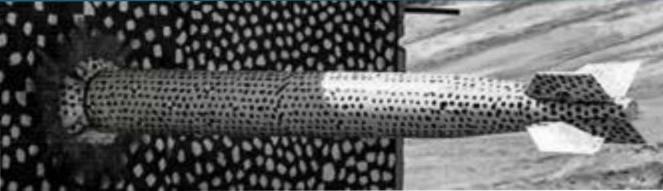
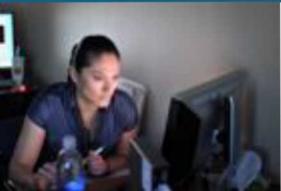




A classification of innovation processes precipitated by the rise of deep-threat multi-use technologies



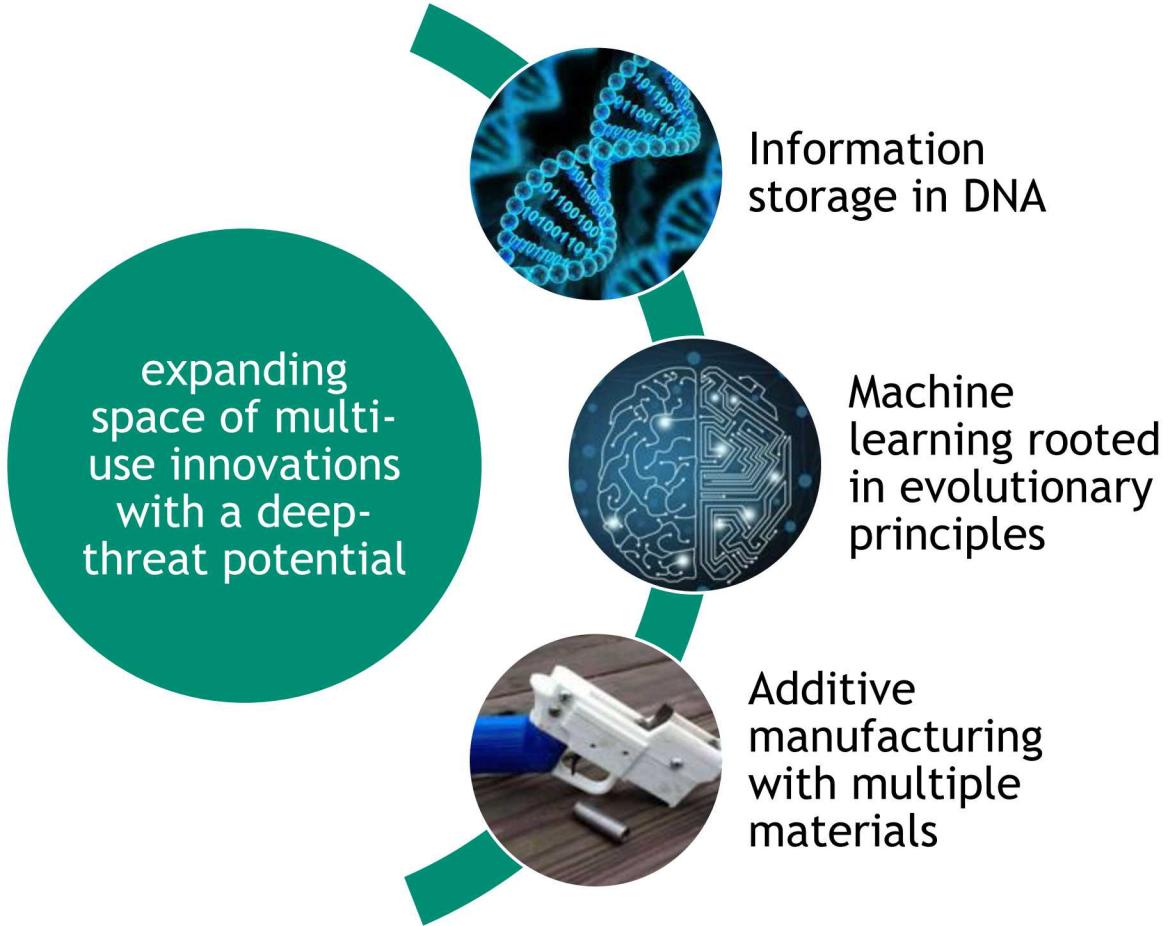
PRESENTED BY

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²Sandia National Laboratories, Albuquerque, NM

