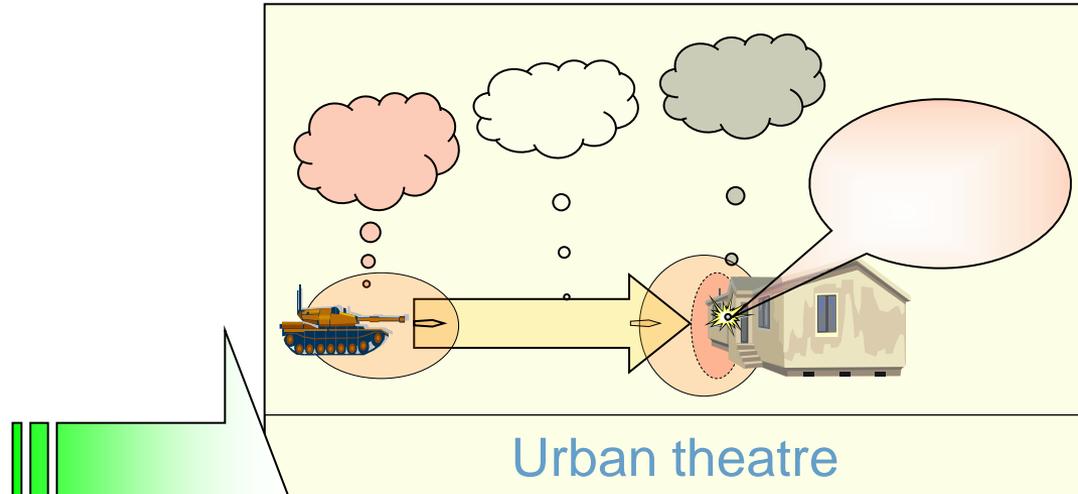




Transition: *from past to present and beyond...*



Measures of Performance
Ammunition Requirements
Ammunition Effects
Fire doctrine
Development



<i>Measures of Performance??</i>
<i>Ammunition Requirements??</i>
<i>Ammunition Effects???</i>
<i>Fire Doctrine??</i>
<i>Development??</i>



IST: Experiments...

ammunition effect on, in front and behind the target

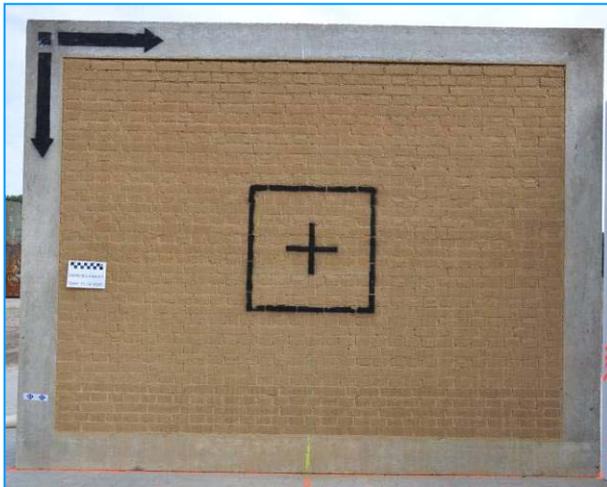


Wall (outer)
(inner wall)

- Ammunition
- Weapon system
- Impact velocity
- Weather conditions
- Photography
- Witness screens
- High Speed Video
- Blast measurements



Targets used



- › Thickness:
 - › 80cm - 40cm - 20cm
- › Build-up
 - › Drying time > 14 weeks

Mass (incl. frame) >> 7000 kg



- › STANAG4536
 - › Thickness: 20 cm
 - › Double reinforcement
 - › Reinforcement: 9mm bars at width of 10 cm



› Indirect fire (155mm)



› Tank (120mm)



› AT/ASM



› IFV (25 – 30 – 35 mm)



› Air-to-ground (20 – 25 – 30mm)



› Infantry (12.7mm)





'AMMUNITION' 'IST+' considered

AP-HE-MP-ABM-PELE-FAP

12.5mm (...)

