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The Missions and Means Framework and the Art of the Trade Study: Combat Power

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Introduction

The Missions and Means Framework (MMF) is an ideal structure for conducting trade studies. MMF has broad applicability in all aspects of the military decision-making and system acquisition process, from requirements development to Live Fire Testing.

In this session, we discuss the MMF trade study process as it relates to requirements development, especially force reconstitution and optimal force mix for specific missions.

The Missions and Means Framework

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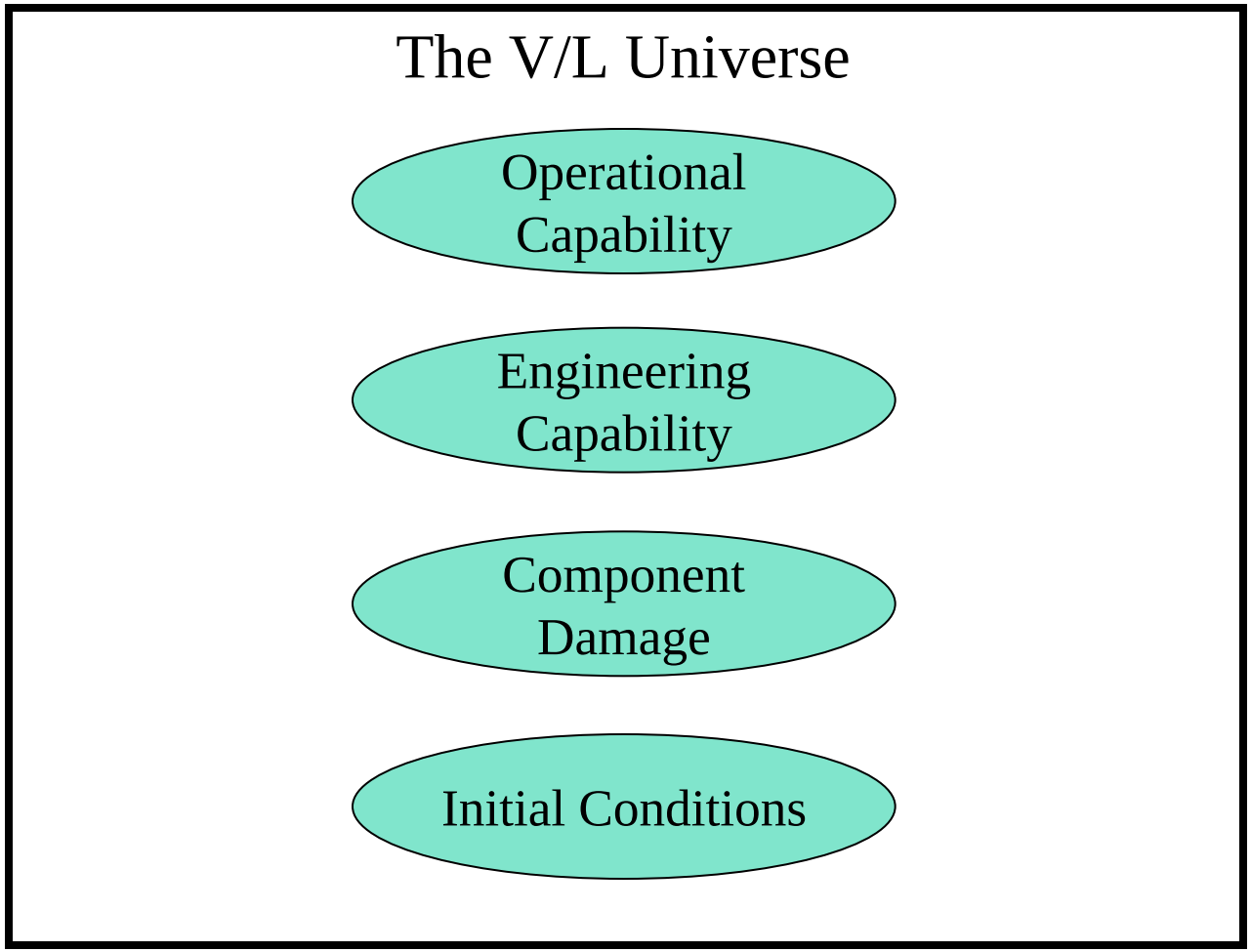
The Vulnerability/Lethality Taxonomy



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Each space is called a Level, numbered 1 through 4. The points in each space are:

Level 4	Operational Capability	Target Operational capability, time.
Level 3	Engineering Capability	Target Engineering capability, time.
Level 2	Component Damage	Component damage state, time.
Level 1	Initial Conditions	Target location and orientation*, threat orientation* and impact location, time.

* Orientation includes velocity and acceleration, where appropriate.

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How would we simulate a military situation?

Situation: A blue soldier fires his weapon at a red soldier.

The simulation needs to answer the question “What are the possible outcomes and consequences for both Red and Blue?”

The starting point:

1. Blue shoots at Red

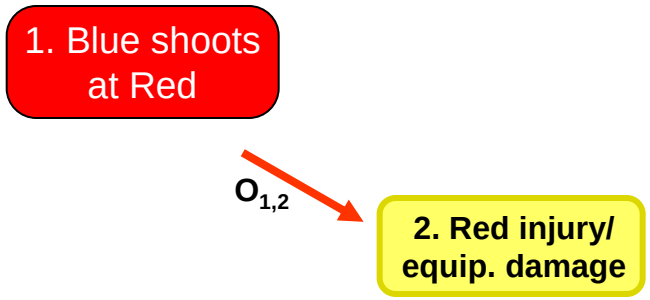
There are any number of possible consequences, including

a) The bullet misses
b) The bullet hits

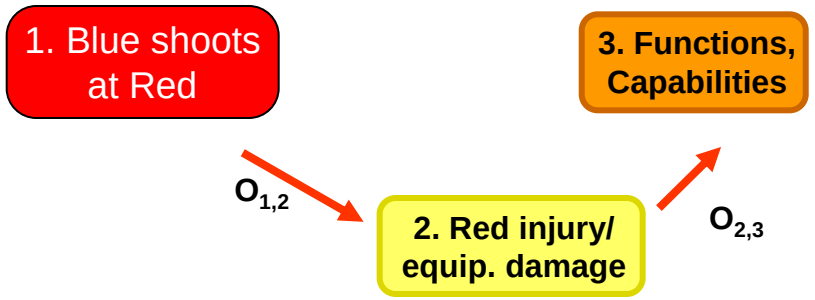
If the bullet hits, the Red soldier and/or his equipment suffers injury/damage;
If the bullet misses, the Red soldier is uninjured and his equipment is intact.

The description of these consequences is called an operator, labeled $\mathbf{O_{1,2}}$

As we proceed, the boxes will be called levels (levels 1 and 2 are shown below) and the actions leading from one box to another are described as operators. Thus, The $\mathbf{O_{1,2}}$ operator goes from level 1 to level 2.



There are resulting consequences for the Red soldier's fighting ability (his functions and capabilities); the description of how injury/damage results in a loss of function or capability is an operator labeled $\mathbf{O_{2,3}}$

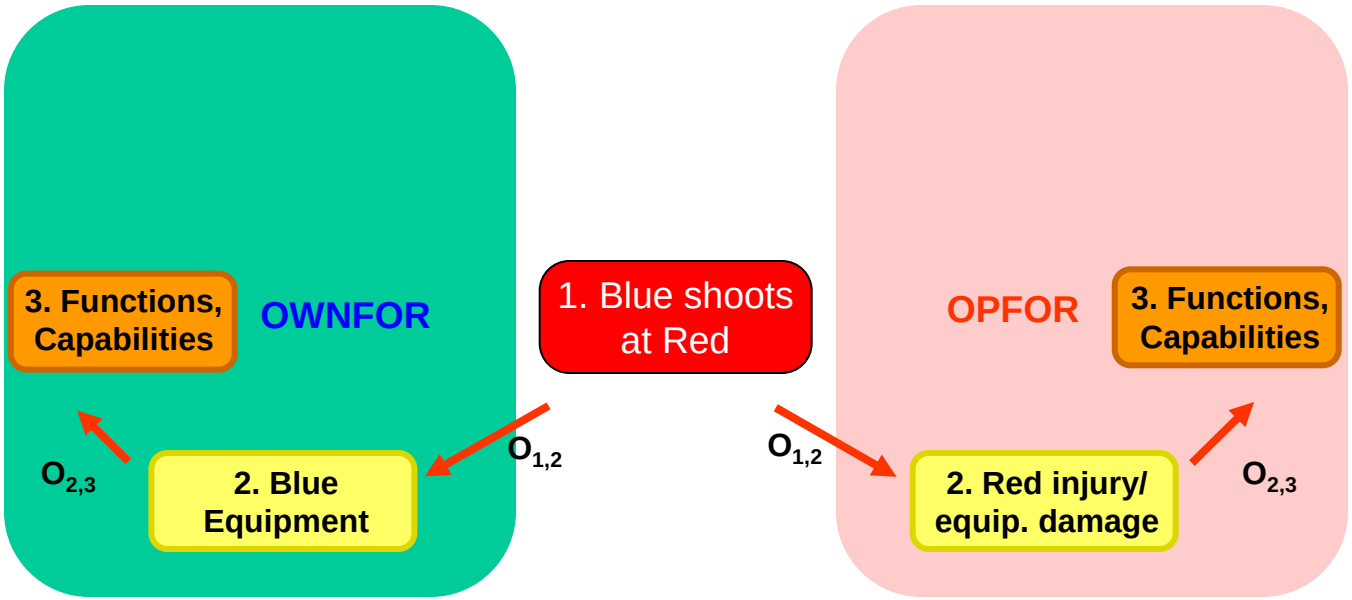


There are also immediate consequences for the Blue soldier.

a) Blue has less ammunition
b) Blue therefore does not have the capability of engaging as many targets as before

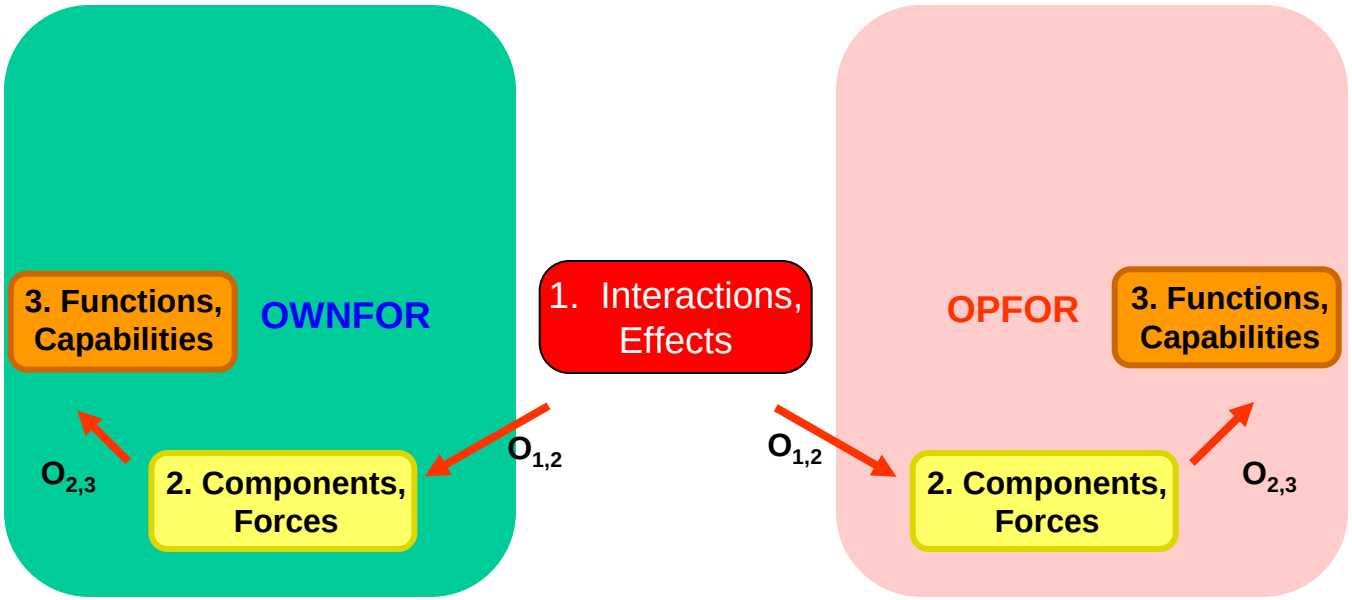
The description of "firing ammunition" is also an $\mathbf{O_{1,2}}$ operator, this time on the "blue" side. The reduced capability (can't engage as many targets as before) is an $\mathbf{O_{2,3}}$ operator.

We can label the two "sides" of this diagram as "OWNFOR" and "OPFOR"



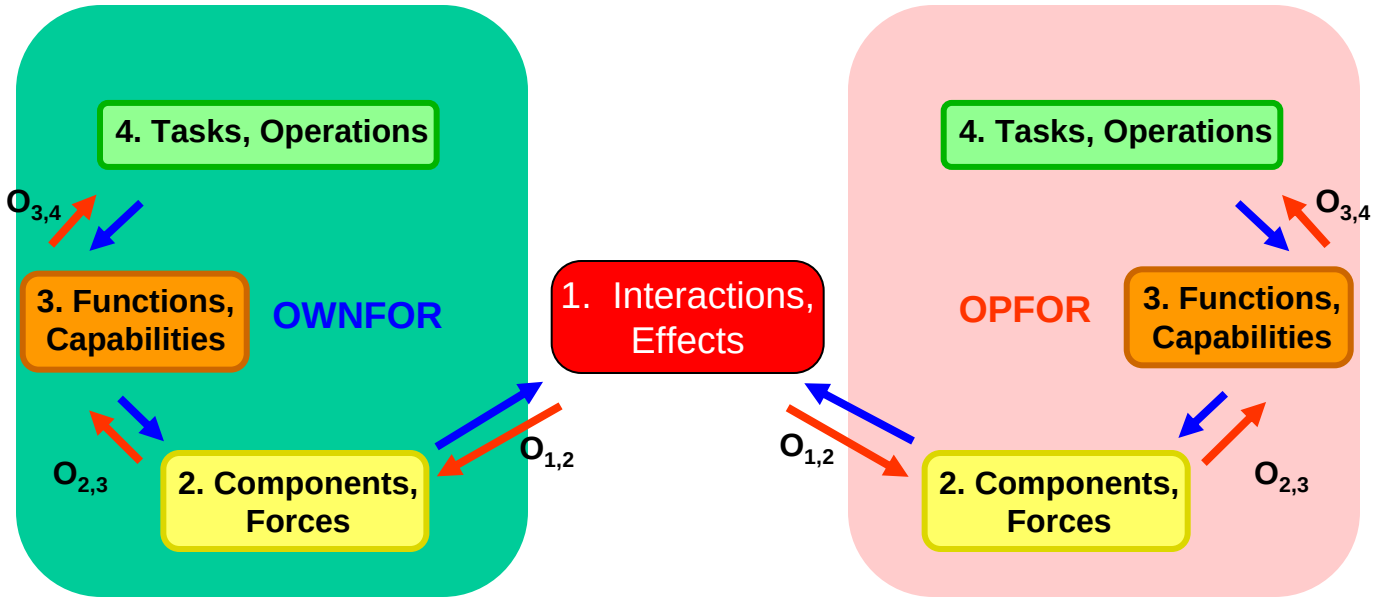
Now, the Red soldier, or perhaps others in his unit, might respond by returning fire. Thus, the consequences ($\mathbf{O_{1,2}}$ and $\mathbf{O_{2,3}}$ operators) cause changes in both Red and Blue components and forces, as well as in their capabilities and/or functions.

The basic military actions (in this case, shooting) and the resulting consequences are labeled “Interactions” and “Effects.”



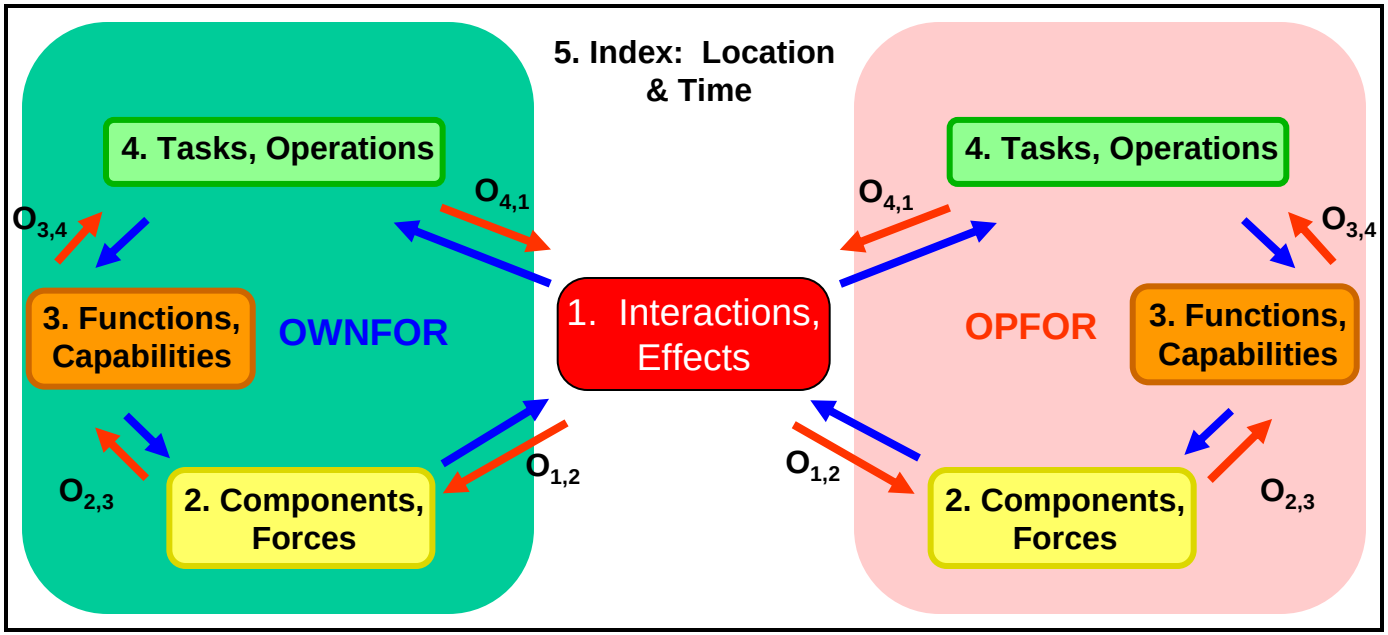
The interactions and effects, together with the consequences, result in changes or adaptations to both Red and Blue plans, shown on the diagram as blue arrows.