Understanding and adopting a new style of innovation may be needed to address the evolving national security landscape



3 New kinds of capabilities are appearing, enabled by new phenomena, new technologies, and a different way of thinking – used for good or harm



Cell phones



<https://www.dhs.gov/sites/default/files/publications/Security-and-Resiliency-Guide-Lodging-Annex.pdf>

Trigger IEDs

<https://www.dhs.gov/sites/default/files/publications/Security-and-Resiliency-Guide-Lodging-Annex.pdf>



Enable new communities

<https://www.uspto.gov/custom-page/inventors-eye-organizations-inventors-1>



<https://www.defense.gov/observe/photo-gallery/igphoto/2002015881/>

Used for military purposes



Used in agriculture

<https://arpa-e.energy.gov/?q=impact-sheet/pacific-northwest-national-laboratory-terra>

Easily accessible databases



<https://rush.house.gov/media-center/press-releases/rush-introduces-the-data-accountability-and-trust-act>



<http://classes.dma.ucla.edu/Fall13/161/projects/adam-lai-fatt/5-style/html/cyberterrorism.html>



<https://www.publichealth.va.gov/exposures/publications/gulf-war/gulf-war-2018/cp-examiner-training.asp>

Doctors with no data analytics training can predict disease...



Adversaries with no data analytics training can predict troop movements...

Evolving U.S. National Securityscape and its impact on the innovator's environment



Evolving securityscape



Funding



Transforming research models



Evolution of the innovator's relationship with knowledge



Questions driving our research...



Have these shifts in environmental factors led to the emergence of new processes of innovating?

If so, do these new processes lead to new types of outcomes?

Research into the
theory and
processes of
innovation



Today's focus

What is the current state of innovation art at the U.S. national security laboratories?

Case study of the
state of innovation
art at Sandia National
Laboratories



Origination

Exploring science from the same or adjacent domains in development of new phenomena and technologies in the same or new domain

Assimilation

Exploring science and technologies from disparate domains in development of new application spaces or technologies

Refinement

Exploiting existing technologies through modifications from the same (or closely adjacent) domain

Compilation

Exploit technologies from disparate domains to develop new combinatorial based technologies

Exemplar: Drones



ORIGINATION

Ability to fly a full-size plane without a pilot



<https://www.digitaltrends.com/cool-tech/history-of-drones/>

Unmanned & remote control aircraft

ASSIMILATION

Use same idea and some same technologies to develop modes of transportation in other domains



China's Purported Marine Lizard

Landcraft



Watercraft

<https://www.businessinsider.com/china-builds-first-stealth-amphibious-assault-drone-for-island-warfare-2019-4>

Amphibiouscraft

REFINEMENT

Decreasing size while expanding range of independent operation (communication, power, & obstacle avoidance)

Radio control



<https://www.indiamart.com/p/roddetail/sky-king-remote-control-airplane-1248862233.html>

WiFi



<https://www.digitaltrends.com/cool-tech/history-of-drones/>

COMPILED

Add other technologies to drone to expand capabilities



<https://www.sandiego.gov/ohs/unmanned-aircraft-systems>



Payload delivery
Weaponization

Cameras
Mapping & intelligence

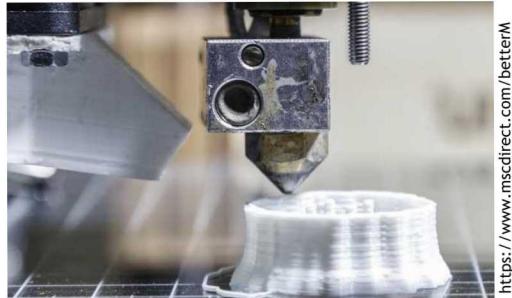
<https://www.hstoday.us/subject-matter-areas/terrorism-study/terrorists-use-of-drones-promises-to-extend-beyond-caliphate-battles/>