20mm

25mm (YPR)

30mm

35mm (CV9035)

120mm (Leo2A6)

155mm (PzH)

60-90-110mm AT

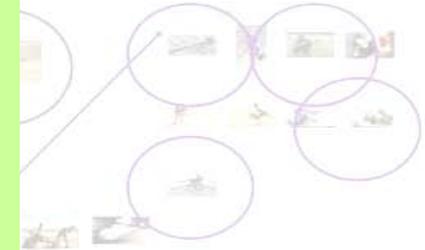
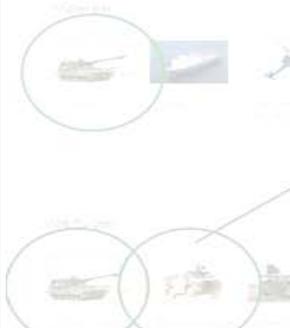
&

TP

Firing distance 20-200 m

0 NATO & 45NATO

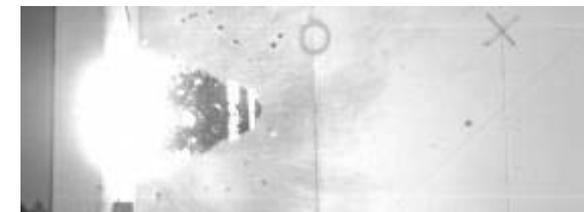
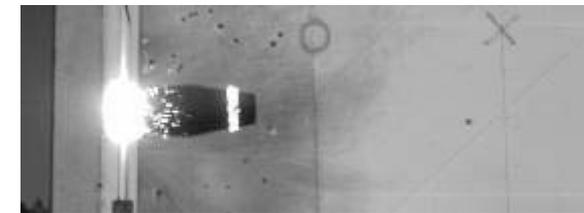
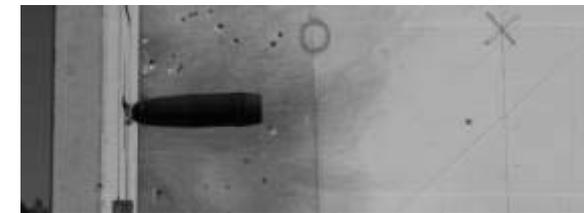
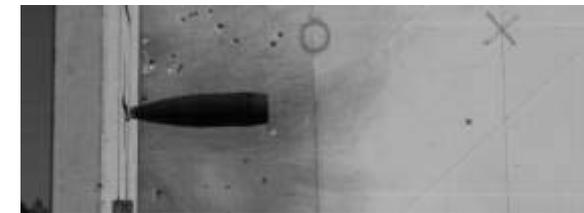
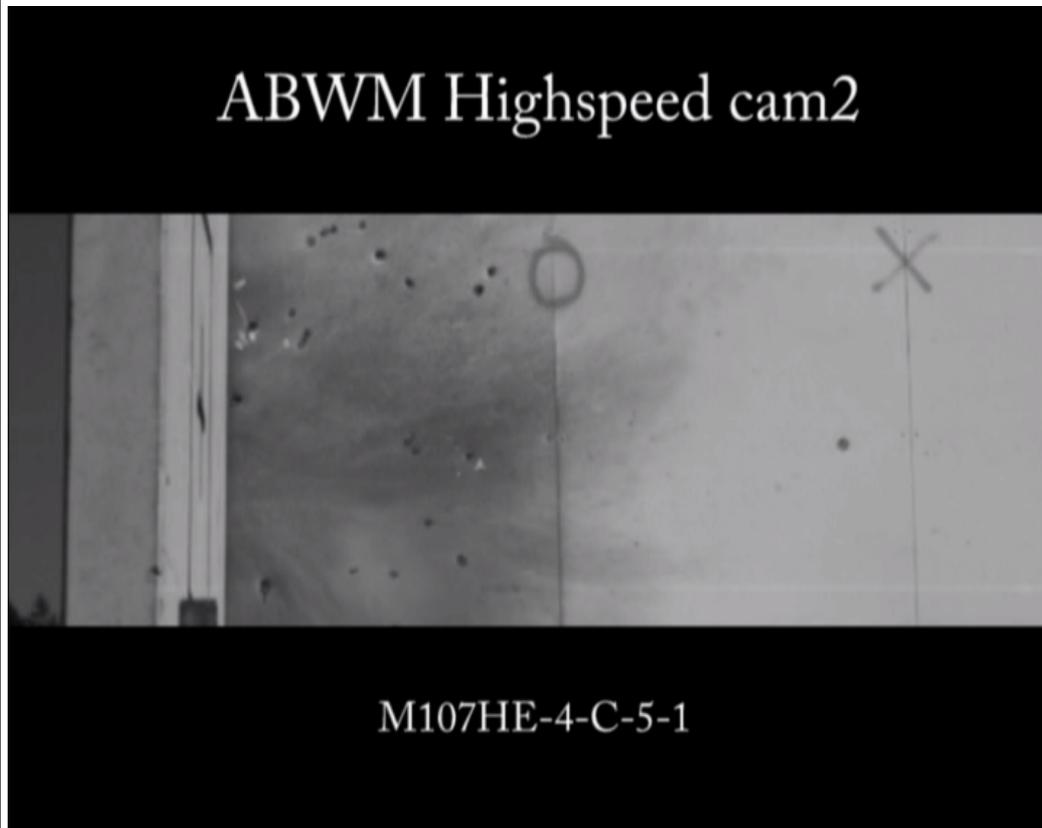
ADOBE-CONCRETE-BRICK