There will also be resulting changes in the tasks and operations conducted by each force. These changes are described by what is labeled the $\mathbf{O_{3,4}}$ operator, and likely differ from what was originally planned. (Both soldiers have to take time out from what they were doing to fight each other, resulting in delays to original plans.)

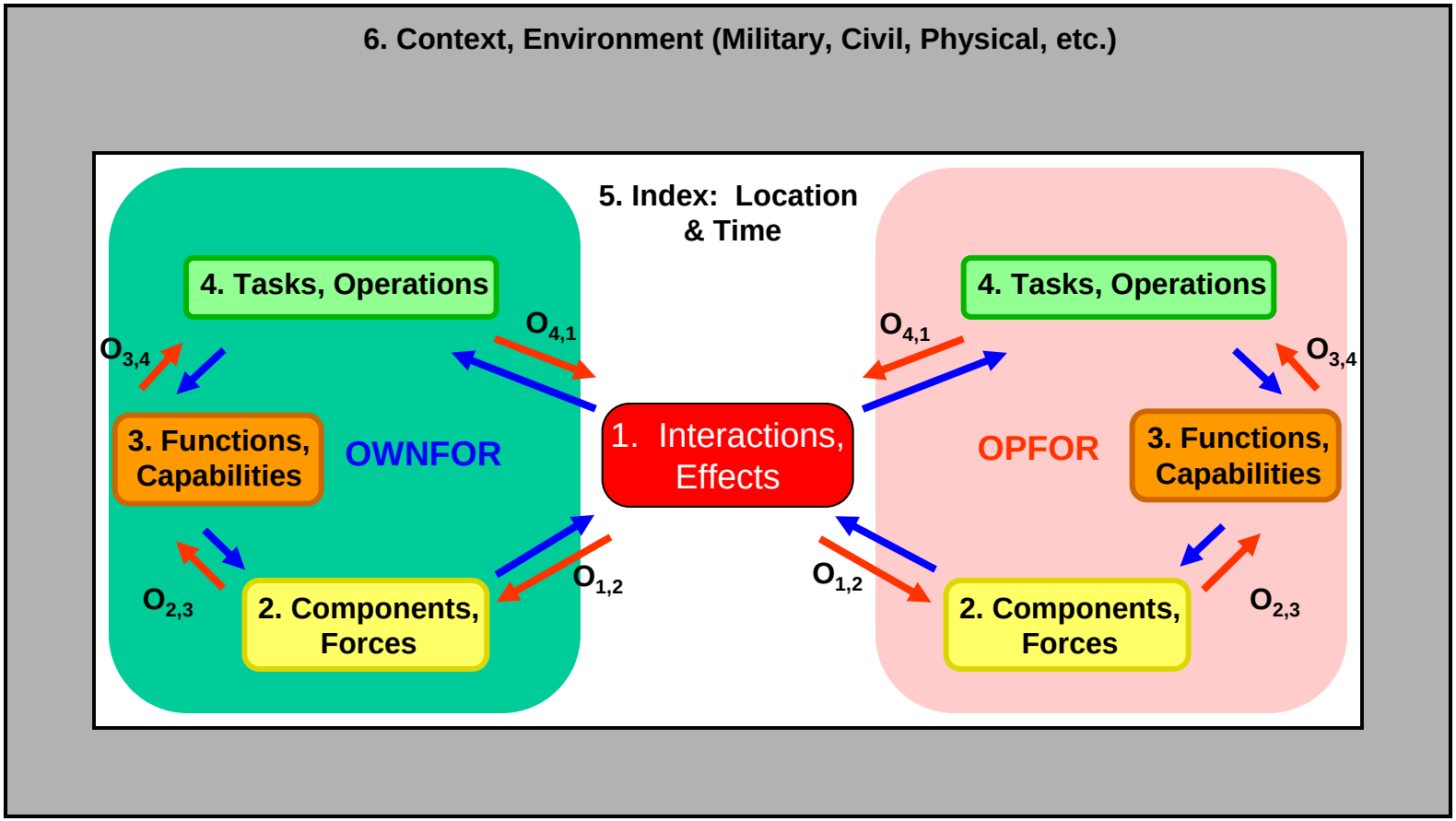


The changes to the tasks and/or operations will have a resulting effect on future Blue/Red interactions (described as the $\mathbf{O_{4,1}}$ operator). This entire action, or set of actions, takes place during a given time period, which also has an influence (nighttime, daytime) and consequences (long duration, short duration). This is the same for both forces.

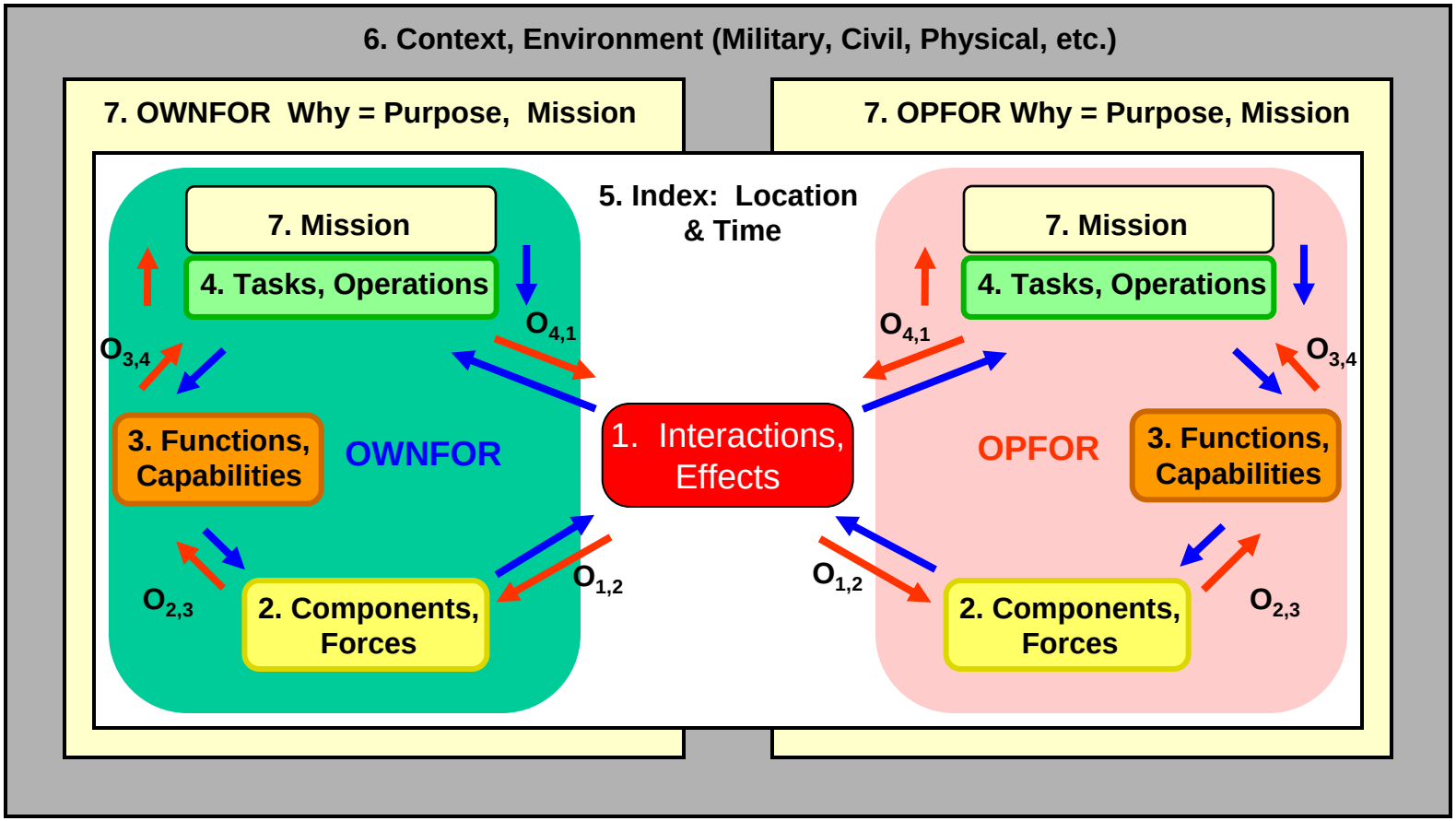
The location in which the action takes place also plays a role (mountains, urban, desert, etc.) This is the same for both forces.



There is also a context to the situation – it might occur solely in the presence of other military and involve only "acts of war," or, it could involve both combatants and non-combatants. This context is the same for both forces.

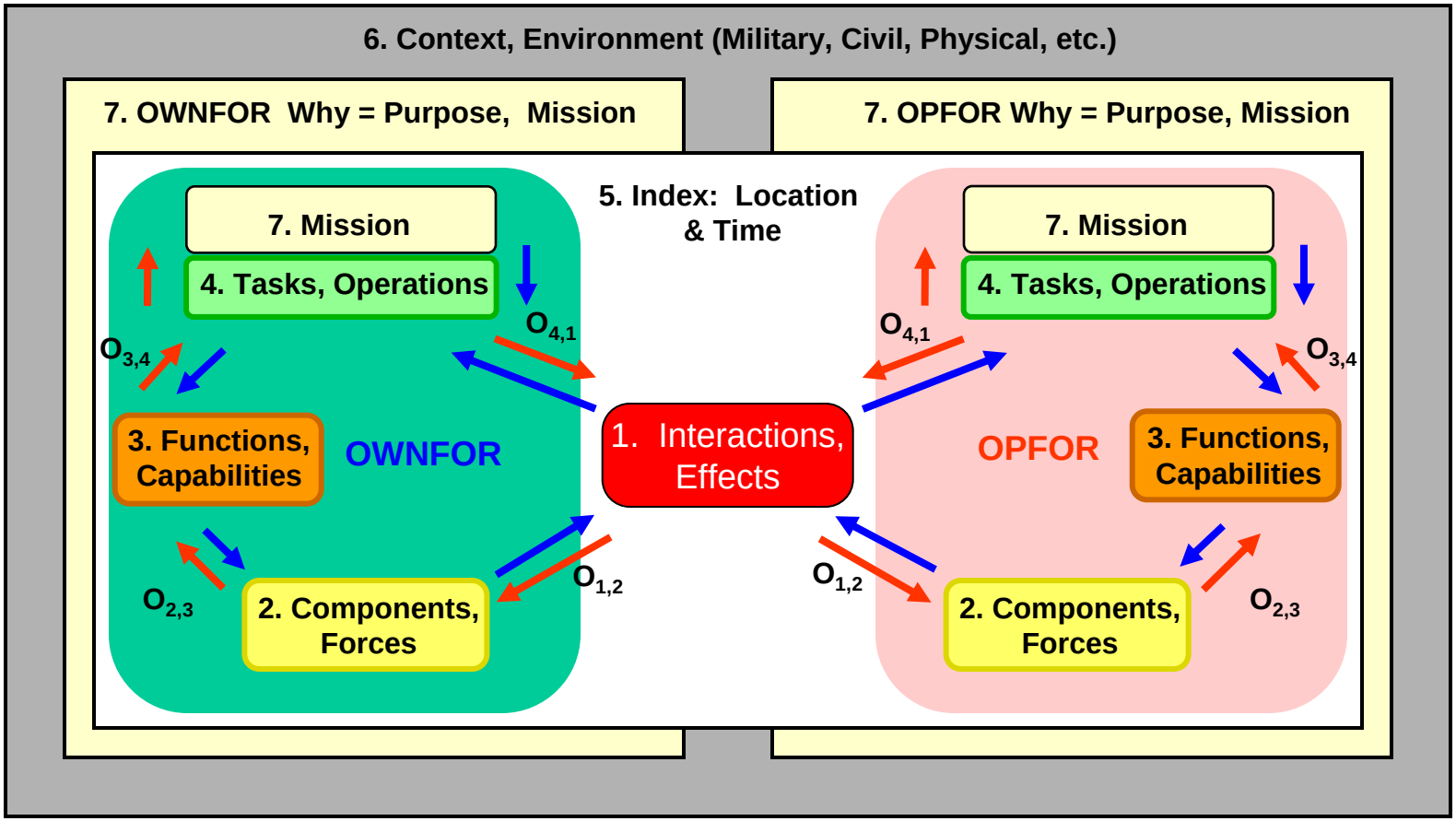


Finally, each force has its own mission and reason or purpose in being where it is and doing what it is doing or planning to do. These are generally different for each force. The interactions (progression of action) generally have an effect on the mission and the tasks and operations performed by each force.



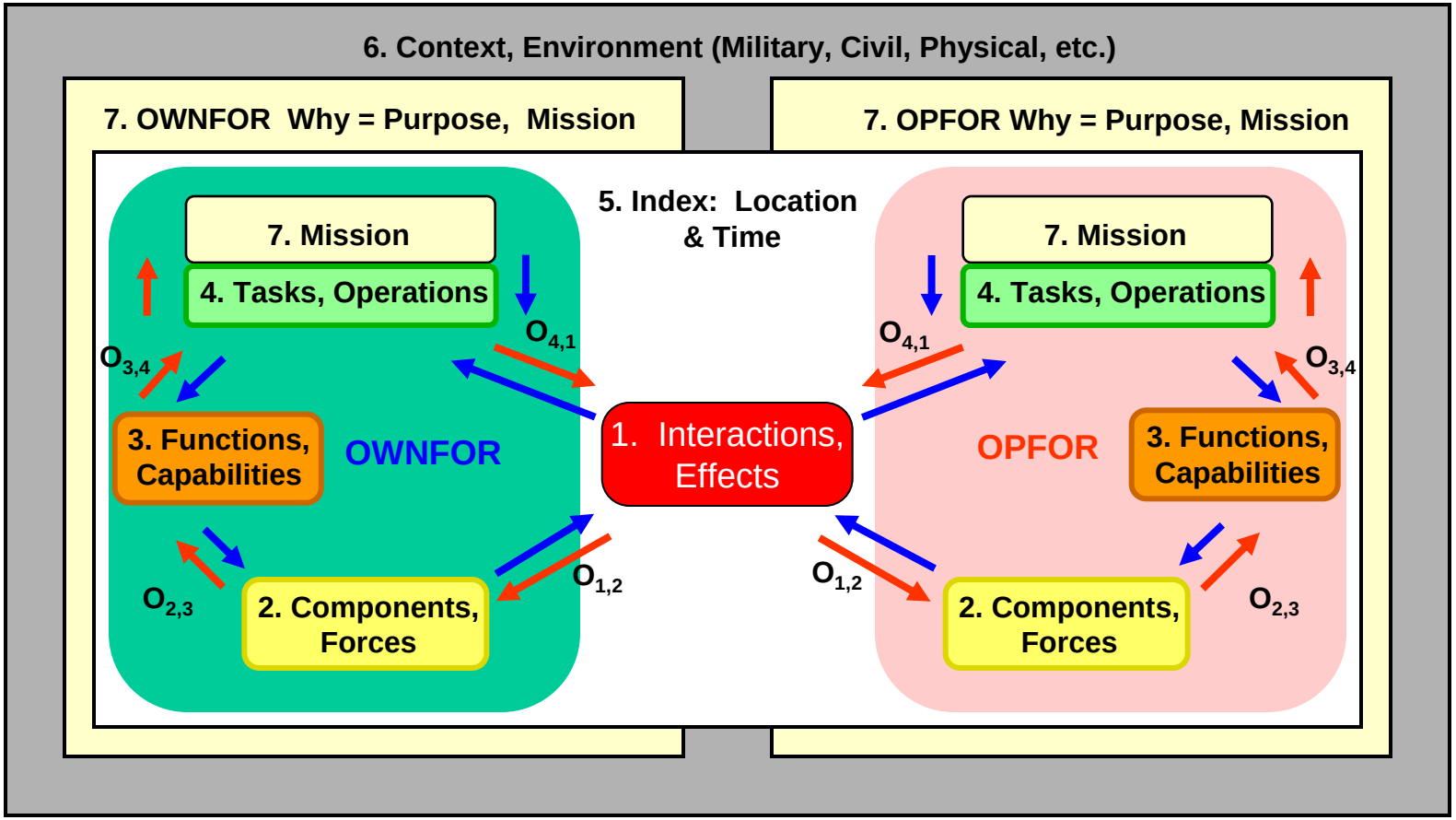
This is now the framework for describing or simulating military activity.

The red arrows represent actual occurrences; the blue arrows represent planned actions. The framework provides a common means to describe or simulate actions across a broad spectrum of disciplines.



