



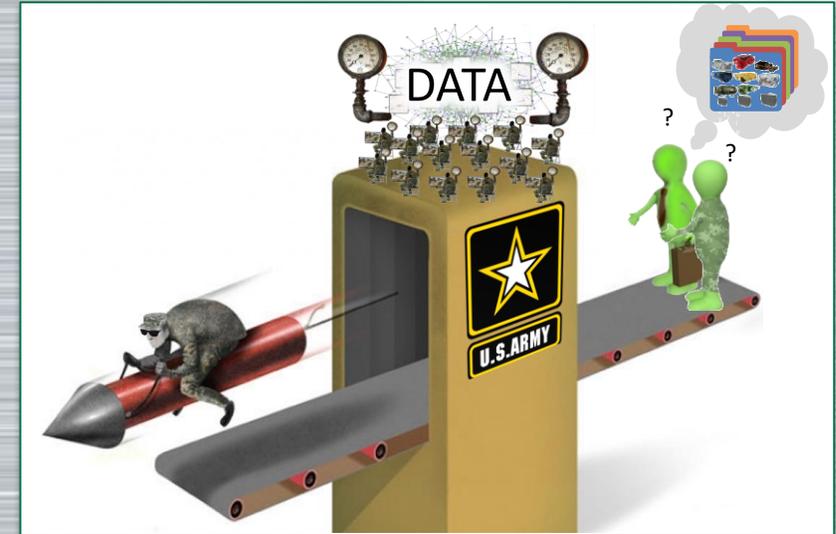
# The Soldier and the Scientist: A Learning Singularity

Mad Scientist Learning in 2050

8 August 2018

Robert E. Smith, PhD

[robert.e.smith1699.civ@mail.mil](mailto:robert.e.smith1699.civ@mail.mil)





### DISCLAIMER:

Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government, and shall not be used for advertising or product endorsement purposes.



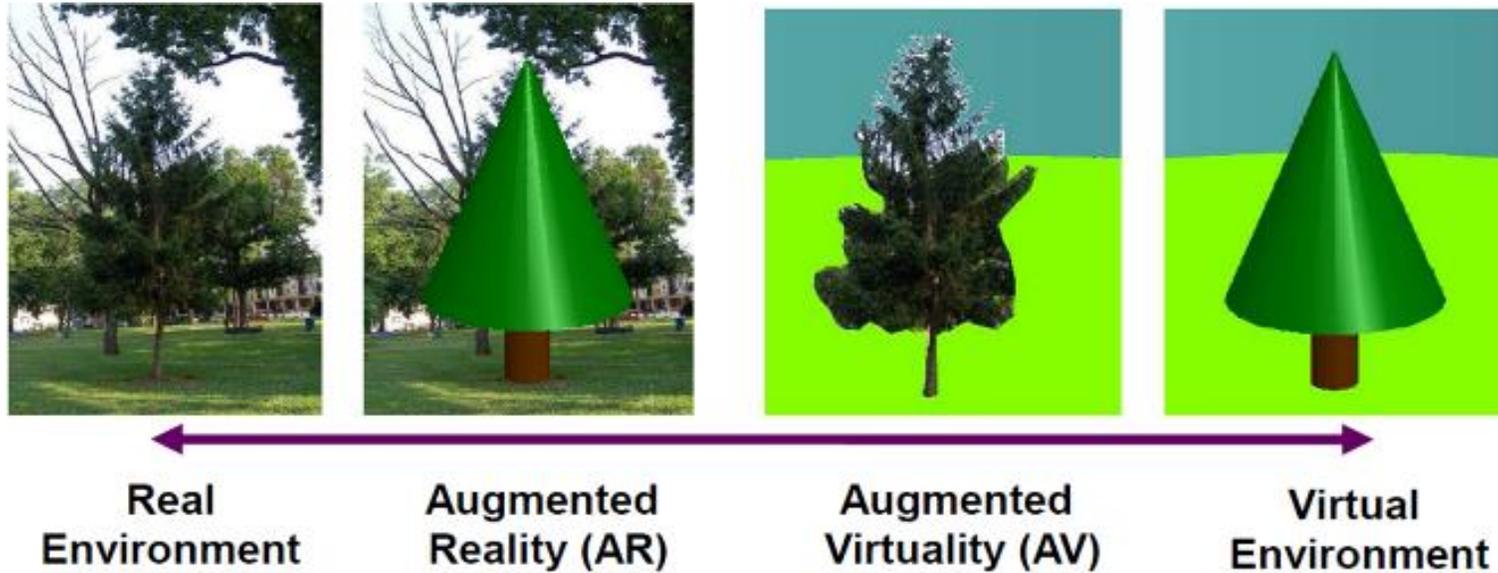
## Somewhat Dystopian World in 2050

- Most technologies available globally
- ROI negative for “widget” S&T investments
- Unknown enemy / no homefield advantage
- Individual platforms not important
  - Swarms of deadly hobby drones
  - Best AI wins