30mm GK
30mm BushII
127mm

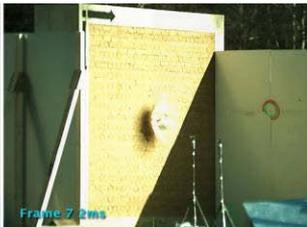


HE (M107) on concrete (zoomed) ... Functioning of ammunition by impact...





High speed video frames...





35 mm APFSDS (DM43) on 80 cm // 40 cm Adobe wall

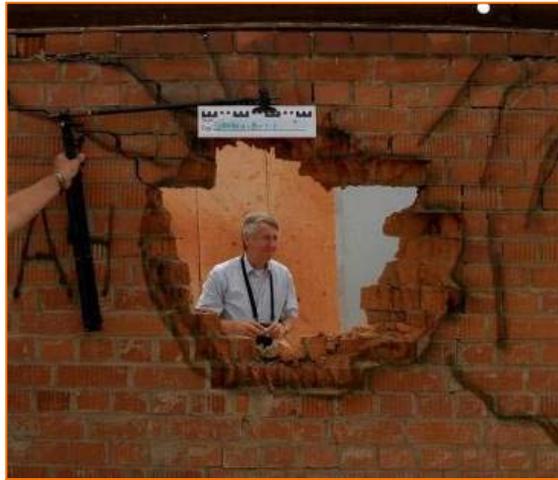




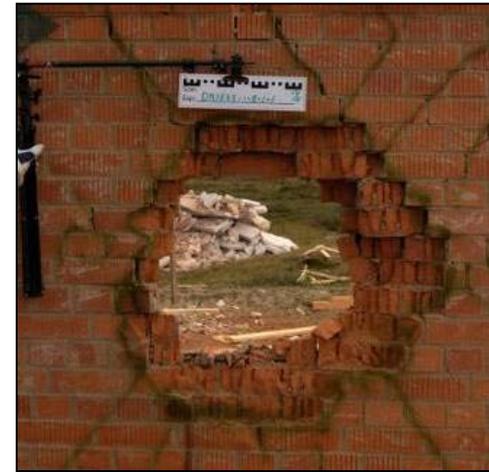
Breach effect



HEAT TP (DM18A4)



HEAT TP (DM18A5)



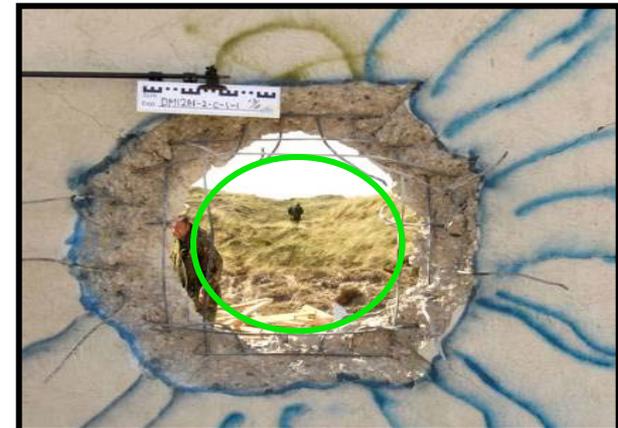
HEAT TP (M831)