Missions and Means Framework

11 Fundamental Elements: 7 levels, 4 operators

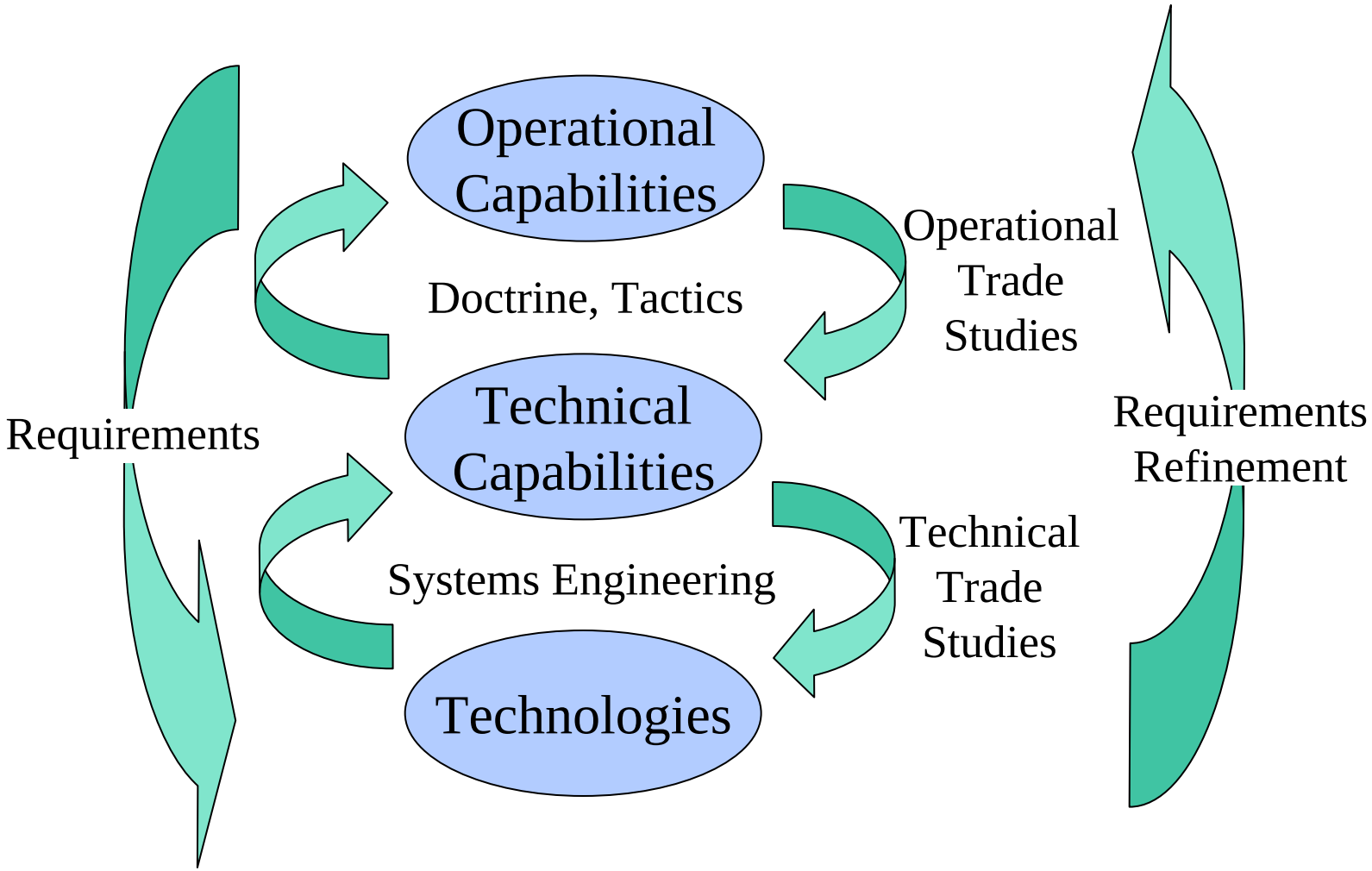


Planning

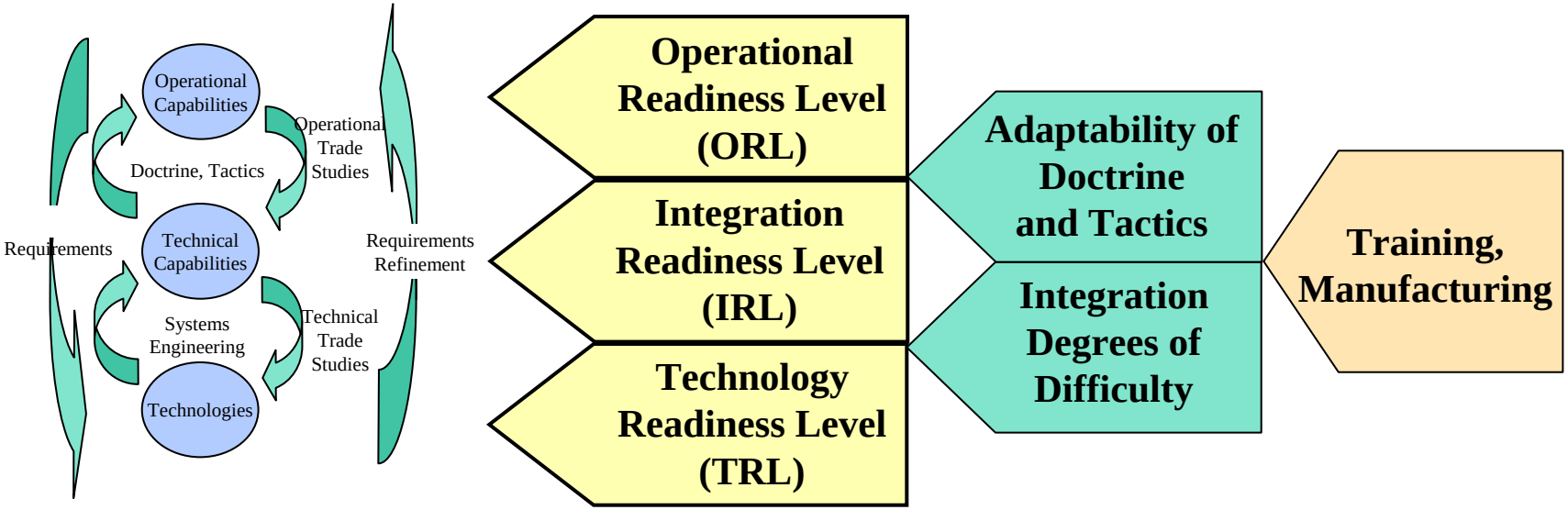
Employment

The Art of the Trade Study

A System Development Model



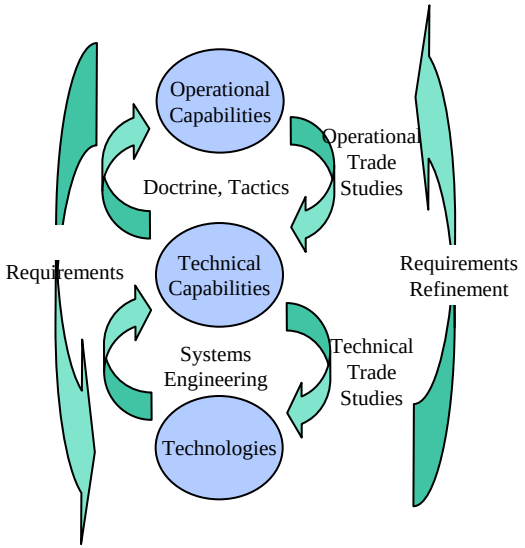
In this model, Technology "maturity" is *Necessary*, but **not** Sufficient*

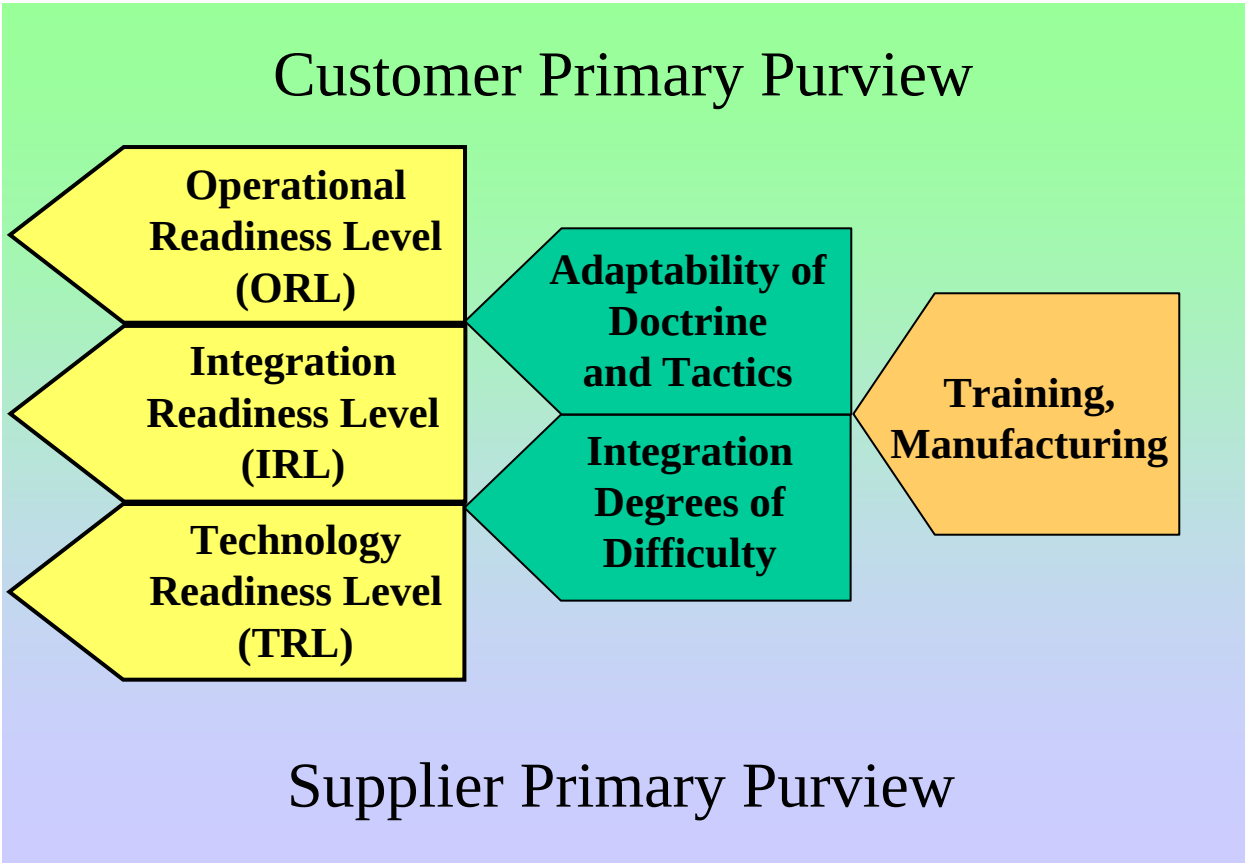


Risk ***must*** be managed ***throughout*** the process,
both vertically ***and*** horizontally…

* In fact, it may not even be *necessary*!

Risk management is a joint effort between customer and supplier, working together continuously

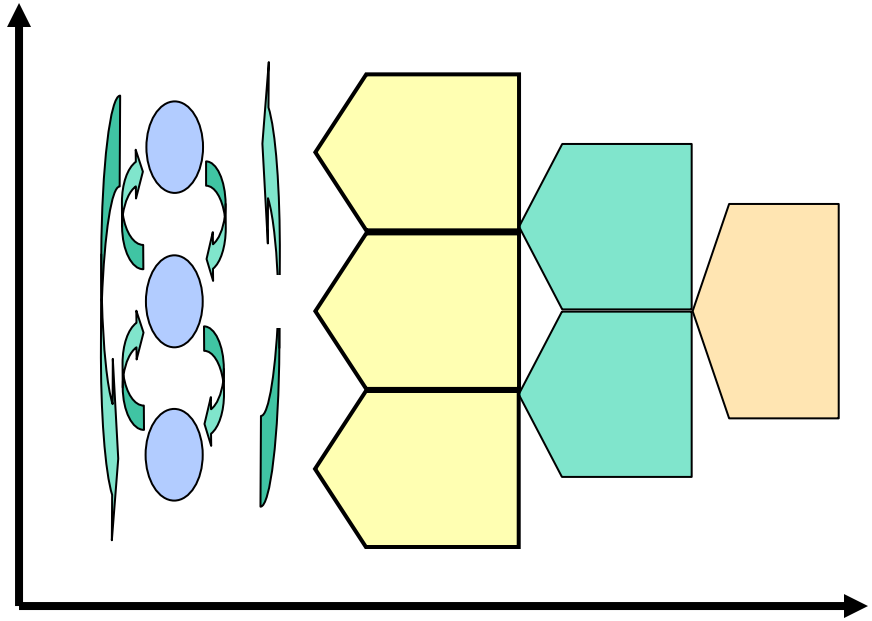




Horizontal and Vertical Risk

Assessing and Managing Vertical Risk

is the process of continuous dialog with the customer, refining and prioritizing requirements in conjunction with total program risk.



Assessing and Managing Horizontal Risk

is the process of creating critical timelines and paths for technology maturation, integration and manufacturing, based on evolving customer requirements in conjunction with total program risk.

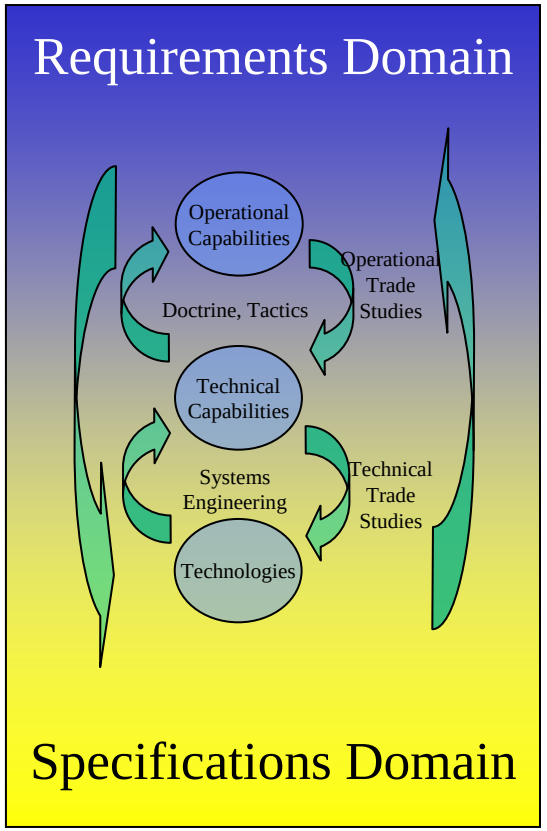
Assessing and Managing Requirements Risk

Supplier and Customer must work together to produce requirements which are both **technically possible** ***and*** **operationally feasible**.

The distinction between requirements and technical specifications is critical:

Requirements delineate ***operational needs***

Technical Specifications delineate ***technology needs***



The first rule of risk management is ***NEVER*** **LET THE REQUIREMENTS SPECIFY TECHNOLOGIES….**

Assessing and Managing Requirements Risk

…The second rule of risk management is

***NEVER* FORGET THE FIRST RULE.**

Why?

In any project, there are three major variables:

Cost, Schedule, and Performance

Any one or two of the three can be fixed, **but *not* all three**.

When a requirement specifies a technology to be used, that locks in the maturation time for that specific technology and the resources required to mature that technology, as well as the requirement.

In this case, Risk is no longer manageable!

Assessing and Managing Requirements Risk

Customer and Supplier must work together continuously in order to keep risk manageable and at a minimum.

Trade Studies *must* include risk, and risk management *must* include trade studies.

Historical example: Henry Ford and the Model T engine crates.

More often than not, separation of requirements and technical specifications is a matter of careful semantics.

Historical examples: Frigidaire; Motorola; “Swim”

An Example…

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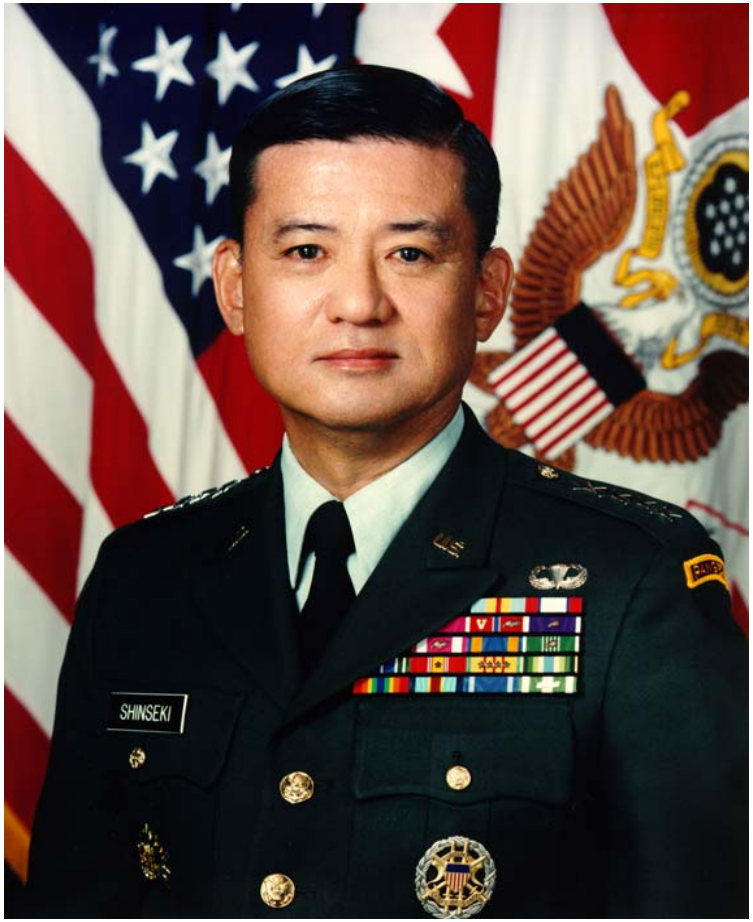
The Objective Force Challenge



"We must provide early entry forces that can operate jointly, without access to fixed forward bases, but we still need the power to slug it out and win decisively. Today, our heavy forces are too heavy and our light forces lack staying power. We will address those mismatches." -- GEN Shinseki, CSA, 23 June 1999