Exemplar: Additive Manufacturing



ORIGINATION

Build an object up *instead* of removing material

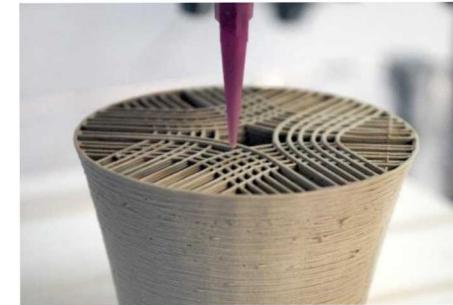


<https://www.msclivect.com/betterworld/metalworking/case-3d-printing-manufacturing>

Stereolithography

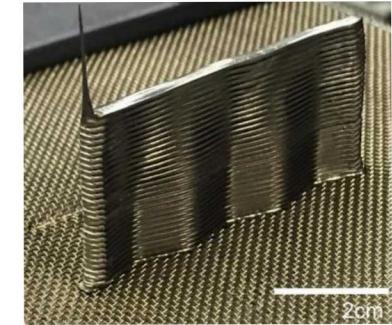
REFINEMENT

Expand the construction material basis to standard manufacturing materials



<http://unfold.be/pages/ceramic-3d-printing>

Ceramics



<https://phys.org/news/2018-09-simple-d-printer-metal.html>

Metals

ASSIMILATION

Print living materials (nonstandard materials)

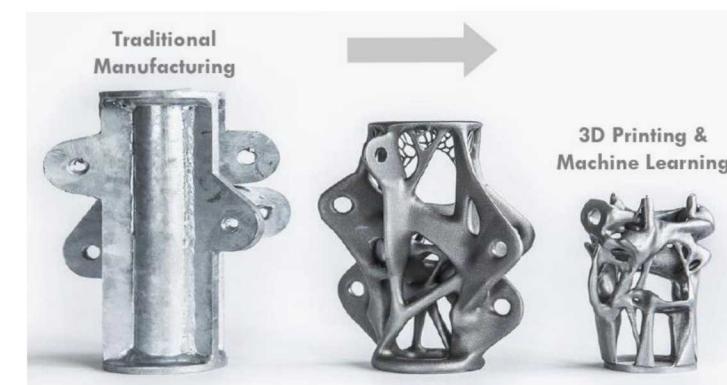


<https://www.popsci.com/science/gallery/2013-07/5-body-parts-scientists-can-3-d-print/>

Human kidney

COMPILED

Use artificial intelligence to design parts that can only be printed with additive manufacturing techniques



B. Winton, J. Wang, C. Burniske, B. Yarasuri, T. Keeney, M. Samy, J. Hemmendinger, and S. Korus. "ARK Invest Disruptive Innovation: BIG IDEAS 2017." ARK Invest, 2017. ark-invest.com.

9 Differentiating attributes – a sampling



Origination

- Domain diversity - Medium
- Ideation strategy - Exploratively developing new phenomena / domains
- Intrinsic surprise - high
- Risk of failure - high

Assimilation

- Domain diversity - High
- Ideation strategy - Exploratively employing existing phenomena from disparate domains to develop new technologies
- Intrinsic surprise - High
- Risk of failure - individual - high, ensemble - low

Refinement

- Domain diversity - Low
- Ideation strategy - Exploitively iterating / modifying existing technologies with existing phenomena from the same domain
- Intrinsic surprise - low
- Risk of failure - low

Compilation

- Domain diversity - High
- Ideation strategy - Exploitively employing existing technologies from disparate domains to develop new technologies
- Intrinsic surprise - low
- Risk of failure - ensemble - low



- ✓ Recognize the importance of knowledge exploitation (not creation)
 - Obtaining, sorting and identifying relevance of information is key
- ✓ Acknowledge the importance of network of Individuals
 - Nurturing cohesive yet geographically and disciplinarily distributed collaborations to ensure novel combinations of perspective is fundamental to this new research model
- ✓ Look for versatile (not narrowly focused) Individuals
 - Identifying, hiring, and encouraging curious and critically thinking individuals capable of and interested in engaging across disciplines is needed - hire people, not skill sets
- ✓ Support ensembles of Ideas (as opposed to a singular pursuits)
 - Look for “*a*” success quickly (even if not “*the*” success originally thought of) which requires flexibility in scope and customer set



Thank you

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