HEAT TP



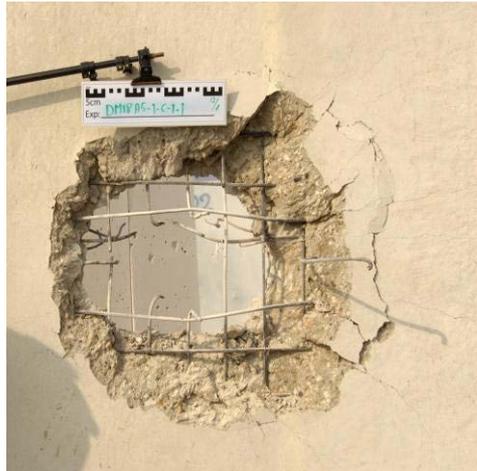
HEAT



HEAT << **S/A distance**



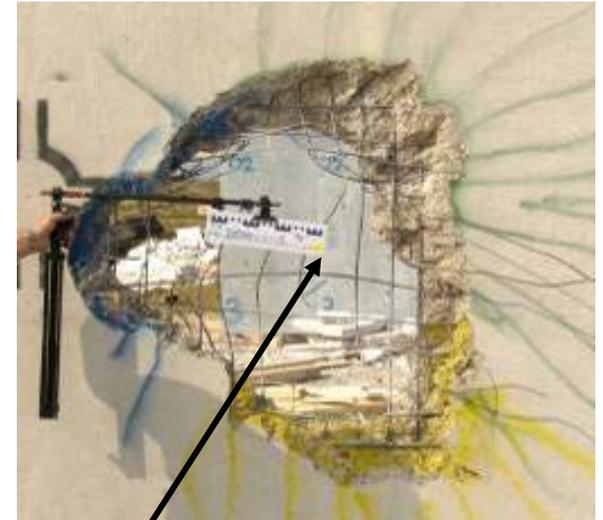
Multiple impacts



DM18A5 (1st shot)



DM18A5 (2nd shot)

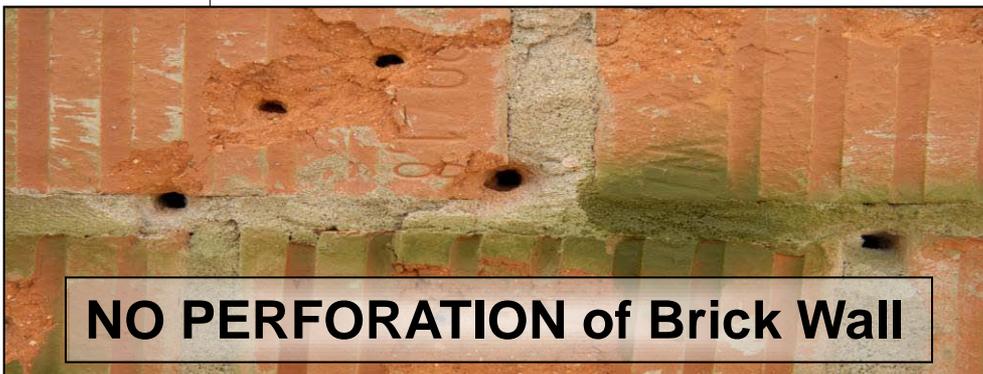


DM18A5 (3rd shot)