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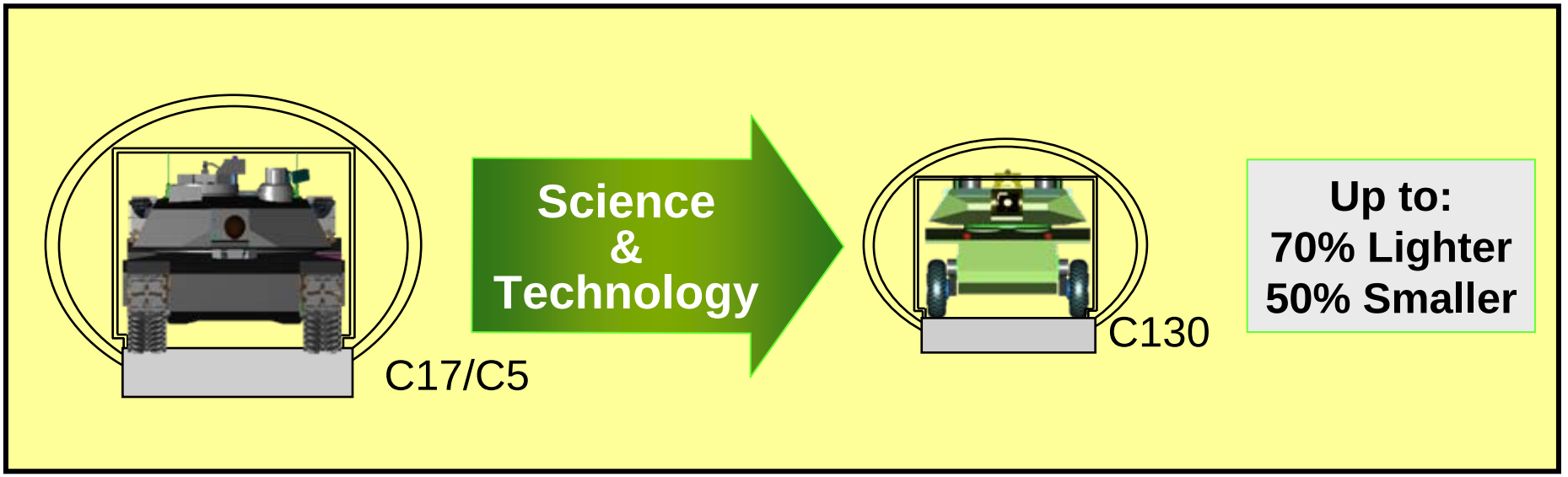
Operational Challenge: Moving the Multi-Mission Force

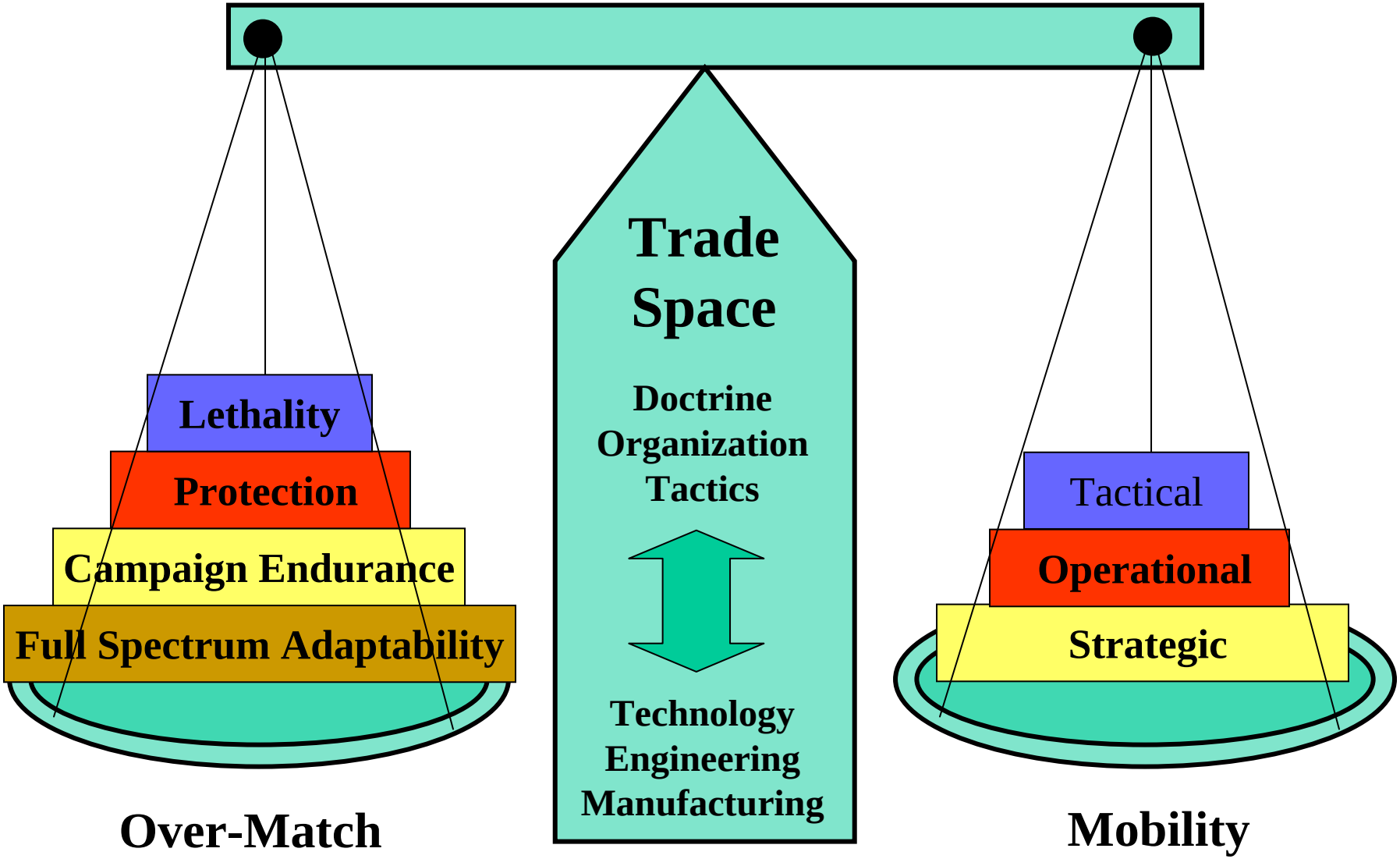
Taken from an early FCS graphic:

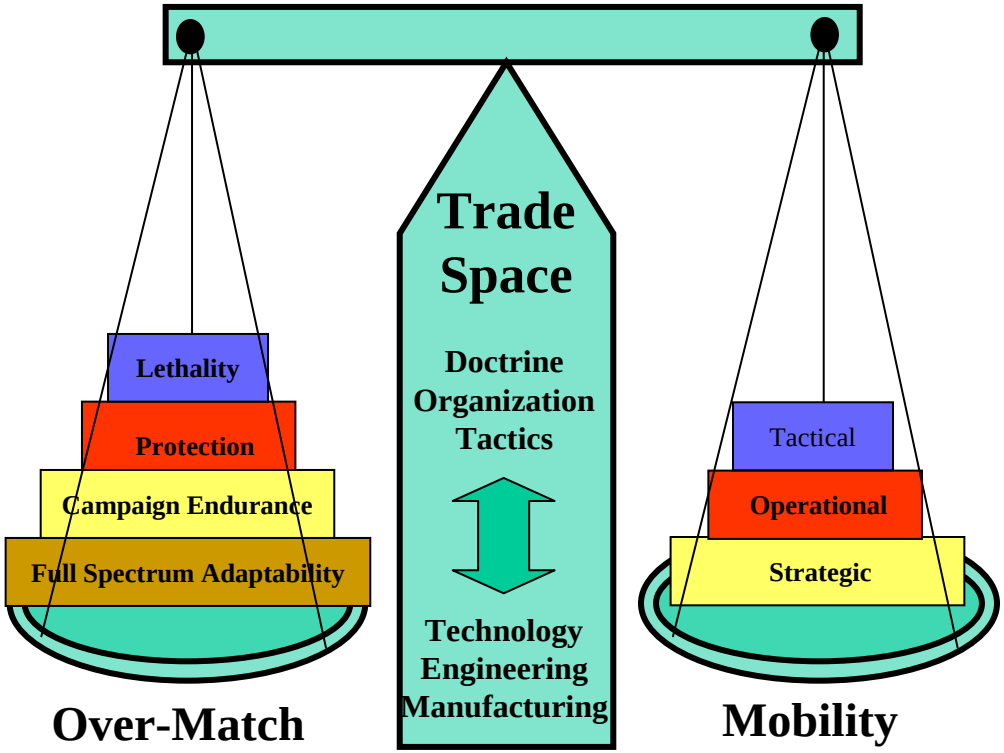


But…

“Science and Technology” *cannot* do the job alone!

The Objective Force Challenge: Striking the Balance





Vertical Risk Management

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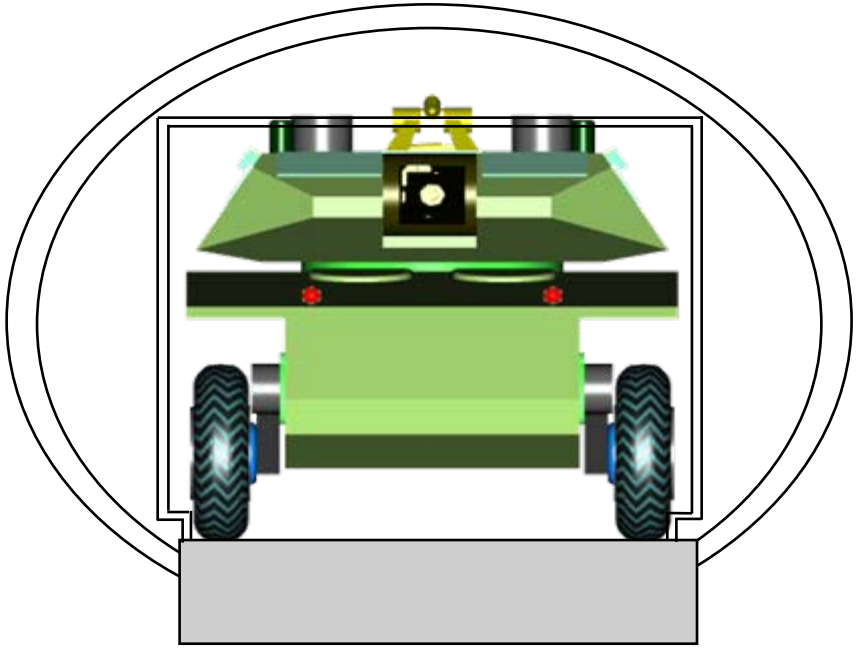
Trade Space implications of C130 Transportability

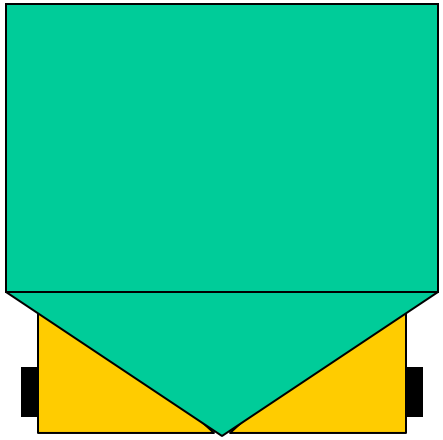


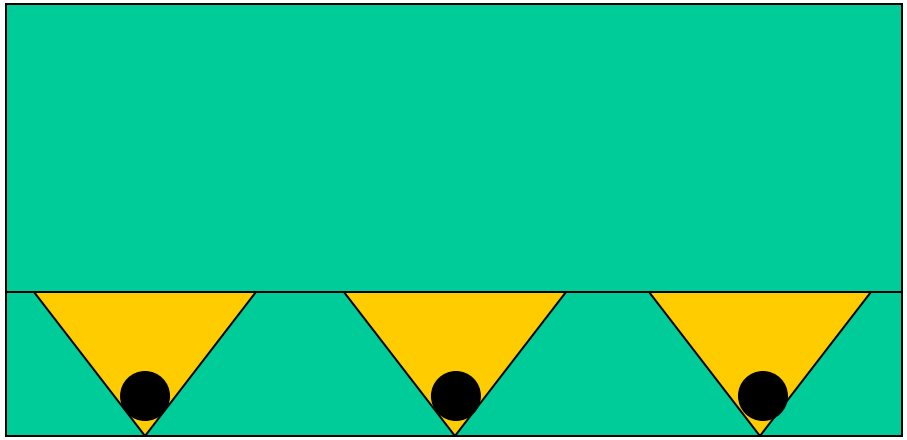
Load Master Clearances
Vulnerability Reduction by Design
Tracks vs. Wheels

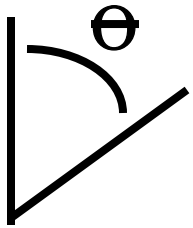
Signature Management
Crew Placement
Sensors and Other Options

For instance…

Hull Design for Mine Blast Mitigation

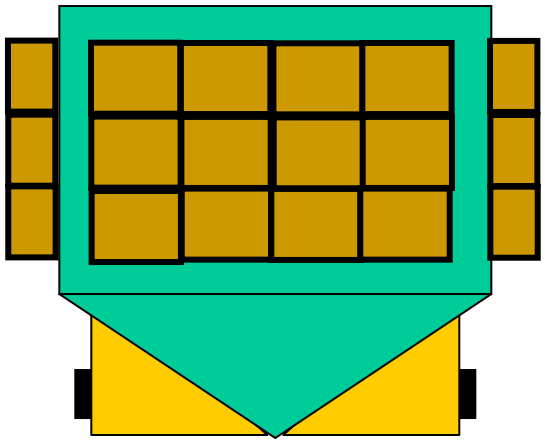


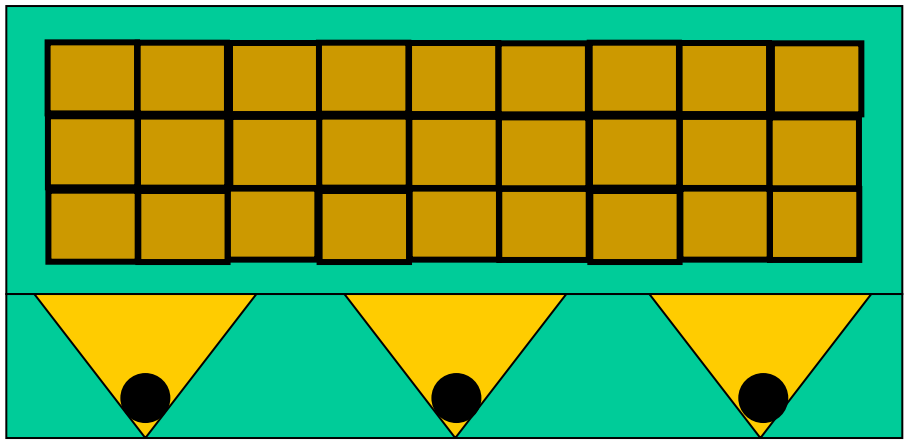




Normal component of blast
Resolves to F sin (**θ**)

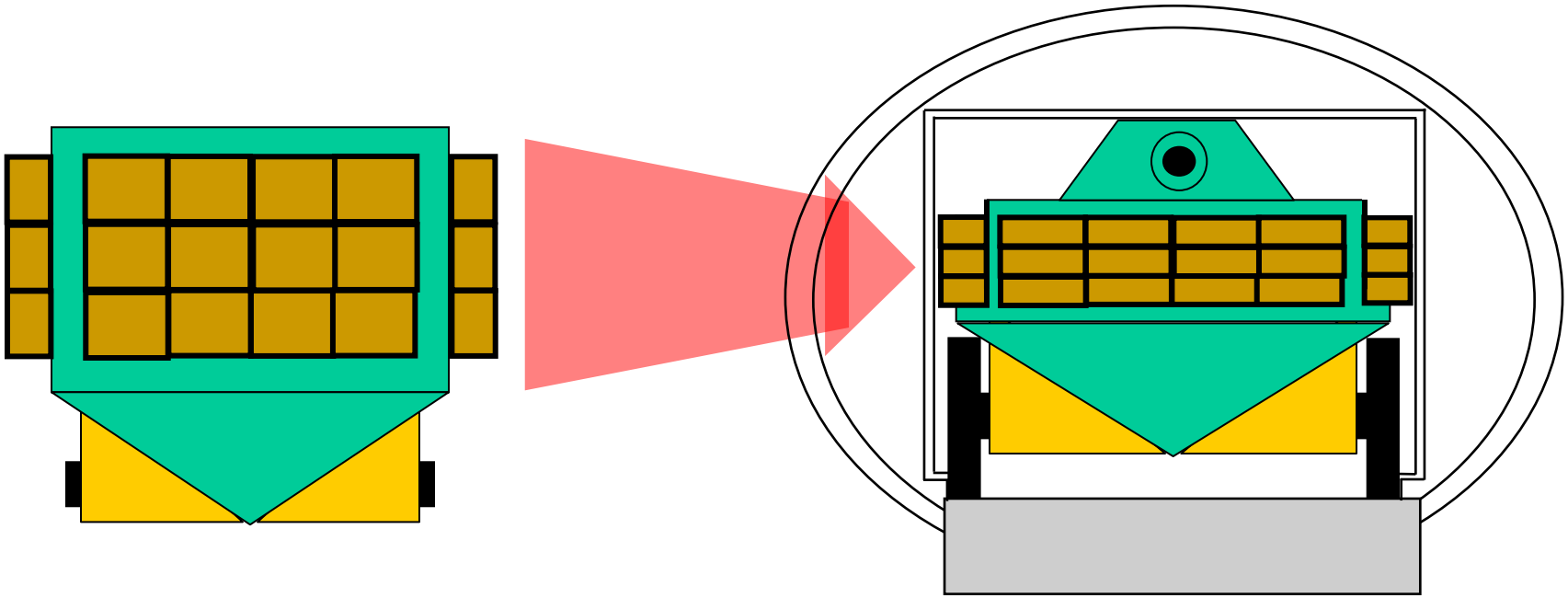
Additional Armor





The best of ideas…

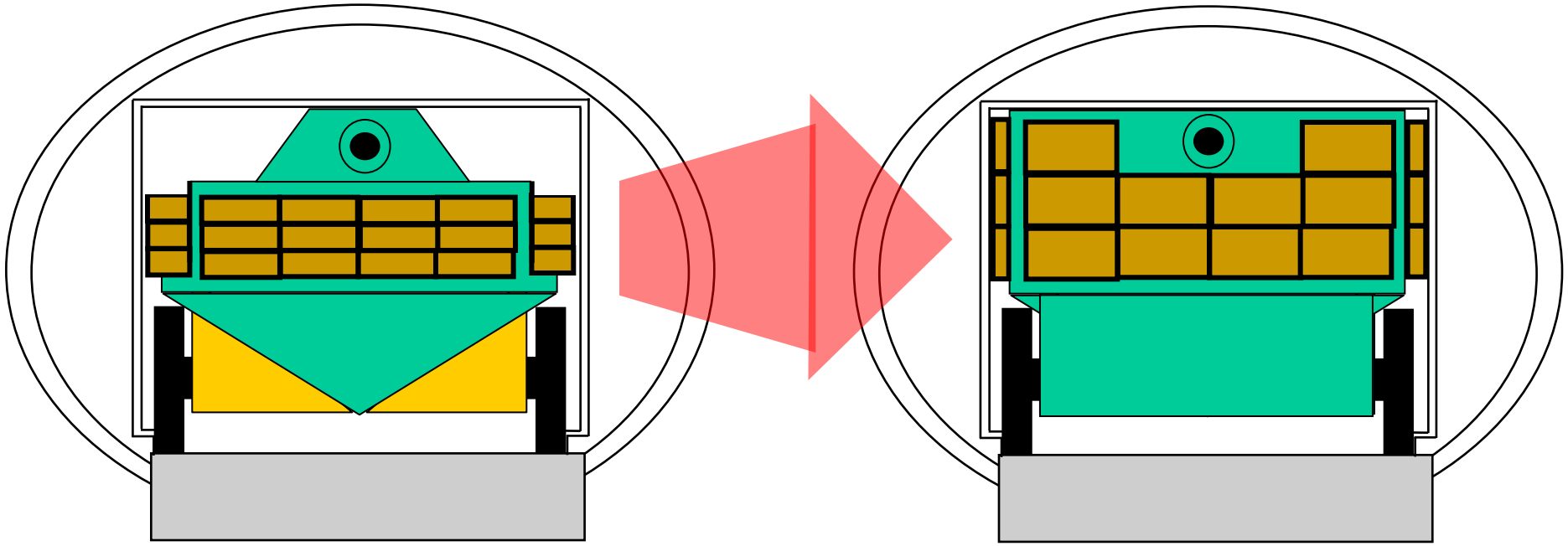
…can fall by the wayside



Horizontal Risk Management

P³I and Block Upgrades (*Now* you tell me!)