# Somewhat Dystopian World in 2050



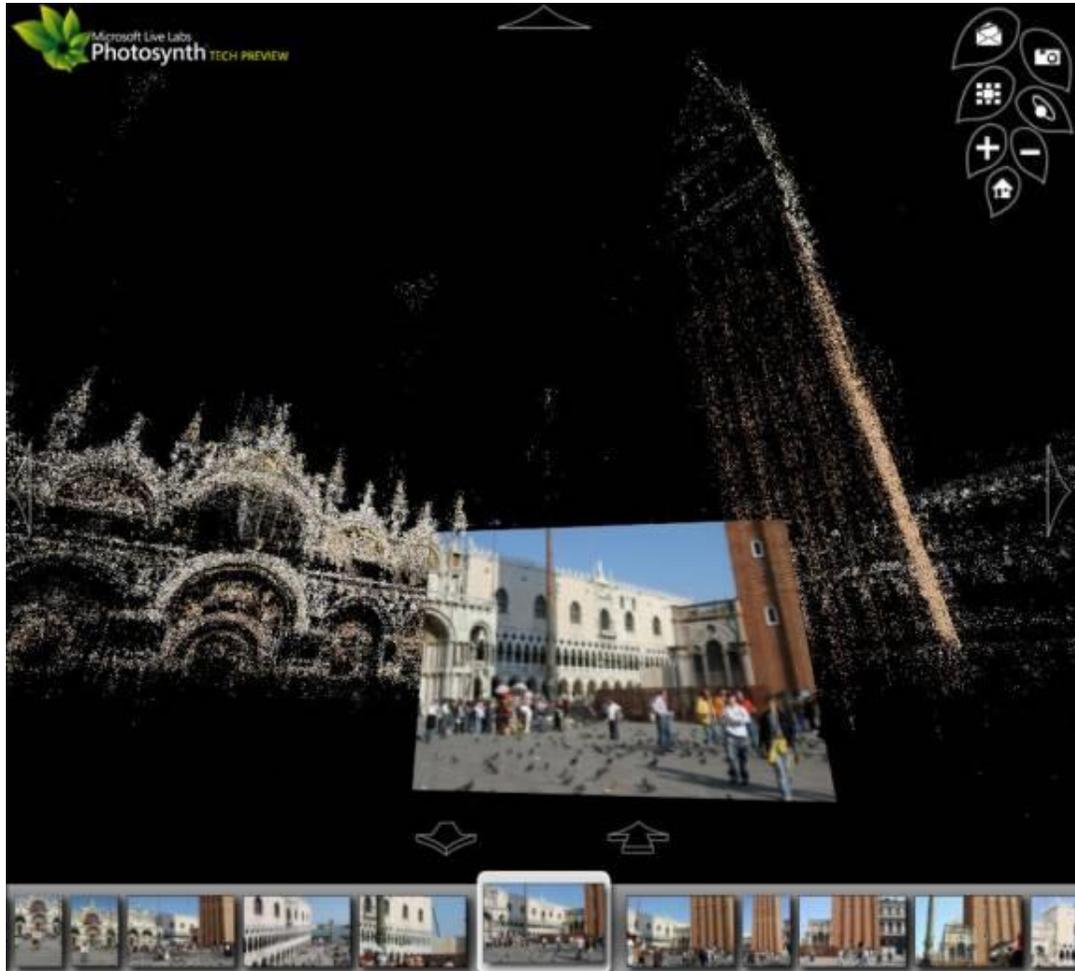
- Reality and Virtual Reality are blurring and ubiquitous



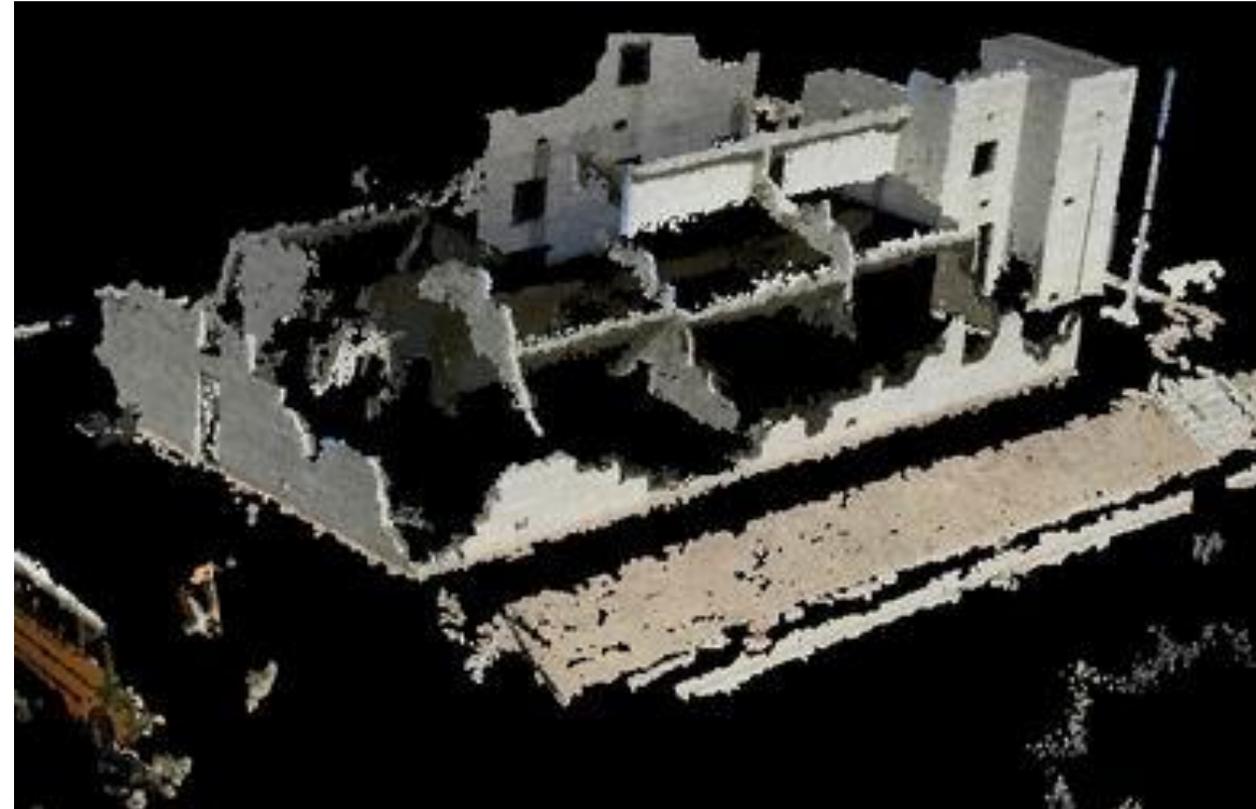
# Reality into the Pure Virtual



## Microsoft Photosynth



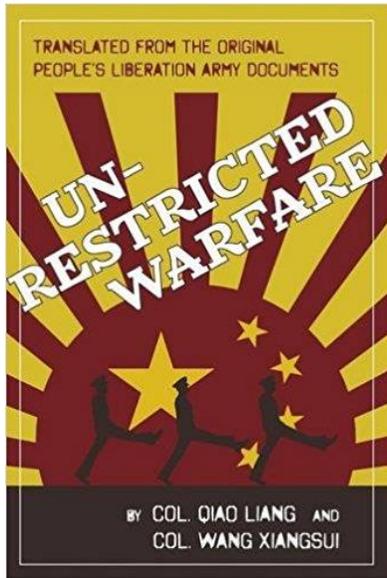
## SPAWAR 3d from motion



# Pure Virtual into Reality



# Somewhat Dystopian World in 2050



China

National Defense Strategy

“Proposing a new concept of weapons does not require relying on the springboard of new technology, it just demands lucid and incisive thinking. However, this is not a strong point of the Americans, who are slaves to technology in their thinking”