Breaching (crater) effect is limited due to reinforcement



35 mm KETF (nr468) programmed Airburst: ignition at various distances



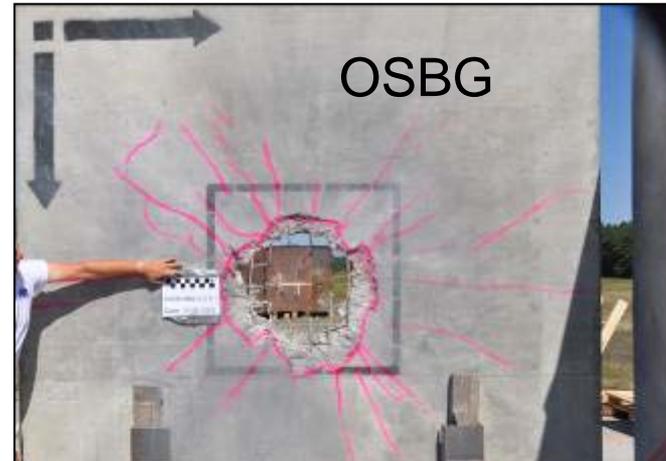
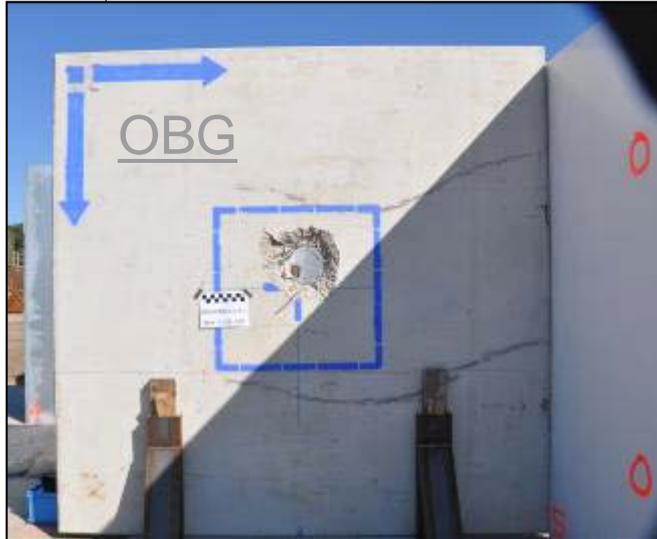


35 mm KETF (nr468) **unprogrammed** (Brick & Adobe wall)





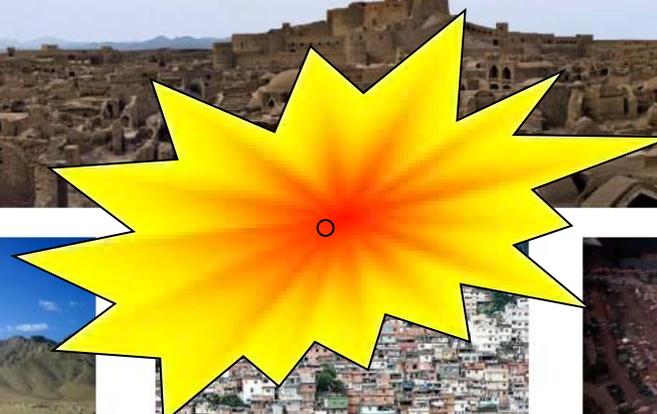
155mm effect on concrete target





Current 'IST' situation...

based on more than 250 firings...





Qualitative Data Analyses



“Would you tell me, please, which way I ought to go from here?”

“That depends a good deal on where you want to get to”, said the Cat.

“I don’t much care where ...” said Alice

“Then it doesn’t matter which way you go”, said the Cat

“... so long as I get somewhere”, Alice added as an explanation.

”Oh, you’re sure to do that”, said the Cat, “if you only walk long enough”

From: Alice’s Adventured in Wonderland, part VI “Pig & Pepper”, Lewis Carroll 1865



Qualitative analyses

Perforation



Fragments after the wall



Breaching



Structural integrity

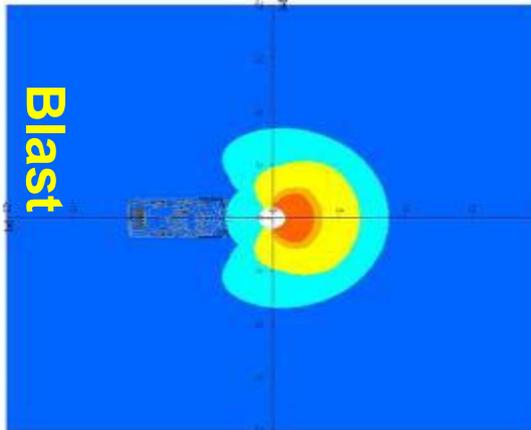


Risk for own personnel





and other effects



**Operations
in
modern, confined theatre
includes
operational safety and risk
for own and friendly troops,
including third parties.**