Better (and thinner) armor; blast-absorbing hull material, and assorted other technological/manufacturing advances…



***But*, can we afford to change it all now?**

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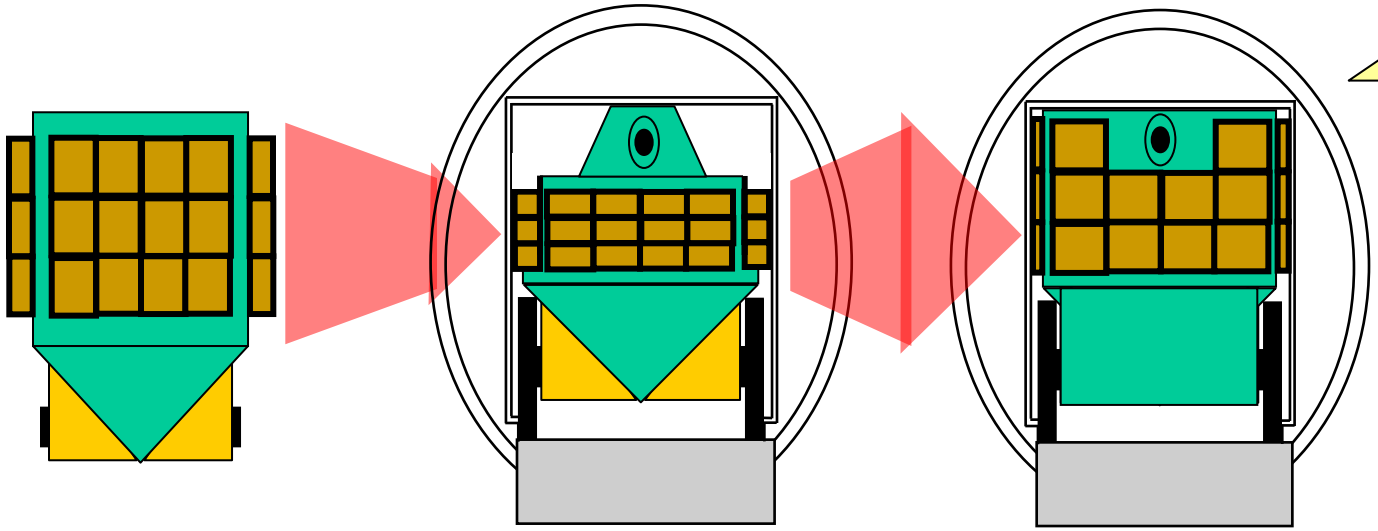
Life-Cycle Cost, Force Durability



Vertical Risk Management

New Training, Tactics, Etc.

Horizontal Risk Management

Technology Transition, Manufacturing, etc.

A Quantitative Model for Combat Power

With acknowledgement to

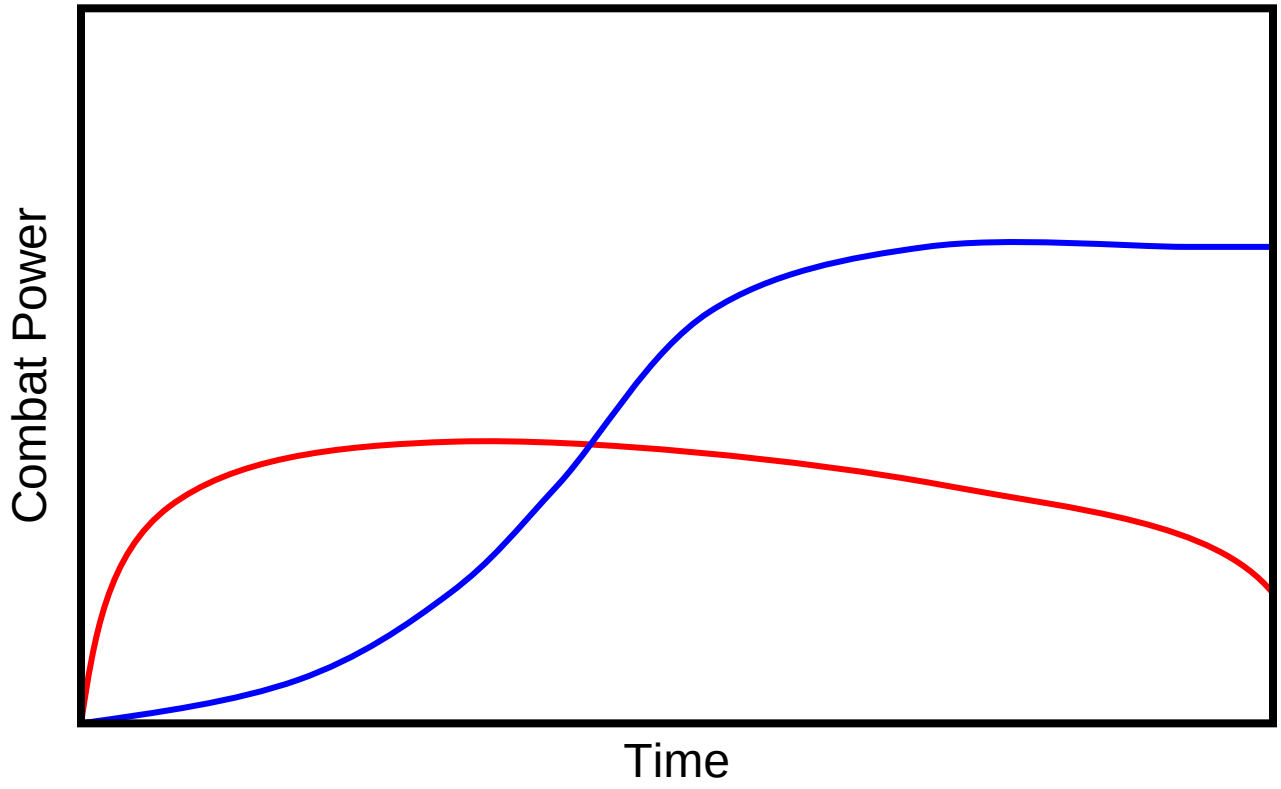
Everett (Pete) Reich (Retired)
Former Senior Analyst
US Army Evaluation Center
Survivability Directorate

who contributed to the development
of the combat power model presented here

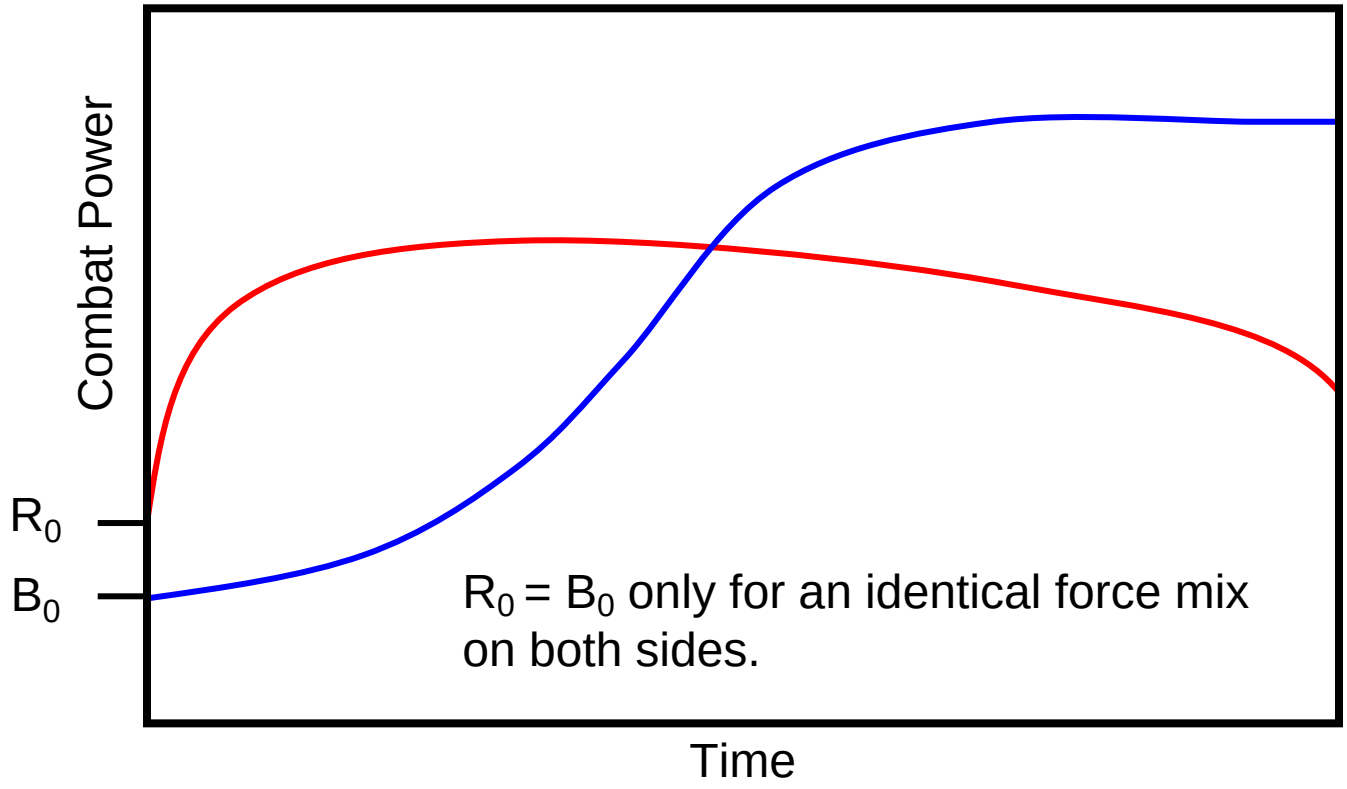
In recent years, the Army's Future Combat Systems (FCS) Program had a requirement to retain sufficient combat power at the conclusion of one mission to go on to the next mission.

What, exactly, is combat power, and how much combat power is required for a particular mission? We begin with a definition of combat power, and then demonstrate how MMF not only facilitates the trade study process, but also provides traceability and justification for specific requirements.

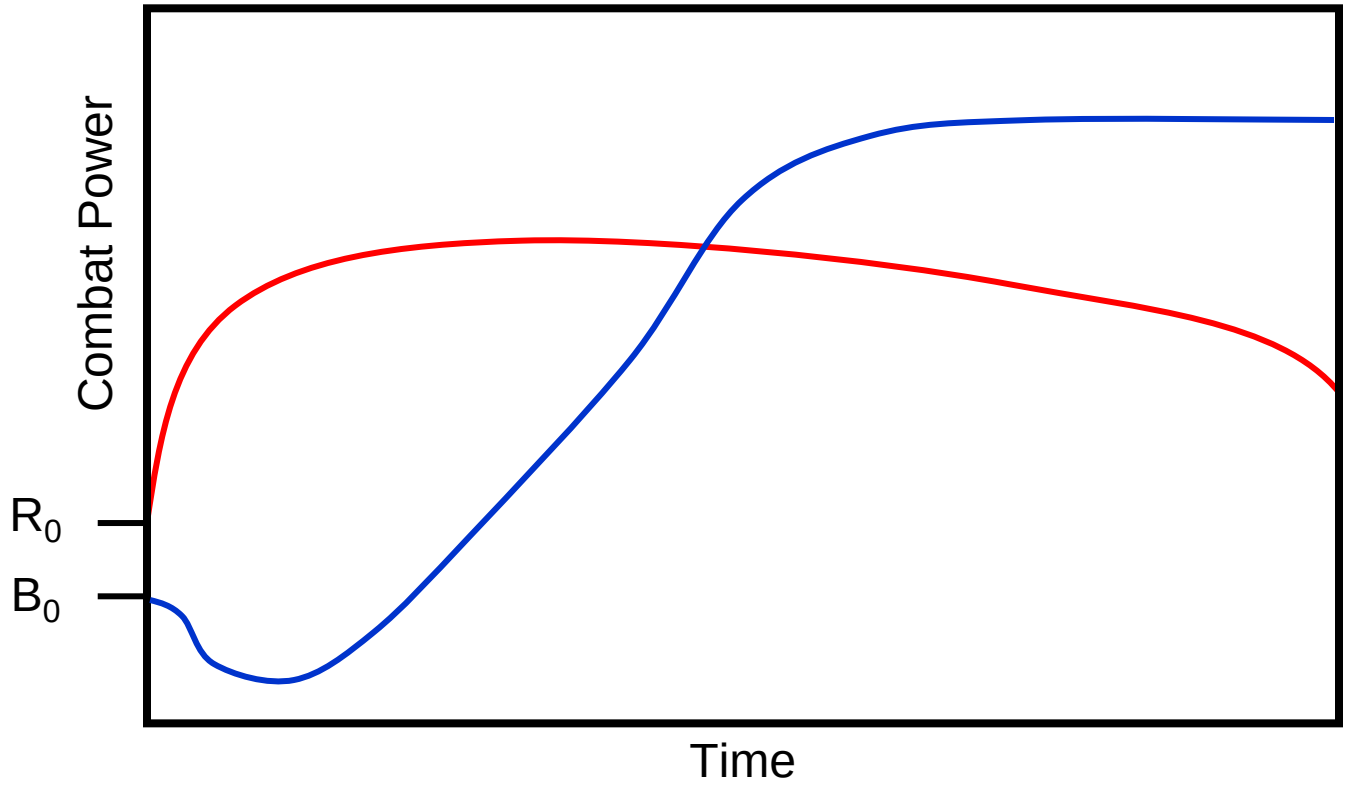
If both sides start with zero combat power, then a non-existent blue force is just as ready for a mission as a million-soldier force; that is, required combat power = 0.