“Customizing weapons systems to tactics which are still being explored and studied is like preparing food for a great banquet without knowing who is coming, where the slightest error can lead one far astray”

“Success no longer goes to the country that develops a new fighting technology first, but rather to the one that better integrates it and adapts its way of fighting....” -



# Robtopian Vision: Continuous Windows of Advantage

Modularize      Optionality

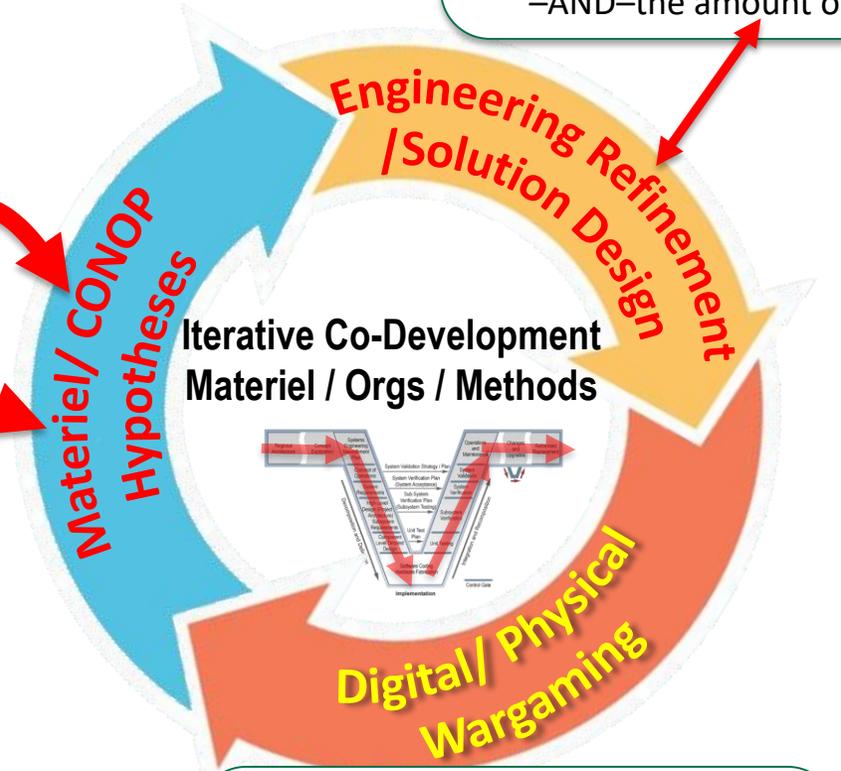
Balance modular versus custom  
-AND- the amount of resilience.

# OUTPUT

Mission Set

Multidomain  
"Widgets"

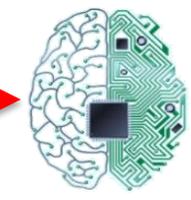
- Global Commercial Tech
- Military Unique Tech
- Future S&T Ideas
- Red Teaming