POTENTIAL COMMANDERS OBJECTIVES	Ammunition				
	???	???	???	???	???
Defeat target in front	-	+	+	+	+
Defeat target after wall	-	+	-	+	+
Breach wall	+	-	-	-	+
Defeat infra	-	-	-	-	+

POTENTIAL AREAS OF COMMANDERS CONCERN	Ammunition				
	???	???	???	???	???
Around weapon platform	+	-	-	+	-
Flight zone	-	+	+	-	-
In front Wall	-	-	+	-	+
“Integrity” Wall/infra	-	-	-	-	+
Behind Wall	-	+	-	+	+



Some thoughts...

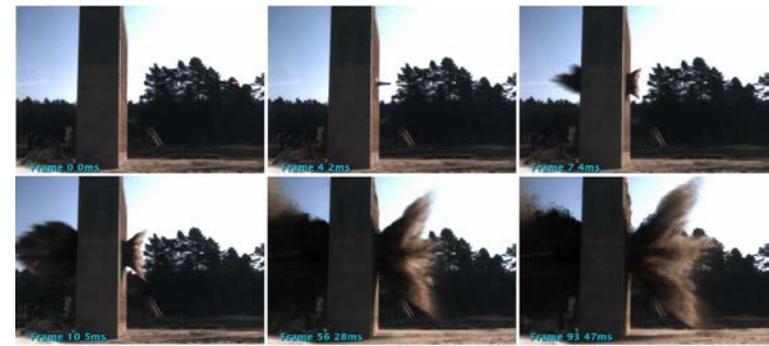
Ammunition and threat mechanisms generated

		Threat Mechanism					
		Blunt	Rod	Frag ment	Jet	Charge	???
Ammunition type	TP	X					?
	AP		X				?
	AT				X	X	?
	HE			X		X	?
	HEAT			X	X	X	?
	??		?	?	?	?	?



Some damage observations ... in front / behind the wall ...

	Threat Mechanism					
	Blunt	Rod	Fragment	Jet	Charge	??
Front debris	Minimal	Minimal	Minimal	Minimal	Much	
Behind deb.	yes	minimal	minimal	minimal	much	
Res threat	no	yes	no	yes	possible	

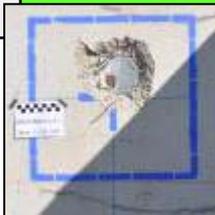




Some damage observations... on the wall



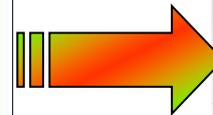
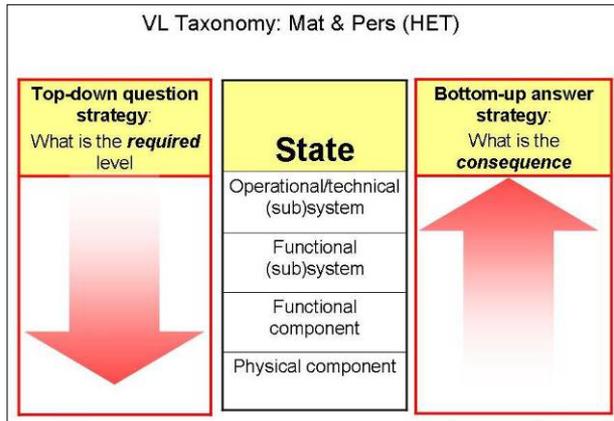
	Threat Mechanism					
	Blunt	Rod	Fragment	Jet	Charge	??
Cracks front	Minimal	Minimal	No	No	Yes	
Crater front	Minimal	Minimal	no	Minimal	Yes	
Perforation \emptyset	$\sim \emptyset$	$\sim \emptyset$ rod	no	$\sim \emptyset$ jet	Large	
Crater rear	relative	Minimal	No	Minimal	Yes	
Cracks rear	relative	Minimal	No	No	Yes	
Reinforcement	Local	Local	Intact	Local	Intact	
Deflection	minimal	No	No	No	Yes	
Integrity	Intact	Intact	Intact	Intact	Damage	