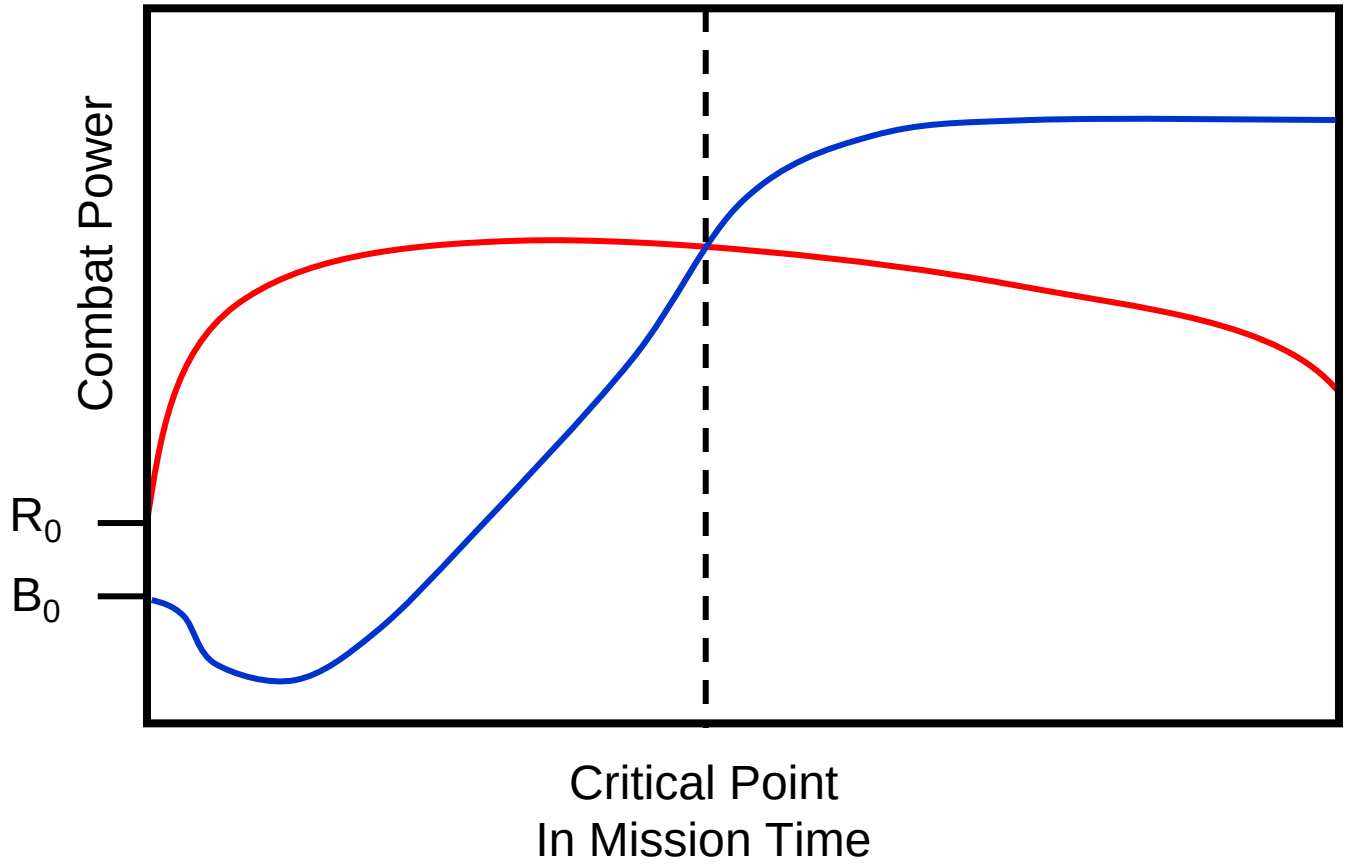
Red and Blue forces ***do*** have some initial level of capability (force mix)



In reality, one expects attrition (loss of some combat power) initially on one or both sides. (Think of the Normandy Invasion)



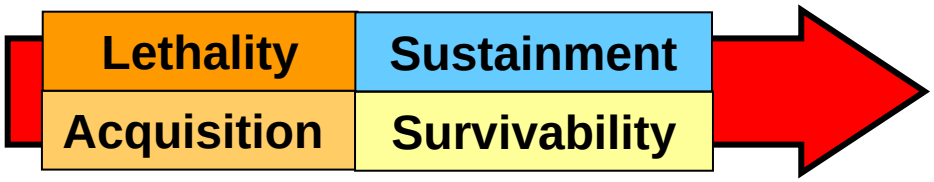
Unless a commander believes he or she can eventually have combat power greater than that of the enemy, the mission will likely not be attempted.



“Sufficient combat power”
is the “force necessary to get to the
‘critical point’ within an acceptable time,
at an acceptable cost.”

“Sufficient *residual* combat power”
is having enough combat power remaining
from one mission to be “sufficient”
for the next mission.

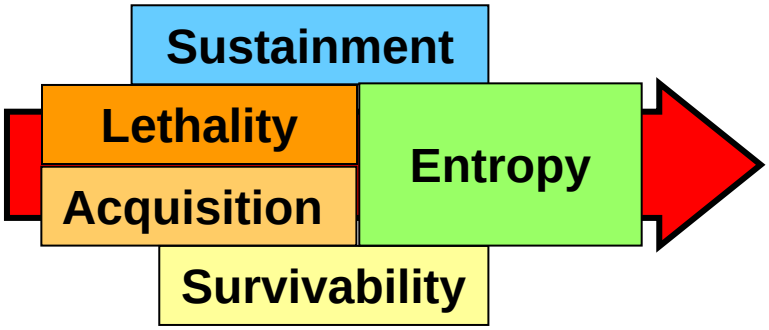
During the cold war, the Soviet Union had a mathematical model for Combat Power, consisting of four categories:



The subjective factors missing from this formulation, of which the Soviets were aware, are also important in estimating combat power. These factors include morale, discipline, and training, among others. Entropy-based warfare modeling is required to incorporate these factors.

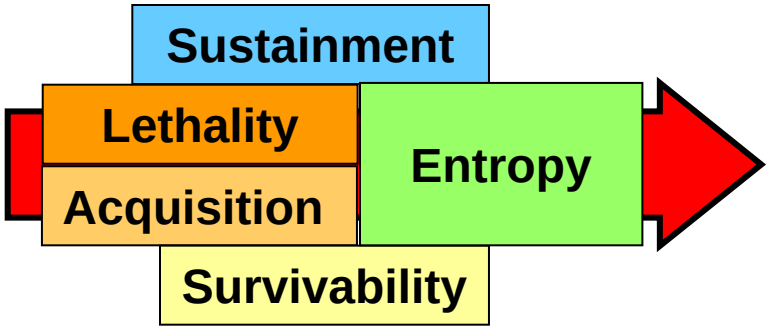
The Walbert-Reich Formulation

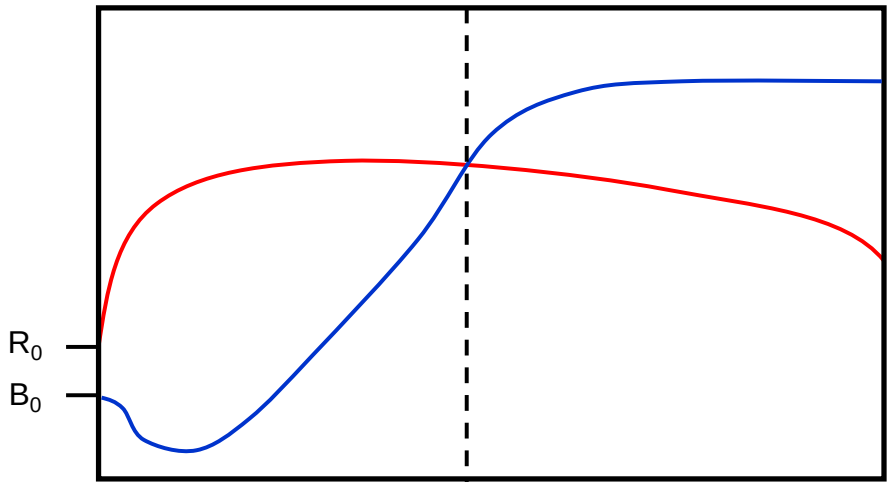
There are in 5 independent categories:



Unit Combat Power Value (CPV)

The Walbert-Reich Formulation

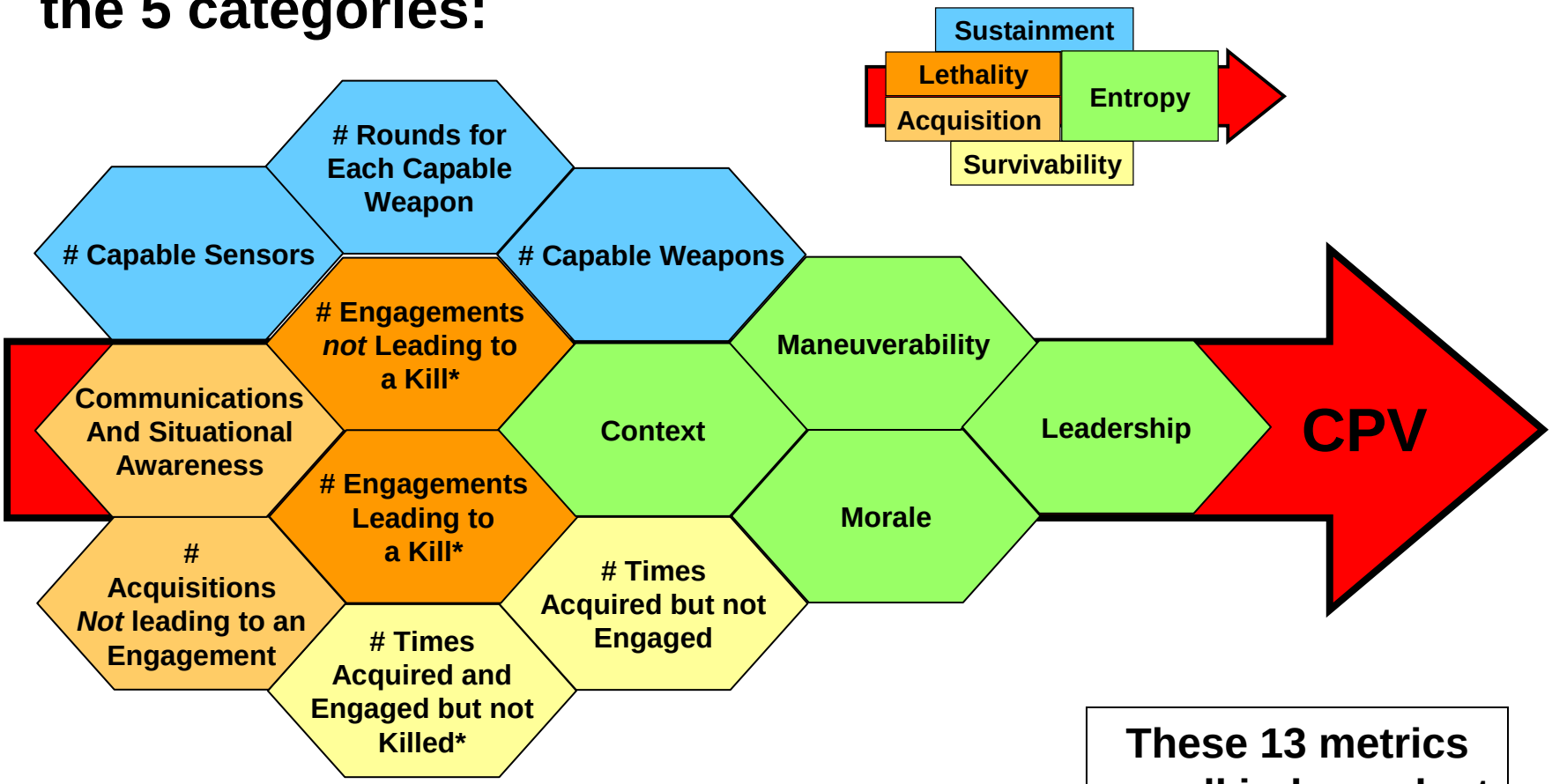




R_0 and B_0 are based solely on the values of the Sustainment and Entropy metrics, since initially all other metrics are zero.

This formulation is applicable to all forms of warfare, including and especially when dealing with asymmetric forces.

There are 13 independent metrics divided among the 5 categories:



These 13 metrics are all independent of one another.

* Note: A kill or loss might mean "out of action" for a certain time period.

The Combat Power Equation

$$\mathbf{CP} = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$

CP	=	Combat Power Value for the force
W_{ik}	=	Weighting factor for metric i for systems of type k
S_k	=	Number of systems of type k in force
P_{ijk}	=	Value of metric i for system j of type k
M	=	Number of metrics
N	=	Number of different types of systems in the force

Comments on the Combat Power Equation

$$\mathbf{CP} = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$

CP, P, T, W, N and $\mathbf{S}_k$ should all be considered as time-varying. For example, artillery might be more important initially (larger W values), than infantry; later, infantry might have larger weighting factors.

N and S_k change only if systems are added; if system #k of type i is removed from the action, $P_{i,j,k} = 0$ for each metric j from that time on.

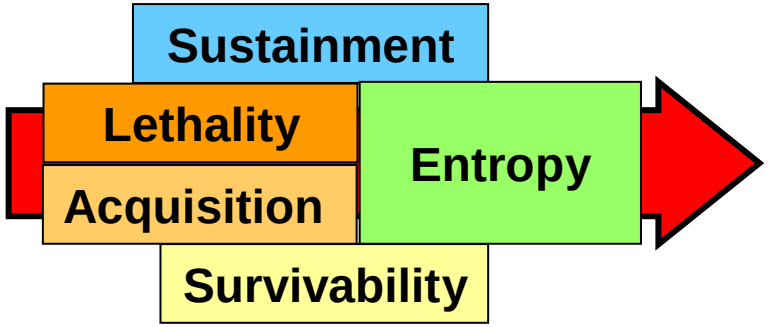
This method can also be used to incorporate BDAR and/or capability states; while out of service and being repaired, $P_{i,j,k} = 0$ for each (or some) metric j; once repaired, $P_{i,j,k}$ has some non-zero value (which may or may not be the same as the original, depending on the level of repair/restored capability) for each metric j.

Comments on the Combat Power Equation (Continued)

$$CP = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$

The weighting factors W_{ik} are situation- and force-dependent.

For example, if a sensing UAV is unarmed, then its lethality metric is weighted low (0); while target acquisition metrics are weighted high.



One can replace “system” with “systems of systems” in the equation.

A simple example

$$\mathbf{CP} = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$

Suppose a force consists of 2 tanks, 1 personnel carrier, and 3 artillery pieces.

In this case,

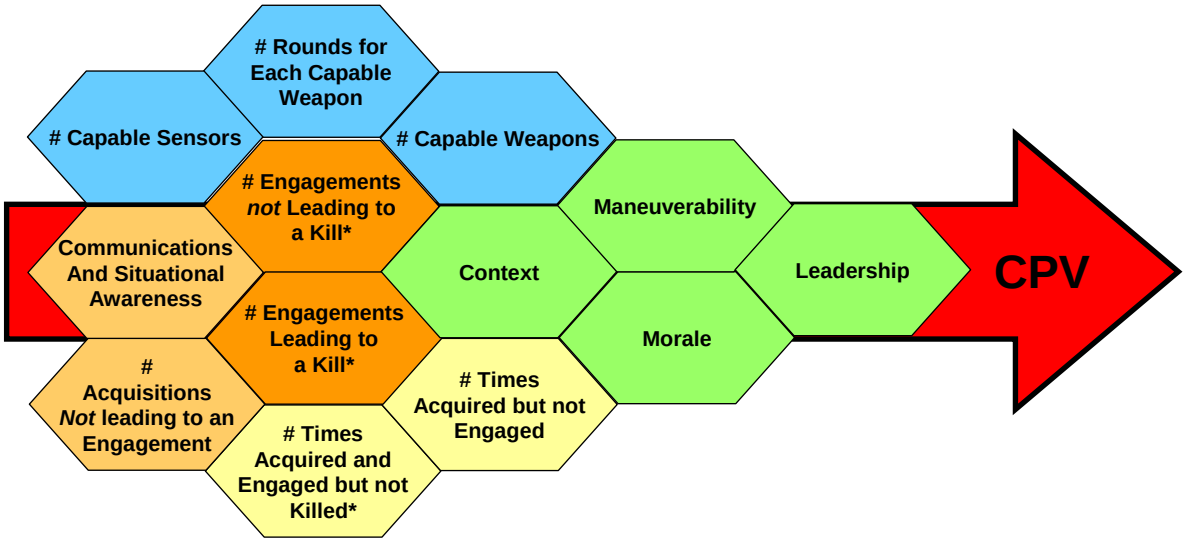
N = 3 (3 types of systems); S_1 = 2; (2 tanks); S_2 = 1; (1 personnel carrier); and S_3 = 3; (3 artillery pieces)

Each tank has 20 main gun rounds and 250 small arms rounds;
The personnel carrier has 50 indirect fire rounds and 750 small arms rounds;
Each artillery piece has 50 artillery rounds.

Each system has 1 sensor.

A simple example (Continued)

$$CP = \sum_{k=1}^{N}\left(\sum_{j=1}^{S_k}\left(\sum_{i=1}^{M} P_{ijk} \times W_{ik}\right)\right)$$

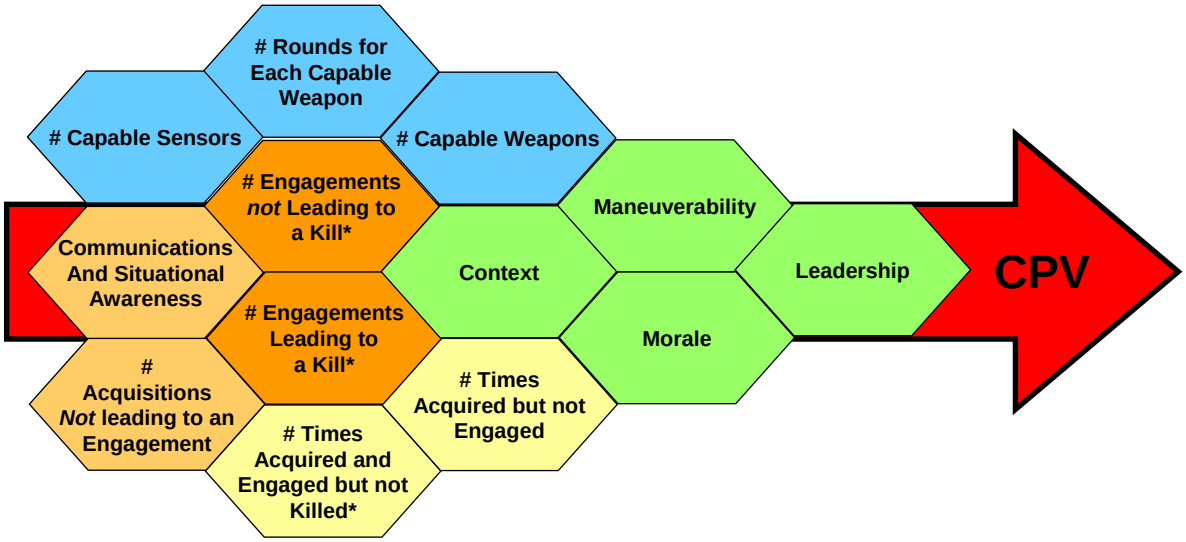


Then for each tank (initially),

Pijk = (1 sensor)*(tank sensor weighting factor)
+ (1 main gun)*(tank main gun weighting factor)
+ (20 main gun rounds)*(tank main gun round weighting factor)
+ (I secondary weapon)*(tank secondary weapon weighting factor)
+ (250 secondary weapon rounds)*(tank secondary weapon round weighting factor)
+ …

A simple example (Continued)

$$CP = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$



… + (4 tank crew)*(crew morale weighting factor)