Physical Prototypes + Virtual Warfighting

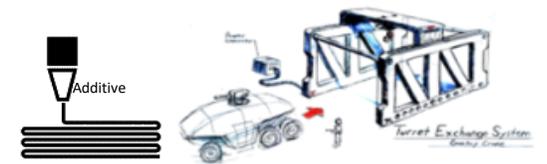
MILLIONS OF HOURS OF **DATA**

## OPTIMAL CONOPS



### Artificial Intelligence Overmatch

## Mission-Tailored Capabilities On Demand



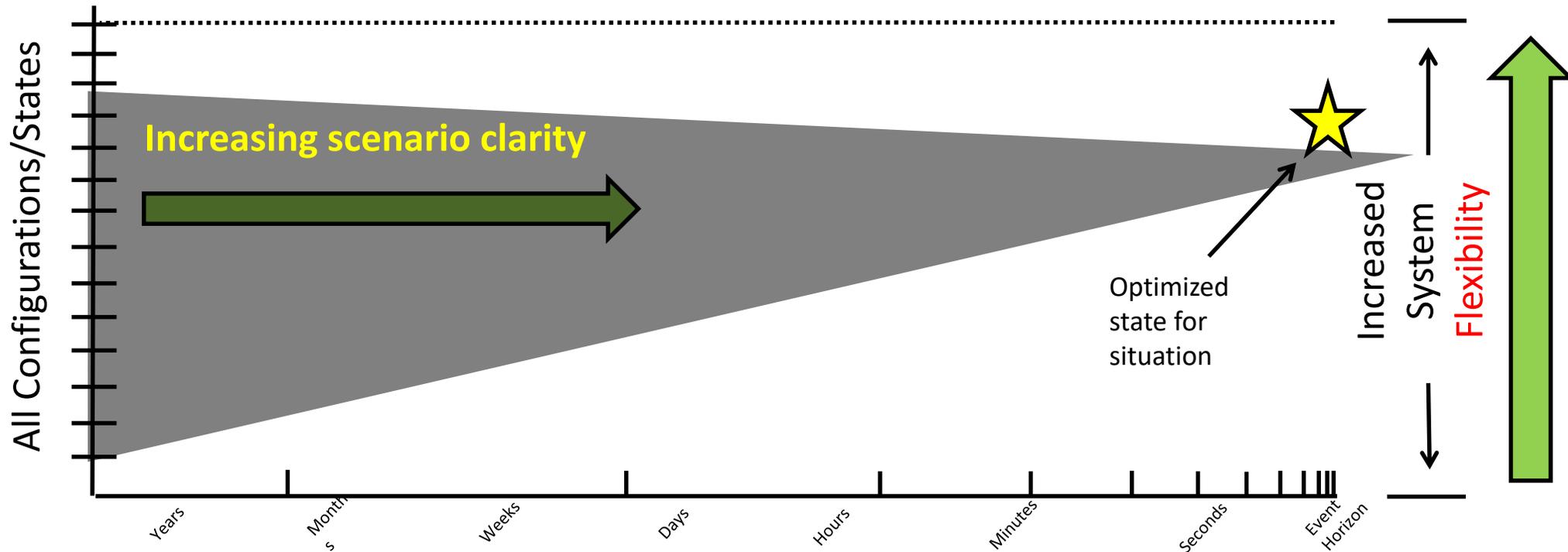
-OR-

-OR-

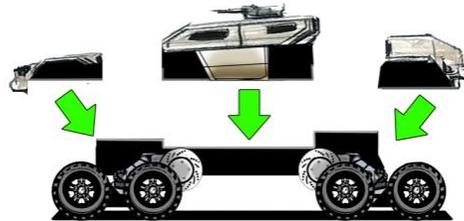


## Disposable?

# Modularity / Changability vs Learning in Time



Wargaming of Potential Scenarios



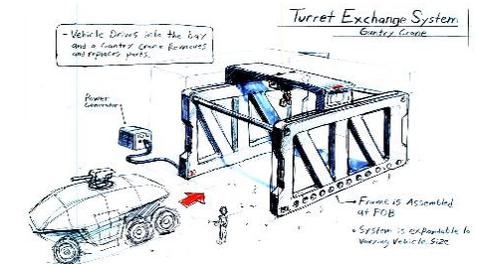
**Modularize**  
Relevant Components



Vehicle **"Templates"**



**Procure on Demand**



Vehicle **Changability**



# Prototyping is the Shorthand of Innovation

- Build to learn – now beats later
- Good prototype worth a thousand pictures
- The whole point is to get feedback - data beats opinions
- Minimum viable prototype
- Prototypes don't have to be physical
- Google principle: Innovation, not instant perfection



**Physical Prototyping**  
(Minimal refights, deep physics)

**Digital Warfighting**

(Lots of mission space/ data, lesser physics)

Magazine Racing: Where you pull out the specs and never run the race.  
**OPINION BASED**

**Camaro SS 2010**

Engine: 6.2 Liter LS3  
Power (SAE): 426 BHP @ 5900 RPM  
Torque: 420 ft-lb @ 4600 RPM  
Weight: 3,860 lbs

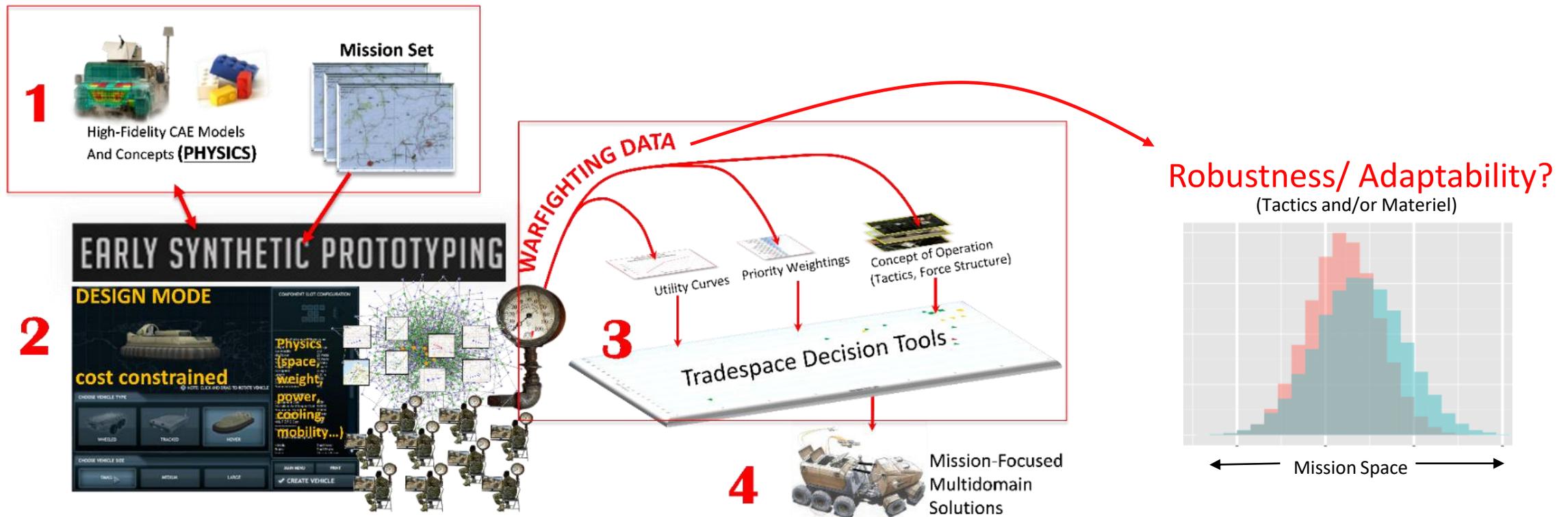
**Mustang GT 2011**

Engine: 5.0L V8  
Power (SAE): 412 hp @ 6,500 rpm  
Torque: 390 ft-lb @ 4,000 rpm  
Weight: 3,605



# Early Synthetic Prototyping (Operation Overmatch)

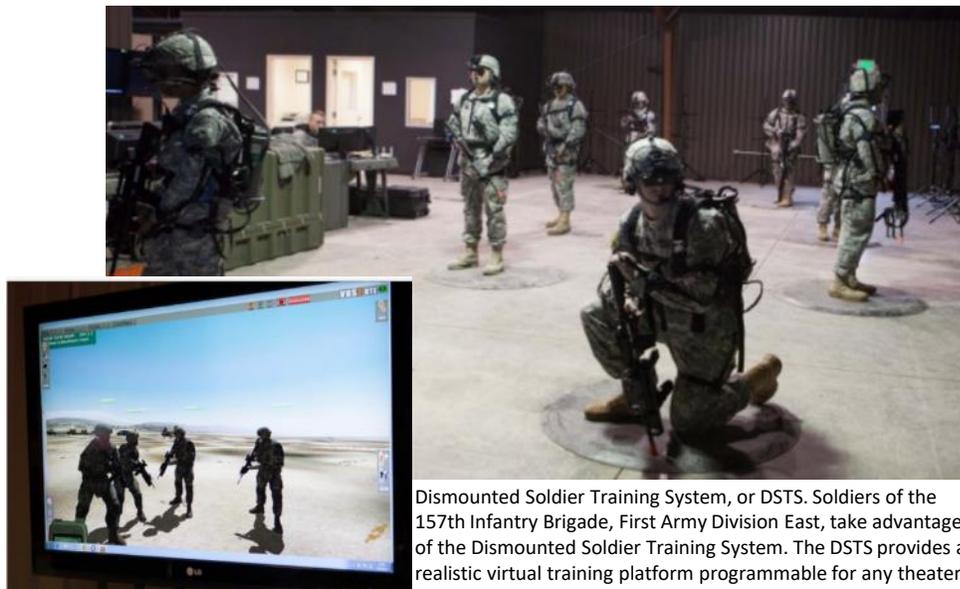
- TRADOC/RDECOM using gaming for acquisitions – not training
- Physics-based and crowdsourced
- First alpha out now Operation Overmatch, first person shooter
- Technical challenge in data mining 12 million hours of play / year