VL TARVAC assessment

- VL simulation environment: physical interaction → Military terms



VL based simulations





Our VL modelling focus

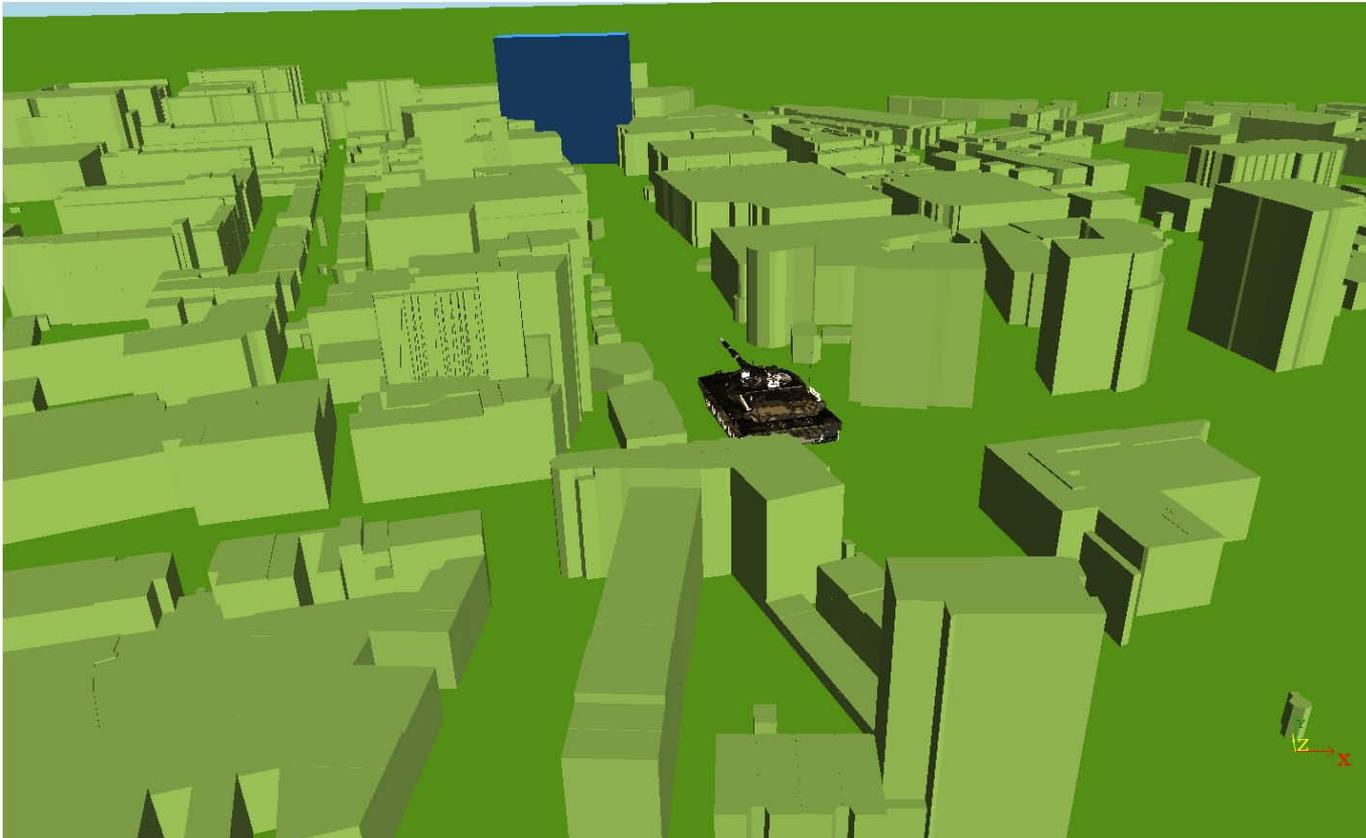
- › To assess ammunition – target interaction effect in terms of:
 - › Measures of Success (“Pk – Bonus”) in combination with
 - › Measures of Concern (“Pk - Malus”).