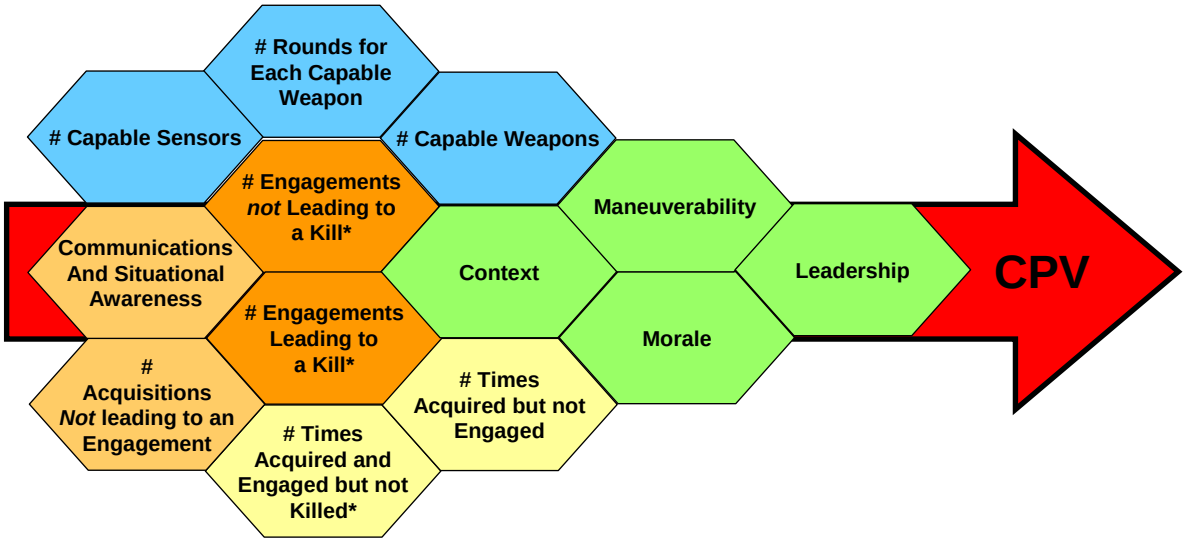
+ (full tank maneuverability)*(tank maneuverability weighting factor)

+ (Context [area where tanks can be used to an advantage])*(weighting factor for context)

+ (Good Leadership [clear mission/task set])*(weighting factor for leadership)

+ (Communications and Situational Awareness)*(weighting factor for communications and situational awareness)

$$CP = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$



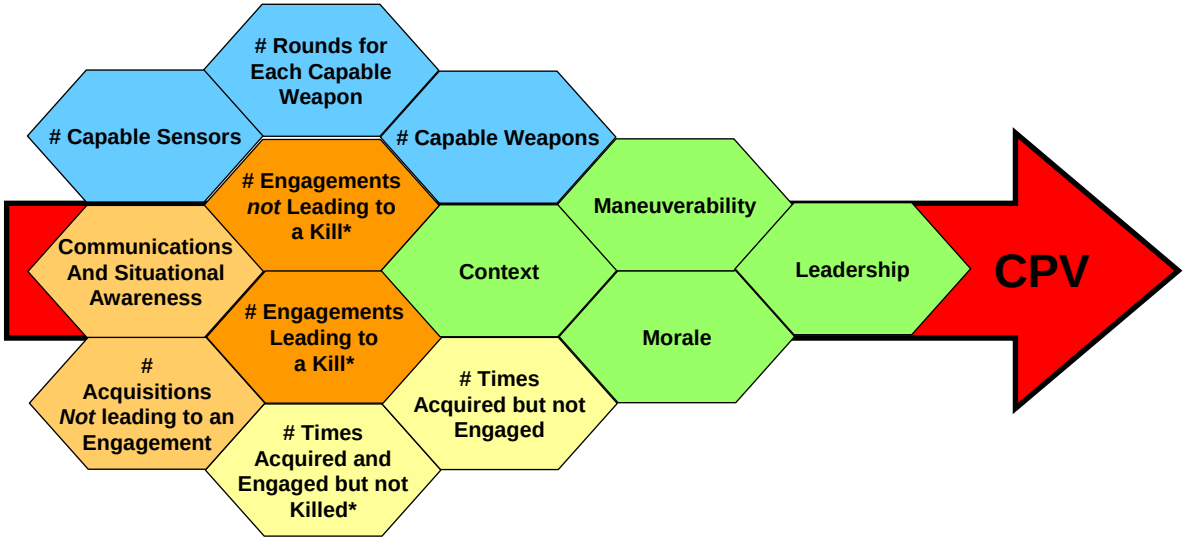
As the battle progresses, each tank will have opportunity to find targets; to engage targets successfully or unsuccessfully; and to be targeted and engaged.

Situational Awareness and Communications will change.

Each round expended reduces available rounds, hence reduces combat power. Resupply increases combat power (and possibly improves morale).

Engaging targets successfully may improve morale, while being engaged by the enemy may decrease morale.

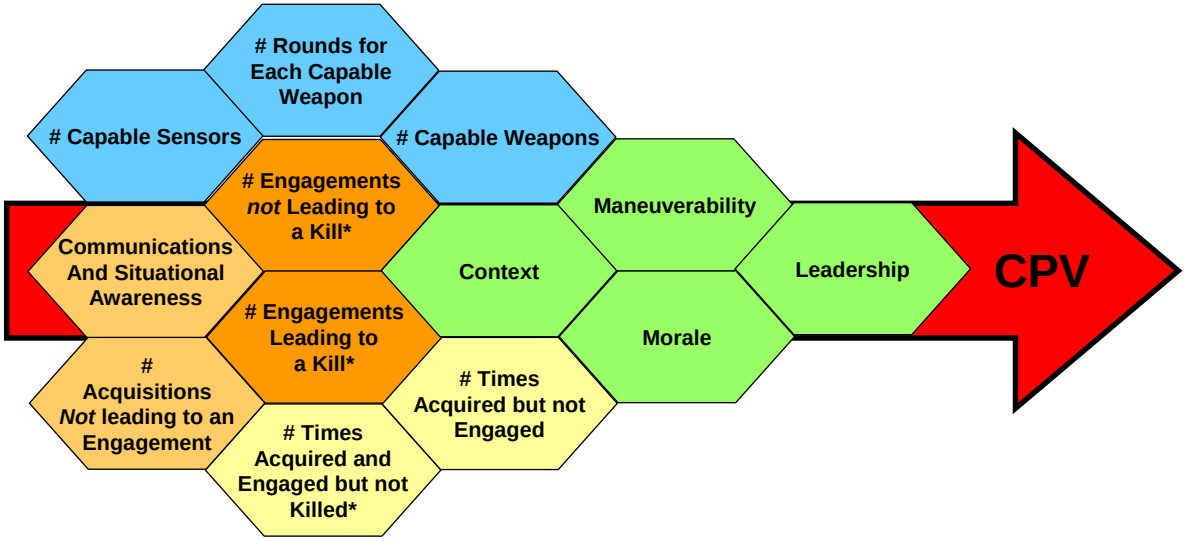
$$CP = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$



Not all the weighting factors are positive, and may in fact change sign during the course of the battle.

As conditions ebb and wane, weighting factors may vary. For example, an isolated long rang encounter (acquisition not leading to an engagement) may have a relatively low importance (weight), while acquisitions not leading to an engagement in melee gunnery involving several tanks from each opposing force could have serious consequences and hence have a high (negative) weight.

$$CP = \sum_{k=1}^{N} \left(\sum_{j=1}^{S_k} \left(\sum_{i=1}^{M} P_{ijk} \times W_{ik} \right) \right)$$

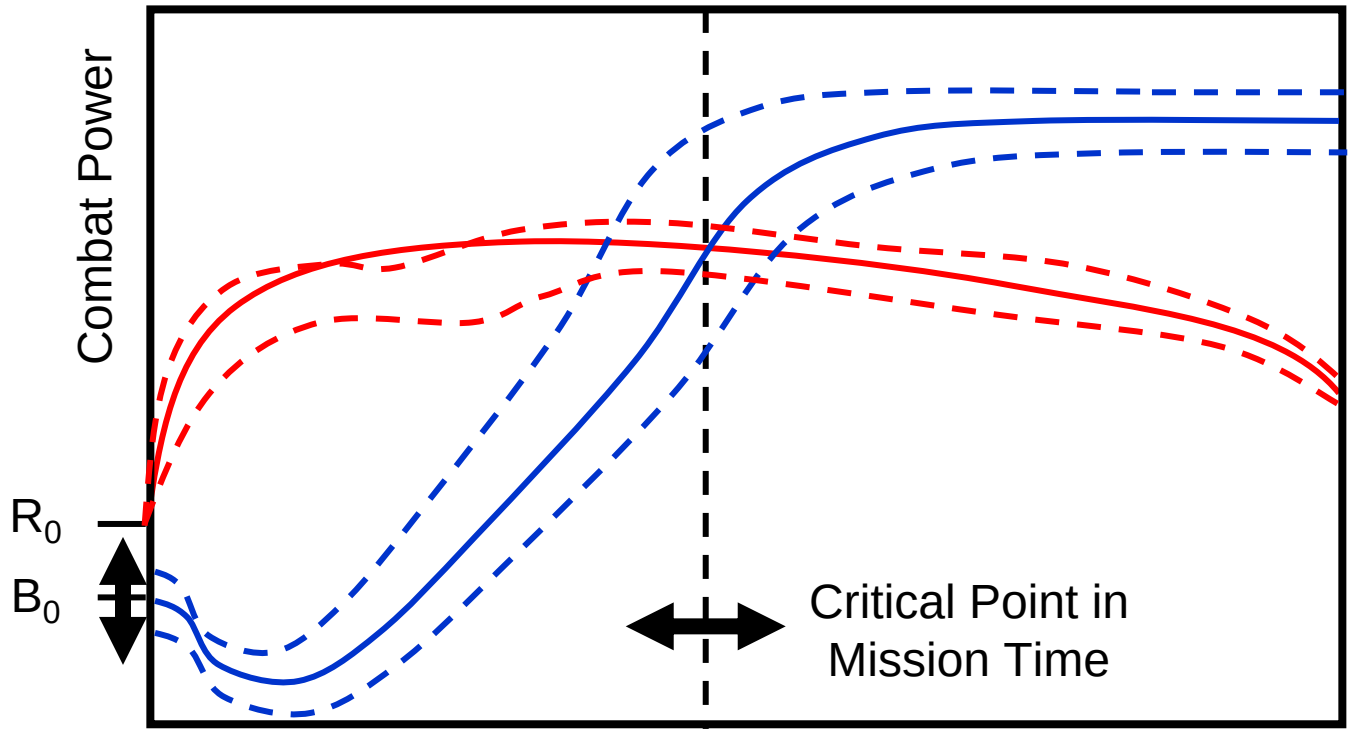


An acquisition not leading to an engagement may have a high (positive) weight for a system with a targeting mission but no engagement capability, such as an unarmed aerial reconnaissance vehicle.

How do we find a value for “sufficient combat power?”

The Process

Iterate on initial force mix until the critical point falls within an acceptable time at an acceptable cost; this is the force that *minimally* constitutes "required combat power" to start the mission. Note that while the initial OPFOR force mix remains fixed, its combat power differs over time in response to the changes in the initial BLUFOR force mix.



As long as what's left after one mission is greater than or equal to "B_0" for the next mission, there is sufficient residual combat power.

The Devil is in the Details…

There has to be a consistent method for assigning values to the Weighting terms in the COFM equation.

This combat power model is only viable if

1) The critical point is “recognizable?”
2) The iterative scheme *always* converges?
3) The computations are comparable to known outcomes of known combat situations?

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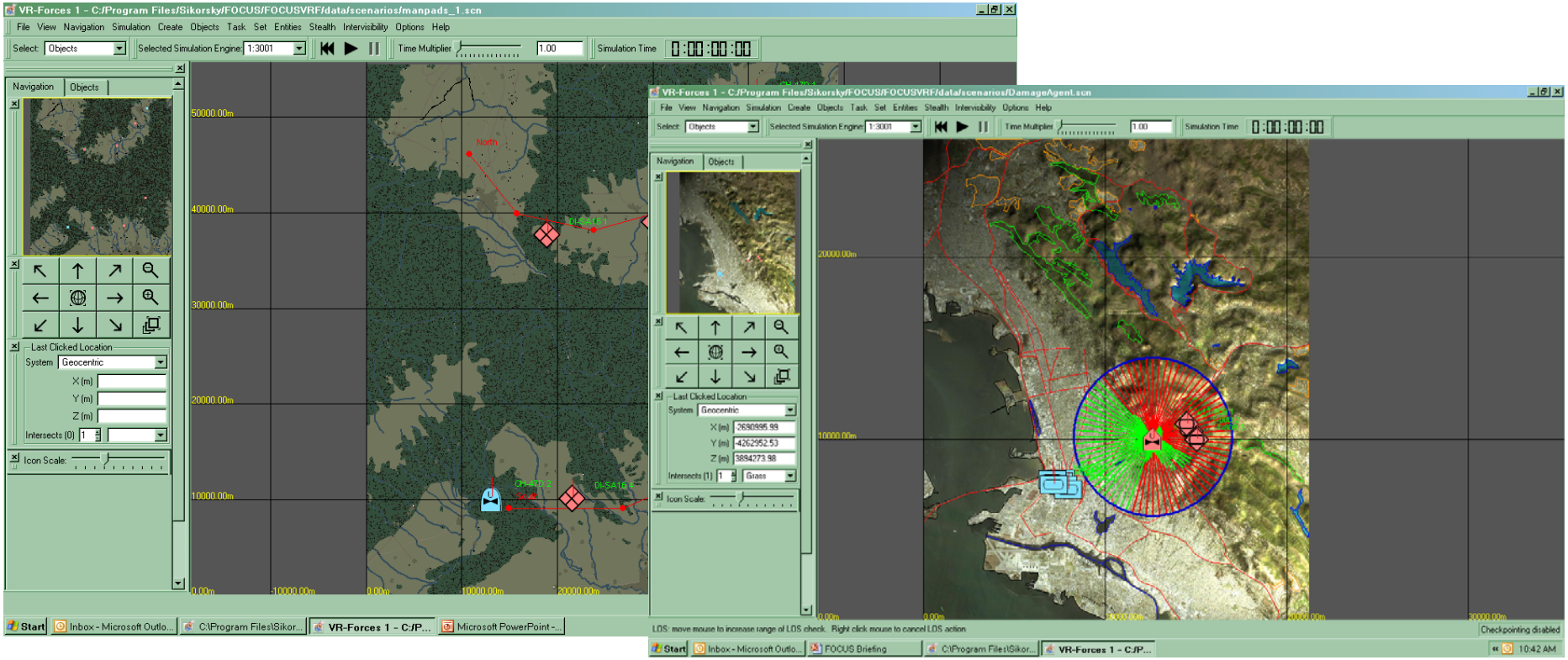
Force-Level Model

SURVICE uses FOCUS, a Sikorsky adaptation of MAK Technologies VR-Forces.

This simulation runs on a lap-top computer, conforms to both DIS and HLA standards; supports virtual/real-time and constructive analytical simulations with DTED and Open-Flight terrain; and includes such factors as Sensors, Weapons and Countermeasures, Weather, Teaming, and Communications.



sim_time	entity_id	resource_name	resource_type	subresource_name	resource_amount
7	1:3001:117	ammo	integer-resource	ballistic_120mm	40
7	1:3001:117	ammo	integer-resource	ballistic_7_62mm	12400
7	1:3001:117	ammo	integer-resource	M2-12.7mm	1000
7	1:3001:117	fuel	real-resource		1907.5
7	1:3001:122	ammo	integer-resource	AT8-Missile	4
7	1:3001:122	ammo	integer-resource	ballistic_7_62mm	1250
7	1:3001:122	fuel	real-resource		1100