# Exploiting Virtual Reality / Augmented Reality

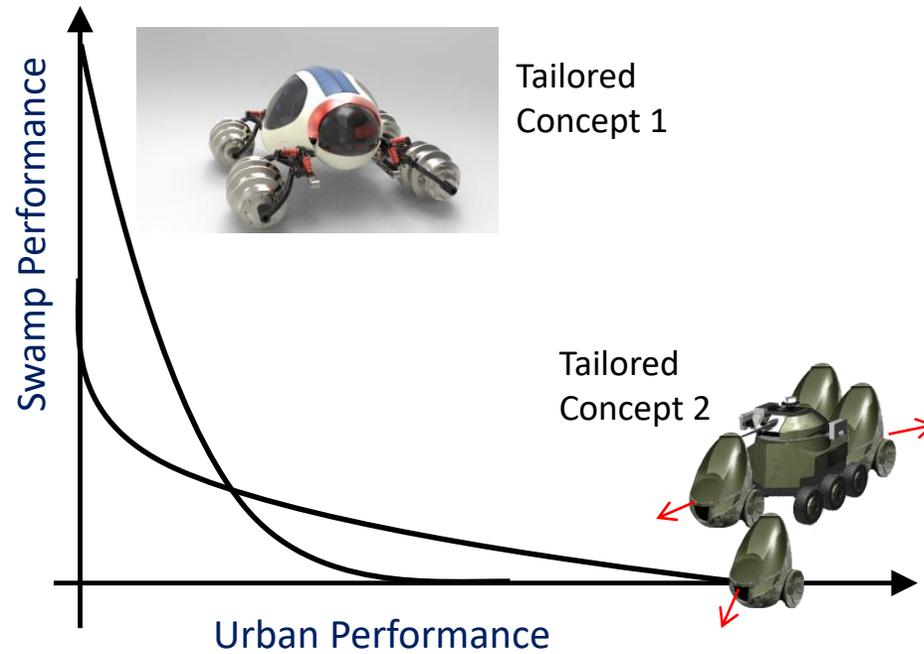
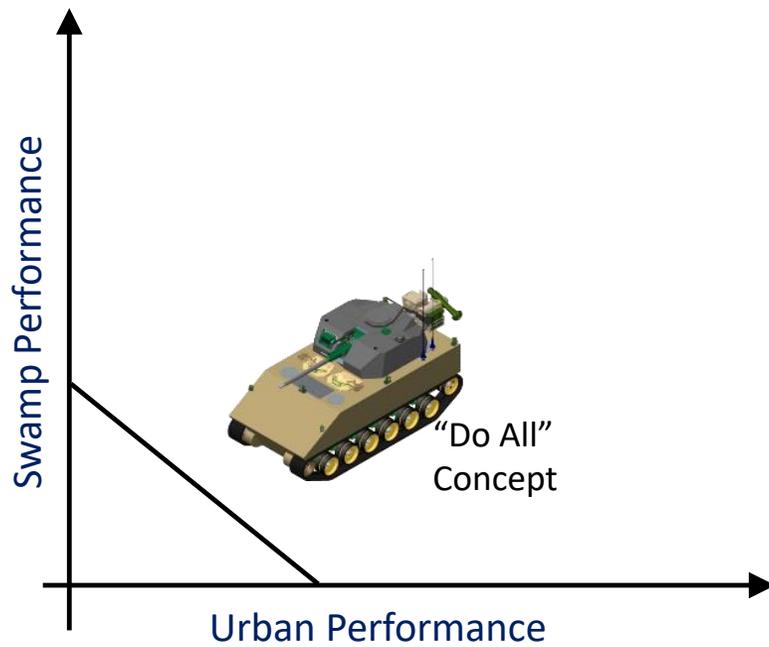


- Soldiers must accrue [SOF-like] experience at a much faster rate over a wide range of operations so they can adapt and innovate.
- Per [Head Strong: How Psychology is Revolutionizing War](#):  
Broad learning exposures allow experts to build huge pattern recognition ability to modify/ act quickly.
- In complex world there won't be a "right way" for most situations  
(unpredictability is also an advantage)
- **Army will learn from students in Complex World**



Dismounted Soldier Training System, or DSTS. Soldiers of the 157th Infantry Brigade, First Army Division East, take advantage of the Dismounted Soldier Training System. The DSTS provides a realistic virtual training platform programmable for any theater of operations while mitigating risk.

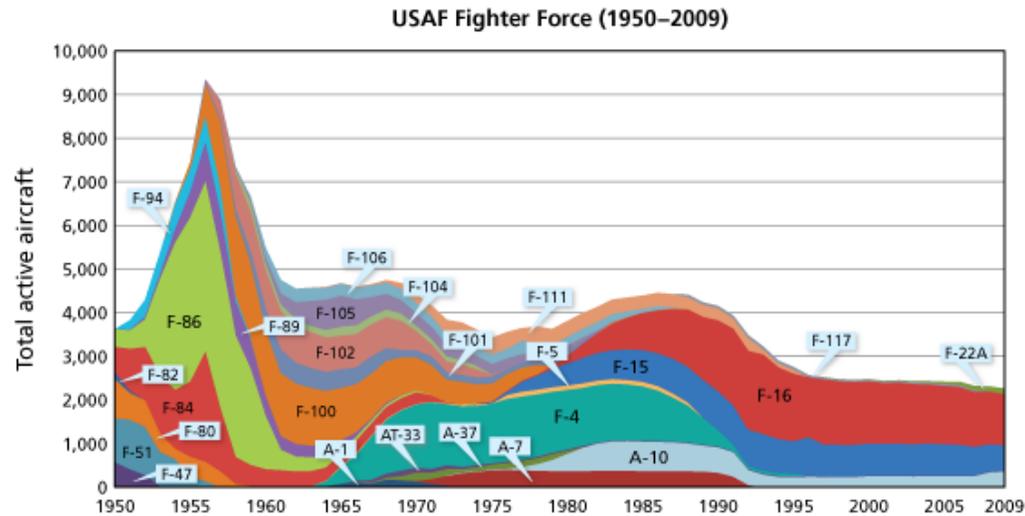
# Tailoring for System Combat Utility



# Disrupting Enemy Learning / Strategic OODA Loops



- DoD should embrace a strategy of options and diversity
  - Create more capability options across a wider, more diverse portfolio
  - Develop a true high-low mix of capabilities
- Between 1950 and 1960 the U.S. Air Force employed 14 different fighter jets, three times as many as today