	Metrics					
	Success	Integrity	Collateral	Risk	Safety	Tempo
Def. target before wall						
Def. target behind wall						
Breach						
Def. infra						



SOLL - Application of gained knowledge

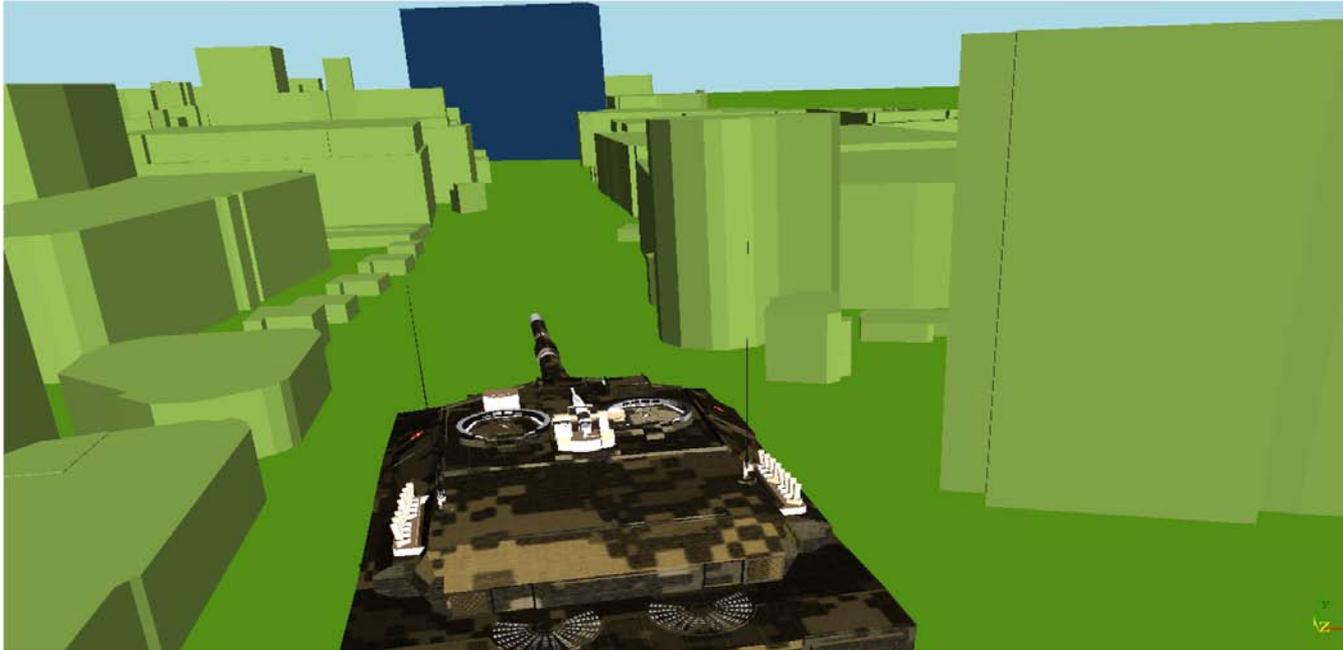
SNEAK PREVIEW





Selection of ammunition

SNEAK PREVIEW



- Mun-1
- Mun-2
- Mun-3
- Mun-4



Gunner view





UO

Combined / joint <-> opposing weapon systems

Munition deployment

Doctrine

O&T

Preparation

Operation

Strategic
Munition
storage

Materiel

Mission
Munition
storage

Personal

Munition
Logistics

Ammunition procurement

Infra

Industry





Conclusion....summary

- › IST
 - › Large scale experimental program & analyses

- › SOLL
 - › Discussion between Defence – Research – Industry
 - › International Standardisation

- › VL TARVAC 7 modelling in progress, including
 - › MOUT targets
 - › Single target -> scenario
 - › Multi-metrics assessment
 - › Time included



PoC Hans Hoeneveld
NL - DMO / Ammunition Department
JC.Hoeneveld@mindef.nl

Theo Verhagen
TNO Defence, Security and Safety
Theo.Verhagen@tno.nl