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sim_time	observer_id	target_id	sensor_name	sensor_type	acquisition_level	range_to_target	azimuth_angle	elevation_angle
273.2	1:3001:126	1:3001:117	IR_SENSOR_1	ir-sensor	Detection	551.76	208.51	0.14
274.4	1:3001:126	1:3001:117	IR_SENSOR_1	ir-sensor	Detection	558.22	206.99	0.14
436.1	1:3001:120	1:3001:125	IR_SENSOR_1	ir-sensor	Detection	598.23	281.66	0.07
436.2	1:3001:120	1:3001:125	IR_SENSOR_1	ir-sensor	Identification	598.23	281.53	0.08
436.3	1:3001:120	1:3001:125	IR_SENSOR_1	ir-sensor	Identification	598.22	281.40	0.08
436.4	1:3001:120	1:3001:125	IR_SENSOR_1	ir-sensor	Identification	598.22	281.28	0.08
439.4	1:3001:125	1:3001:120	IR_SENSOR_1	ir-sensor	Detection	599.60	97.30	0.12
440.7	1:3001:125	1:3001:120	IR_SENSOR_1	ir-sensor	Detection	600.97	95.72	0.53
765.6	1:3001:121	1:3001:125	IR_SENSOR_1	ir-sensor	Detection	1712.84	329.12	-2.02
771.2	1:3001:121	1:3001:125	IR_SENSOR_1	ir-sensor	IdentificationCall	1696.67	326.65	-2.06
773	1:3001:125	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	1691.90	145.80	2.05
774	1:3001:121	1:3001:125	IR_SENSOR_1	ir-sensor	Identification	1689.78	325.40	-2.07
774.2	1:3001:125	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	1689.09	145.26	2.06
810.8	1:3001:122	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	1070.07	207.39	-2.36
812	1:3001:122	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	1054.01	207.36	-2.41
834.2	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Detection	761.86	25.62	3.27
837.8	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	720.06	23.76	3.46
841.5	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	678.00	21.60	3.67
845.1	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	638.11	19.23	3.90
881.6	1:3001:122	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	354.10	149.87	-15.98
882.8	1:3001:122	1:3001:121	IR_SENSOR_1	ir-sensor	Detection	347.48	147.35	-15.94
900.1	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Detection	317.32	309.39	11.48
955.1	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Detection	317.32	309.39	11.48
956.7	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	317.32	309.39	11.48
958.4	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	317.32	309.39	11.48
960.1	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Identification	317.32	309.39	11.48
1016.8	1:3001:121	1:3001:122	IR_SENSOR_1	ir-sensor	Detection	317.32	309.39	11.48

sim_time	event_id	attacker_id	target_id	munition_id	range_to_target
273.8	1:3001:23	1:3001:126	1:3001:117	1:3001:130	556.16
439.7	1:3001:24	1:3001:125	1:3001:120	1:3001:131	613.24
449.3	1:3001:25	1:3001:125	1:3001:120	1:3001:132	668.29
847.9	1:3001:26	1:3001:121	1:3001:122	BallisticRound	635.00
858	1:3001:27	1:3001:121	1:3001:122	BallisticRound	528.13
868.1	1:3001:28	1:3001:121	1:3001:122	BallisticRound	454.17
878.2	1:3001:29	1:3001:121	1:3001:122	BallisticRound	393.22
880.8	1:3001:30	1:3001:122	1:3001:121	1:3001:133	369.06
888.3	1:3001:31	1:3001:121	1:3001:122	BallisticRound	296.88
889.8	1:3001:32	1:3001:122	1:3001:121	1:3001:134	303.15

sim_time	event_id	attacker_id	target_id	munition_id	detonation_type
275.2	1:3001:23	1:3001:126	1:3001:117	1:3001:130	EntityImpact
441.2	1:3001:24	1:3001:125	1:3001:120	1:3001:131	EntityImpact
451	1:3001:25	1:3001:125	1:3001:120	1:3001:132	EntityImpact
848.4	1:3001:26	1:3001:121	1:3001:122	BallisticRound	EntityImpact
858.4	1:3001:27	1:3001:121	1:3001:122	BallisticRound	GroundImpact
868.4	1:3001:28	1:3001:121	1:3001:122	BallisticRound	EntityImpact
878.5	1:3001:29	1:3001:121	1:3001:122	BallisticRound	EntityImpact
881.7	1:3001:30	1:3001:122	1:3001:121	1:3001:133	EntityImpact
888.5	1:3001:31	1:3001:121	1:3001:122	BallisticRound	EntityImpact
890.6	1:3001:32	1:3001:122	1:3001:121	1:3001:134	EntityImpact

sim_time	event_id	attacker_id	target_id	munition_id	damage_type	surface	force_type	sim_time_destroyed
275.2	1:3001:23	1:3001:130	1:3001:117	1:3001:130	catastrophic-kill	left-side	ForceFriendly	275.3
451	1:3001:25	1:3001:132	1:3001:120	1:3001:132	catastrophic-kill	left-side	ForceFriendly	451.1
890.6	1:3001:32	1:3001:134	1:3001:121	1:3001:134	catastrophic-kill	left-side	ForceFriendly	890.7

entity_id	entity_name	force_type	sim_time_created	sim_time_destroyed
1:3001:117	M1A2 1	ForceFriendly	6.6	275.3
1:3001:120	M1A2 2	ForceFriendly	6.6	451.1
1:3001:121	M1A2 3	ForceFriendly	6.6	890.7
1:3001:122	T-80B 1	ForceOpposing	6.6	
1:3001:125	T-80B 2	ForceOpposing	6.6	
1:3001:126	T-80B 3	ForceOpposing	6.6	

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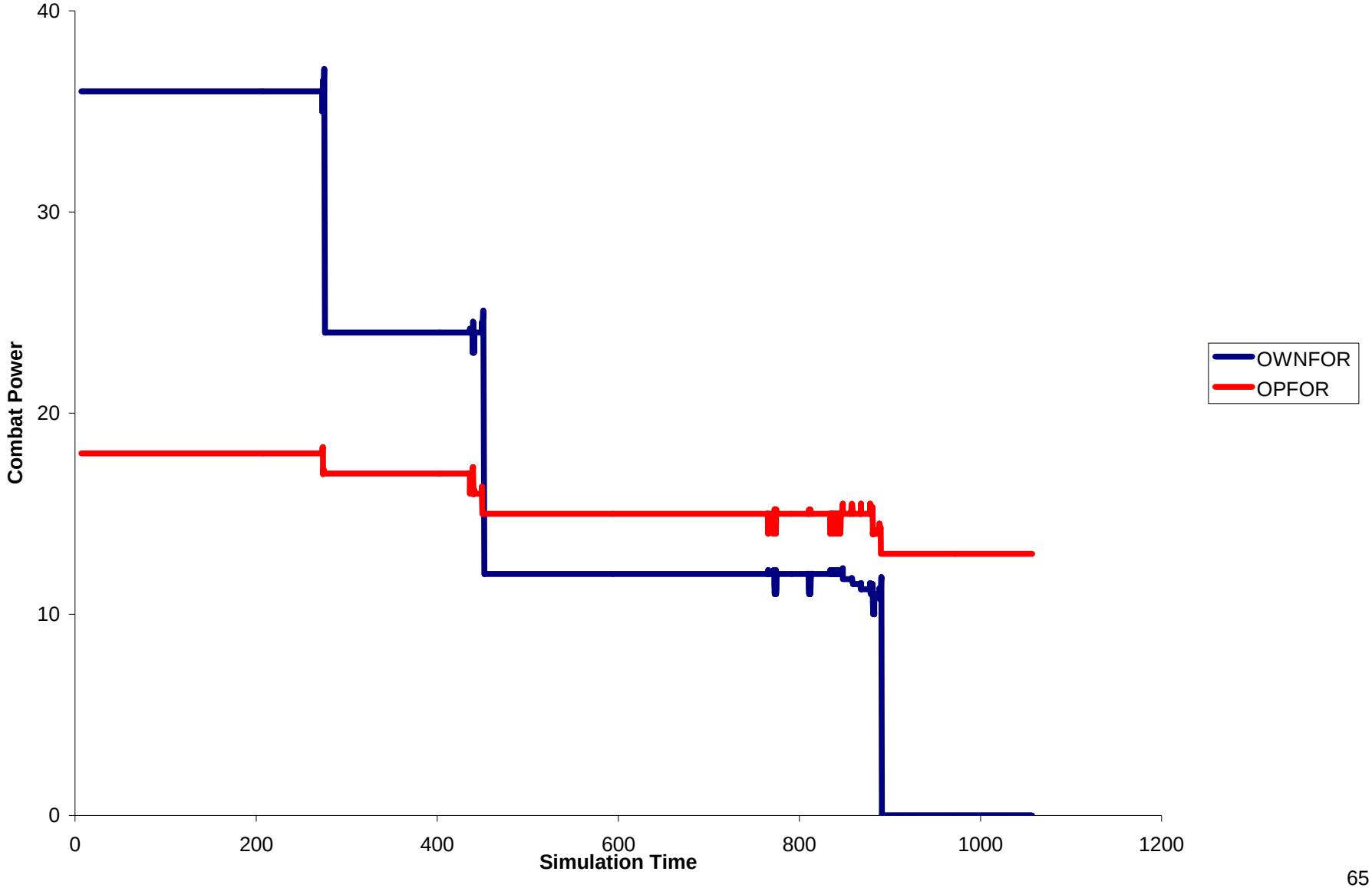
SIM. TIME	OWNFOR # Capable Weapons	OWNFOR # Rounds for Primary Weapon	OWNFOR # Capable Sensors	OWNFOR ...	OWNFOR COMBAT POWER	OPFOR # Capable Weapons	OPFOR # Rounds for Primary Weapon	OPFOR # Capable Sensors	OPFOR ...	OPFOR COMBAT POWER
7	3	120	3		126	3	12	3		18
8	3	120	3		126	3	12	3		18
9	3	120	3		126	3	12	3		18
.										
.										
.										
300	2	80	2		84	3	11	3		17
301	2	80	2		84	3	11	3		17
302	2	80	2		84	3	11	3		17
.										
.										
.										
449	2	80	2		84	3	10	3		16
450	2	80	2		84	3	9	3		15
451	1	40	1		42	3	9	3		15
.										
.										
.										
900	0	0	0		0	3	7	3		13
901	0	0	0		0	3	7	3		13
902	0	0	0		0	3	7	3		13


40
30
20
10
0
Combat Power
0
200
400
600
800
1000
1200
Simulation Time
OWNFOR
OPFOR

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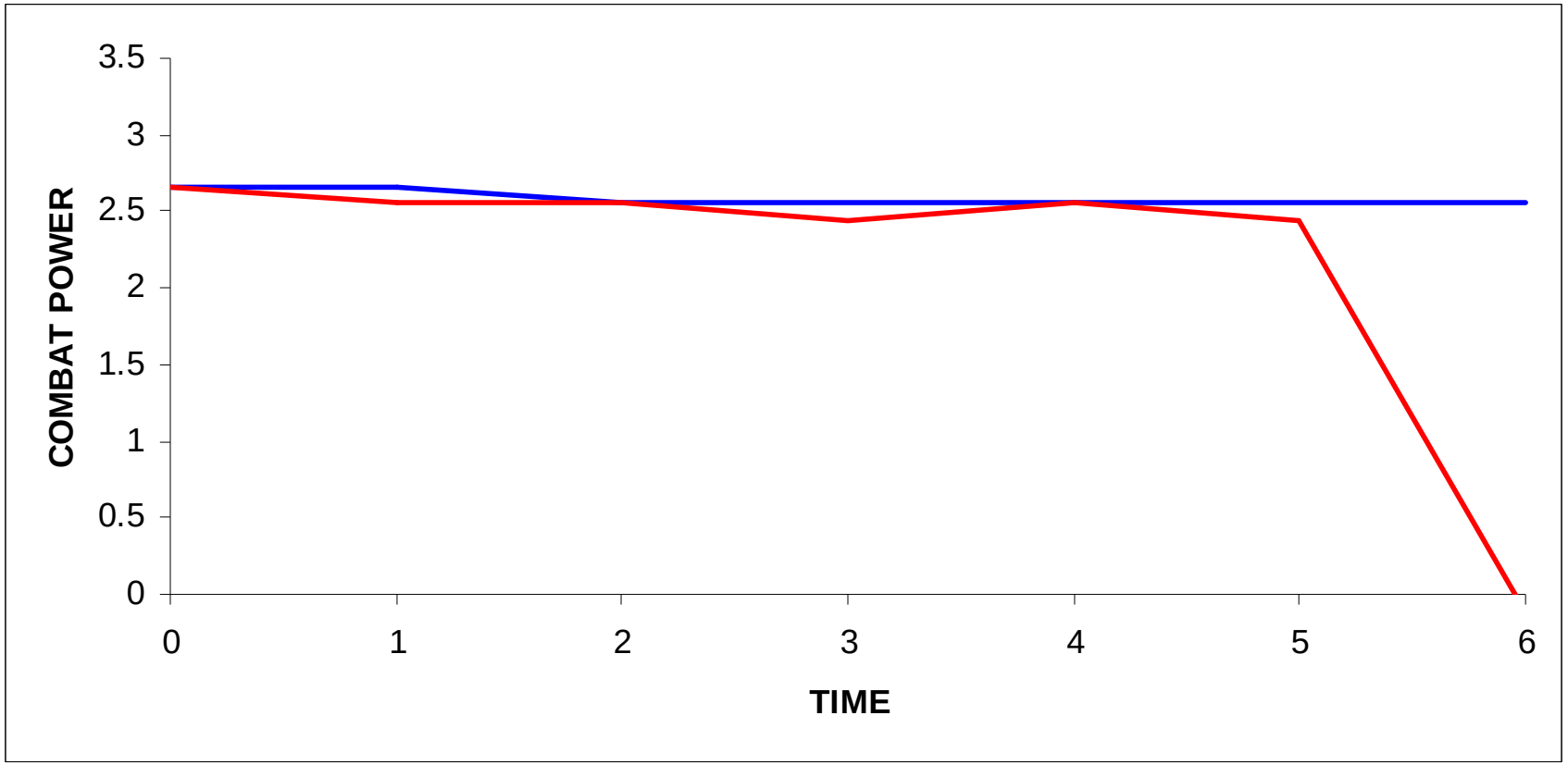
		OPFOR								
		Sustainment			Lethality		Acquisition	Survivability		
	Weighting Factors:	1/9	1/9	1/9	1/9	1/9	1/9	- 1/9	- 1/9	
Operation Time	Action	# Capable Weapons	# Rounds for Primary Capable Weapon	# Capable Sensors	# Engagements not leading to a kill	# Engagements leading to a kill	# Acquisitions not leading to an engagement	# Times acquired but not engaged	# Times Acquired and engaged	CPV
0	Start	1	20	3	0	0	0	0	0	2.667
1		1	20	3	0	0	0	0	1	2.556
2	Acquire OWNFOR	1	20	3	0	0	0	0	1	2.556
3	Engage OWNFOR	1	19	3	0	0	0	0	1	2.444
4	Miss OWNFOR	1	19	3	1	0	0	0	1	2.556
5		1	19	3	1	0	0	0	2	2.444
6		0	0	0	1	0	0	0	2	-0.111

		OWNFOR								
		Sustainment			Lethality		Acquisition	Survivability		
	Weighting Factors:	1/9	1/9	1/9	1/9	1/9	1/9	- 1/9	- 1/9	
Operation Time	Action	# Capable Weapons	# Rounds for Primary Capable Weapon	# Capable Sensors	# Engagements not leading to a kill	# Engagements leading to a kill	# Acquisitions not leading to an engagement	# Times acquired but not engaged	# Times Acquired and engaged	CPV
0	Start	1	20	3	0	0	0	0	0	2.667
1	Acquire OPFOR	1	20	3	0	0	0	0	0	2.667
2	Engage OPFOR	1	19	3	1	0	0	0	1	2.556
3	Miss OPFOR	1	19	3	1	0	0	0	1	2.556
4		1	19	3	1	0	0	0	1	2.556
5	Engage OPFOR	1	18	3	1	1	0	0	1	2.556
6	Kill OPFOR	1	18	3	1	1	0	0	1	2.556


COMBAT POWER
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
TIME

Conclusions

The Missions and Means Framework (MMF) is an ideal structure for conducting trade studies related to requirements development and combat capability.

The concept of Combat Power as defined in this tutorial illustrates the importance of MMF as a guiding framework, and provides the analytical means for determining the optimal force mix for specific missions.

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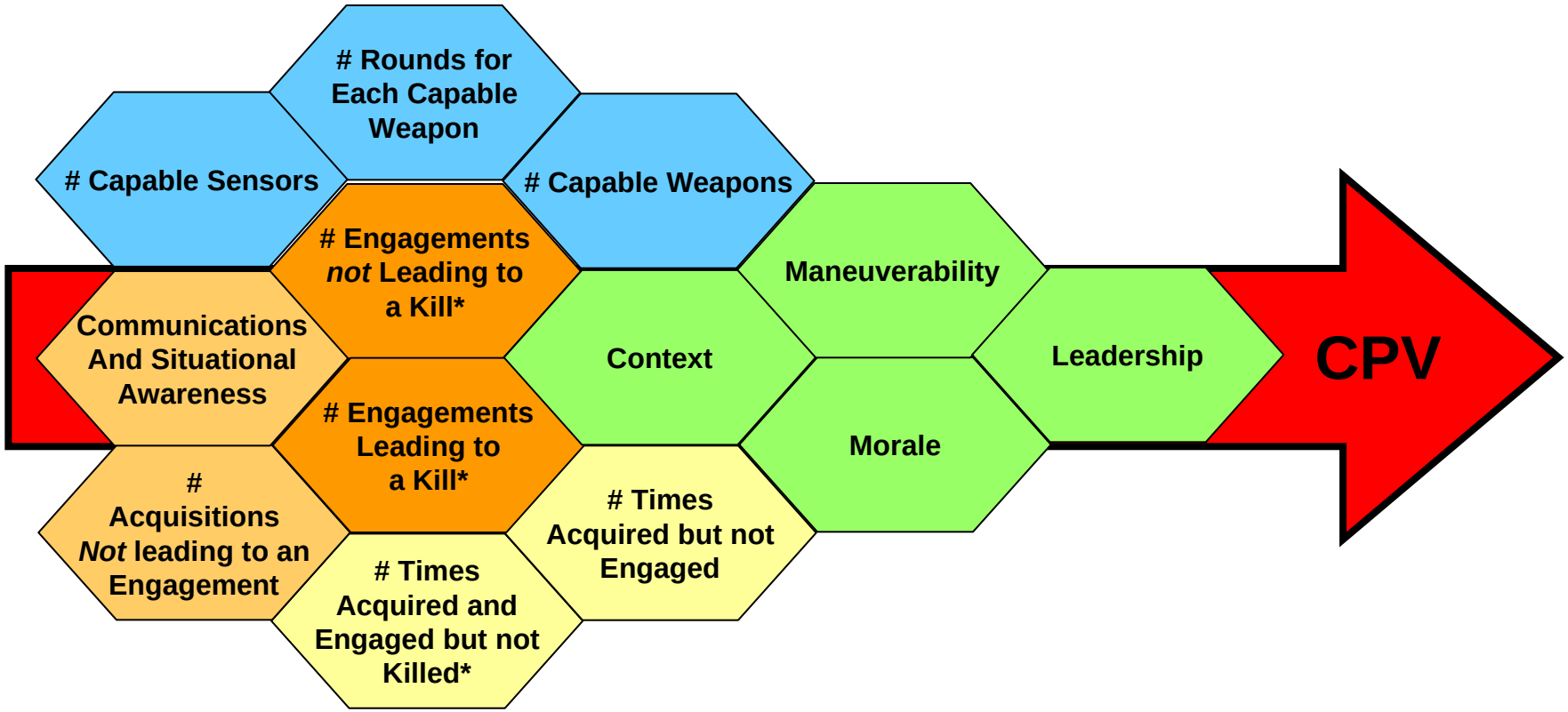
Rounds for Each Capable Weapon
Capable Sensors
Capable Weapons
Engagements *not* Leading to a Kill*
Maneuverability
Communications And Situational Awareness
Context
Leadership
CPV
Engagements Leading to a Kill*
Morale
Acquisitions *Not* leading to an Engagement
Times Acquired but not Engaged
Times Acquired and Engaged but not Killed*