We have just over 60 F-117s, but the world must react to those F-117s just as if we had many hundreds ... Our problem, though, is the F-117s operate in a fairly constrained, well known altitude and speed block ... Our answer must be an F-118 and an F-119

--Colonel John Warden

# Disposable? DARPA AVM XC2V



Idea to vehicle in 4 months



“Maybe we did not do the same development that [the contractor] did, to make sure the strut on the vehicle lasts a million miles. But if it saves a life, and it lasts for a whole conflict, haven’t we done a better thing?”

-- Jay Rogers, Local Motors

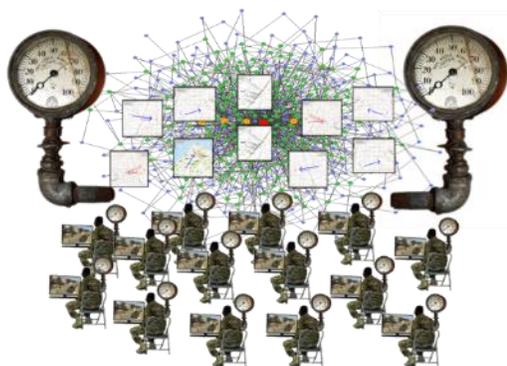
“Not only could this change the way the government uses your tax dollars—think about it, **instead of having a 10-year lead time** to develop a piece of equipment, if we were able to collapse the pace of which that manufacturing takes place, that **would save taxpayers billions of dollars**—but it also could get technology out to the theater faster, which could save lives. “

--President Barack Obama 2011



# Learning from Game Analytics

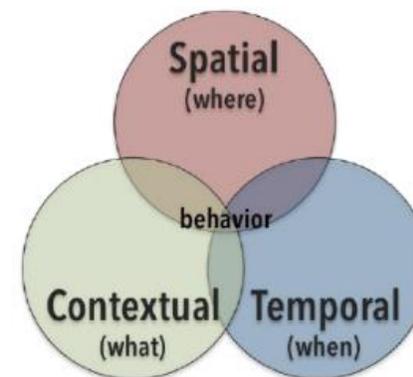
Virtual Physics-Based  
Gaming Environment



~12 million hours of Soldier  
gameplay per year

## Data Mining

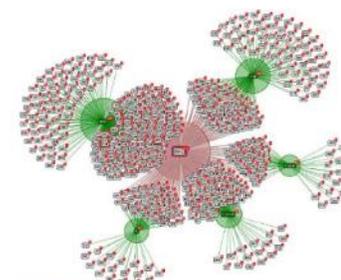
- What are they doing?
- Where are they doing it?
- Why they are doing it?
- How effective is this?
- Terrain versus movement choices
- What are they talking about/ when/ how often
- Optimal Force structure



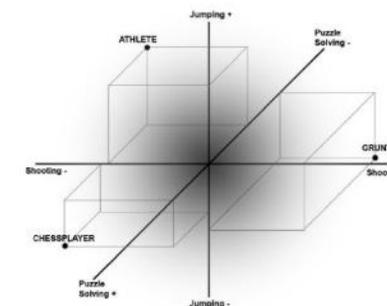
## Visualization



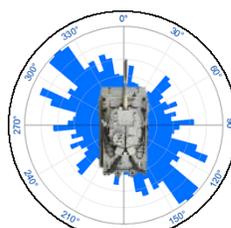
Decision Trees



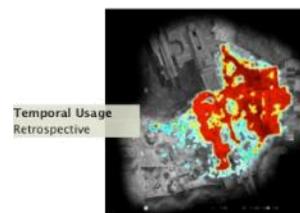
Clustering Cause of Death



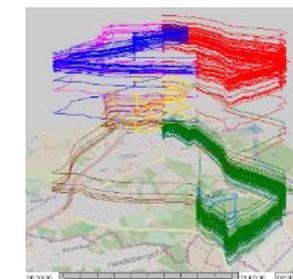
Player Personas



Engagement Sector Cardioid



Player Kills  
Heat Maps



Multi-Run Movement Plots

# What Might We Learn from Gaming and Sports?

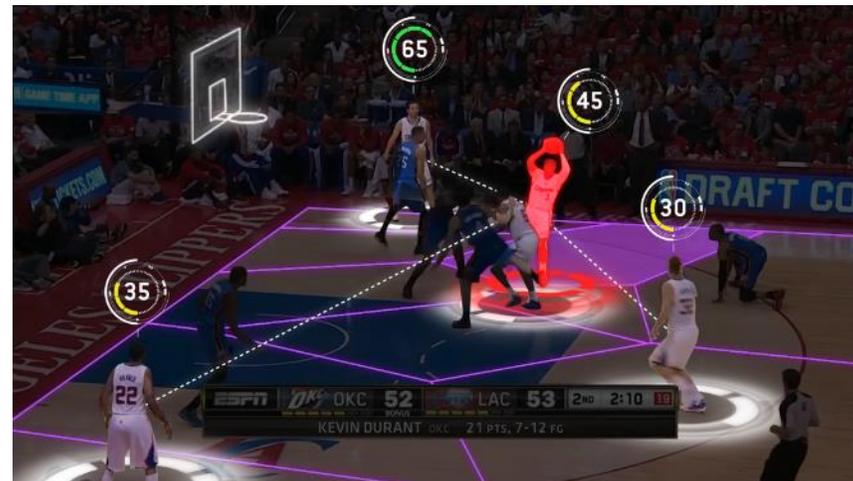


- “Serious sport is war minus the shooting” – George Orwell
- Ability of a coach/players to understand behaviors wins and loses games
- Multiple cameras now allow us to create data sets of player/ball telemetry
- Brain isn’t designed to aggregate hundreds or thousands of traces, but computers can discover complex or very subtle patterns
- Data could be presented to players on the field using augmented reality
- MIT Sloan has dedicated sports/ esports conference (way beyond moneyball)

[www.sloansportsconference.com](http://www.sloansportsconference.com) february 23 - 24, 2018 | Boston



[https://www.ted.com/talks/chris\\_kluwe\\_how\\_augmented\\_reality\\_will\\_change\\_sports\\_and\\_build\\_empathy](https://www.ted.com/talks/chris_kluwe_how_augmented_reality_will_change_sports_and_build_empathy)



[https://www.ted.com/talks/rajiv\\_maheswaran\\_the\\_math\\_behind\\_basketball\\_s\\_wildest\\_moves](https://www.ted.com/talks/rajiv_maheswaran_the_math_behind_basketball_s_wildest_moves)

# Teaching the Machines



Per SCO Director, William Roper: [https://www.youtube.com/watch?v=GLh\\_ApVVBU4](https://www.youtube.com/watch?v=GLh_ApVVBU4)

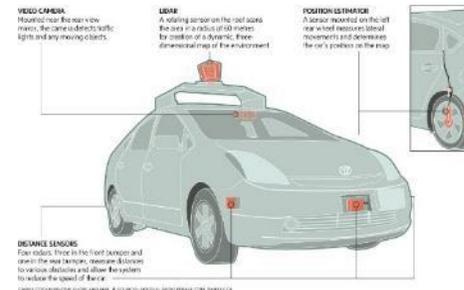
- Google, or Apple, or Amazon think people who have the most data is going to be able to train the most intelligent machine
- “Pentagon should be stockpiling all of its data from every flight, every mission, and every exercise in a way that is machine discoverable.”
- “Try to take a pentagon that is device centric—device being like fighter, bomber, submarine, or tank – and shift it to be data centric. To merely think of their systems as being data producers and the data being more important than the systems themselves.”

Per Vladimir Putin: <https://www.theverge.com/2017/9/4/16251226/russia-ai-putin-rule-the-world>

- Nation that leads in AI ‘will be the ruler of the world’
- Predicts that future wars will be fought by countries using drones. “When one party's drones are destroyed by drones of another, it will have no other choice but to surrender”

Waymo(Google) car ~1GB of sensor data / second

- 2 Petabytes of data per year (2 million GB) per car



## Als without Data Useful Too



- Open AI trained on DOTA2 solely by playing itself
- The AI win stunned the gaming community, because bots are generally considered inferior to expert human players.
- Probably best combination in future is by combining human heuristics and AI self-learning.
- The trick with most AI (neural networks) is we don't know what the network is learning.

<http://money.cnn.com/2017/08/12/technology/future/elon-musk-ai-dota-2/index.html>

<https://www.youtube.com/watch?v=l92J1UvHf6M>

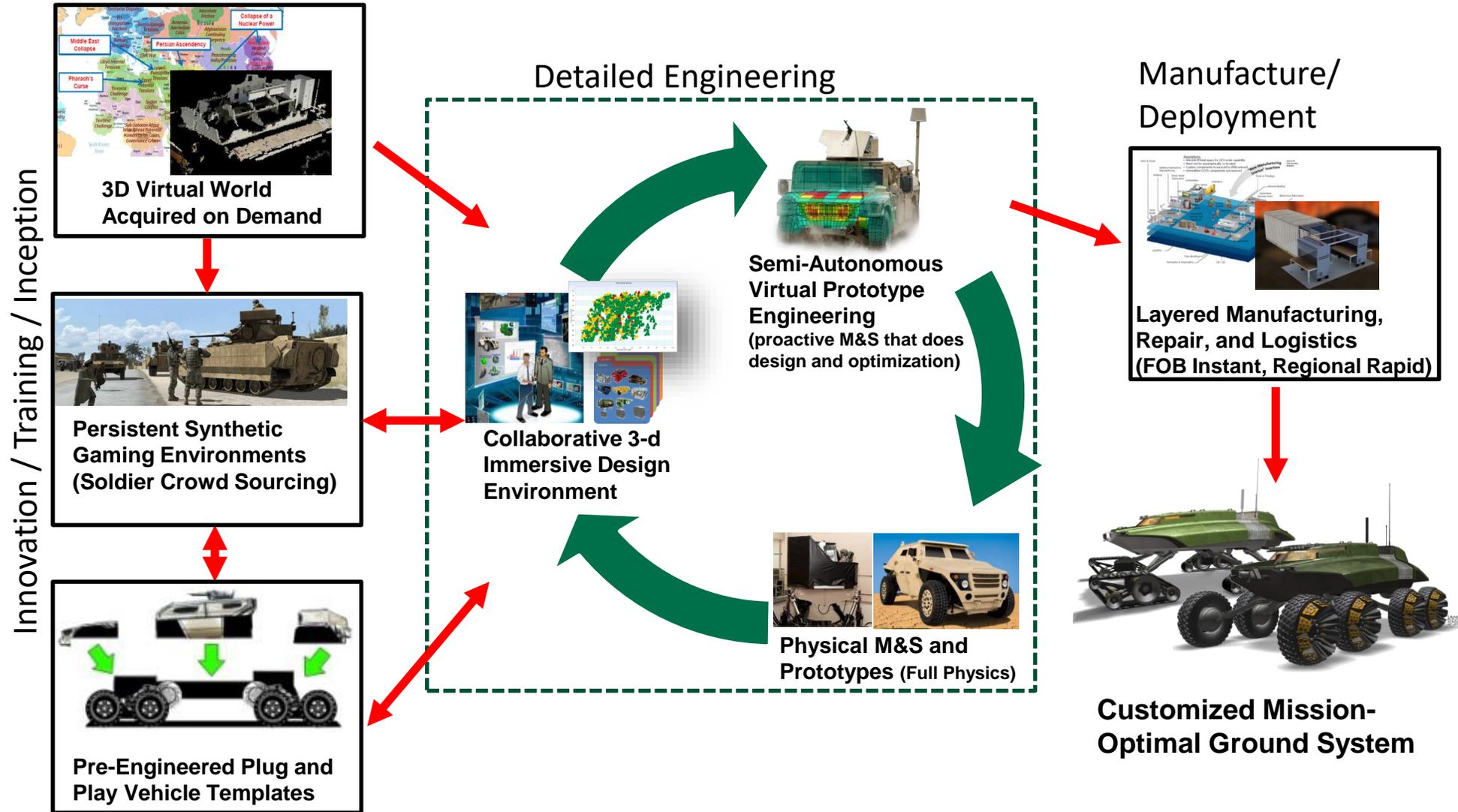




# QUESTIONS



# Future Investments That Could Be Made...

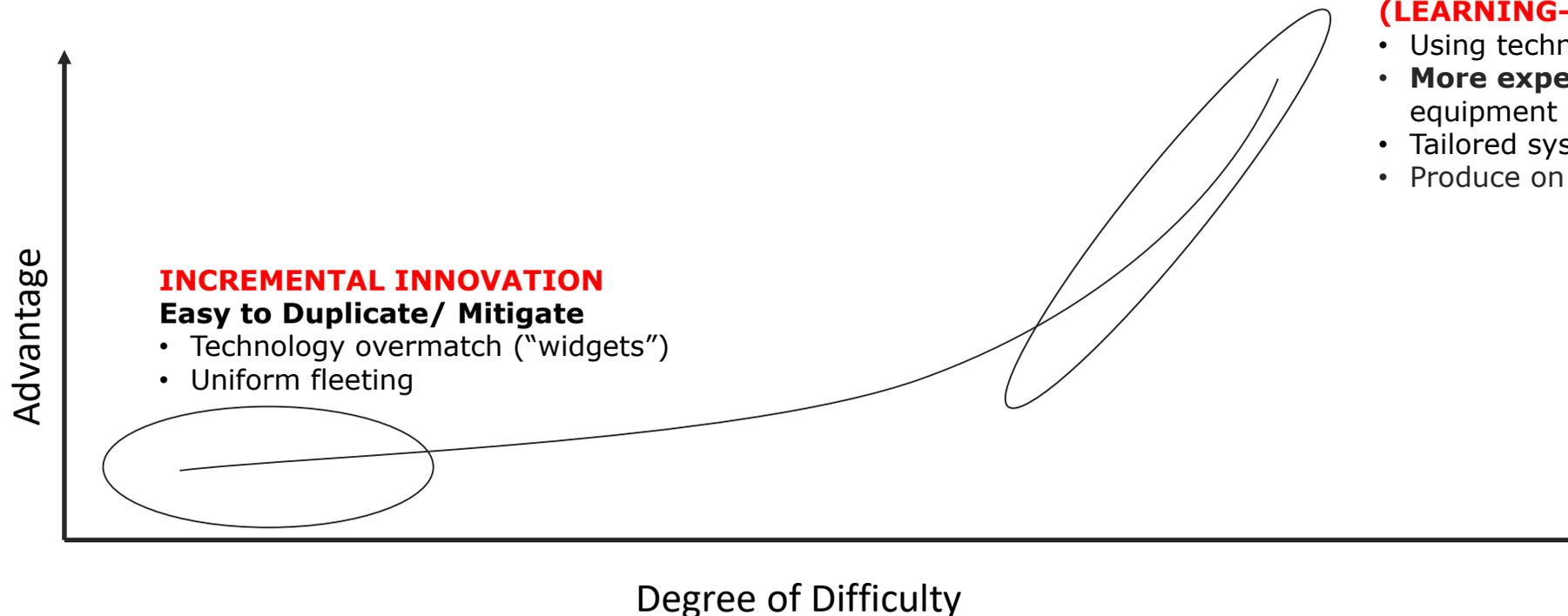


# Somewhat Dystopian World in 2050



- Most technologies available globally
- Unknown enemy
- ROI negative for “widget” S&T investments
- Individual platforms not important
  - Swarms of deadly hobby drones
  - Best AI wins

*“Success no longer goes to the country that develops a new fighting technology first, but rather to the one that better integrates it and adapts its way of fighting....” - The National Defense Strategy (2018).*



# It's all about storytelling/ physics/ immersion...

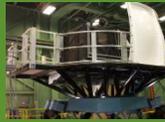
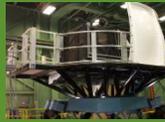
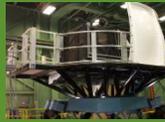


U.S. ARMY  
**RDECOM**  
GROUND VEHICLE  
SYSTEMS

Select appropriate venues, physics, and timing



Virtual Experiment Test Plan

<p><i>Video Storyboard</i></p>  <p>Video <a href="http://www.youtube.com/watch?v=JoeagekLx9c">http://www.youtube.com/watch?v=JoeagekLx9c</a> Feedback link <a href="https://www.research.net/s/technologyfortactics">https://www.research.net/s/technologyfortactics</a></p>	<p><b>Purely Virtual</b> @TARDEC, ESP</p>  	<p><b>Higher Fidelity Experiments</b></p> <table border="1"><tr><td><p><b>Crowd Source Kiosks</b></p><p>Limited Motion</p></td><td><p><b>High-speed Tele-operation</b></p><p>Static</p></td><td><p><b>MITL at TARDEC</b></p><p>SIL</p><p>Motion</p></td></tr></table>		<p><b>Crowd Source Kiosks</b></p>  <p>Limited Motion</p>	<p><b>High-speed Tele-operation</b></p>  <p>Static</p>	<p><b>MITL at TARDEC</b></p>  <p>SIL</p>  <p>Motion</p>
<p><b>Crowd Source Kiosks</b></p>  <p>Limited Motion</p>	<p><b>High-speed Tele-operation</b></p>  <p>Static</p>	<p><b>MITL at TARDEC</b></p>  <p>SIL</p>  <p>Motion</p>				



***Mission Engineering*** treats the end-to-end mission as the system in the operational context to drive performance requirements for individual systems. An assessment framework measures progress towards mission accomplishment through test and evaluation in the mission context.

***Prototype Warfare*** represents the paradigm shift from large fleets of common-one-size-fits-all exquisite systems to small quantities of rapidly-fielded tailored systems. Mission-tailored systems focus on specific functions, specific geographic areas, or even specific fights and are inexpensively produced and possibly disposable.