THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

The Past & Future of Systems Engineering

INCOSE Western States Conference

September 2018

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Northrop Grumman
Flight System Solutions
Business Unit Director

Approved for Public Release: NG18-1948

Northrop Grumman Products

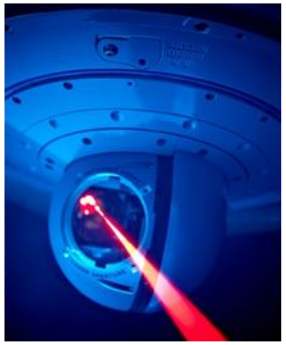
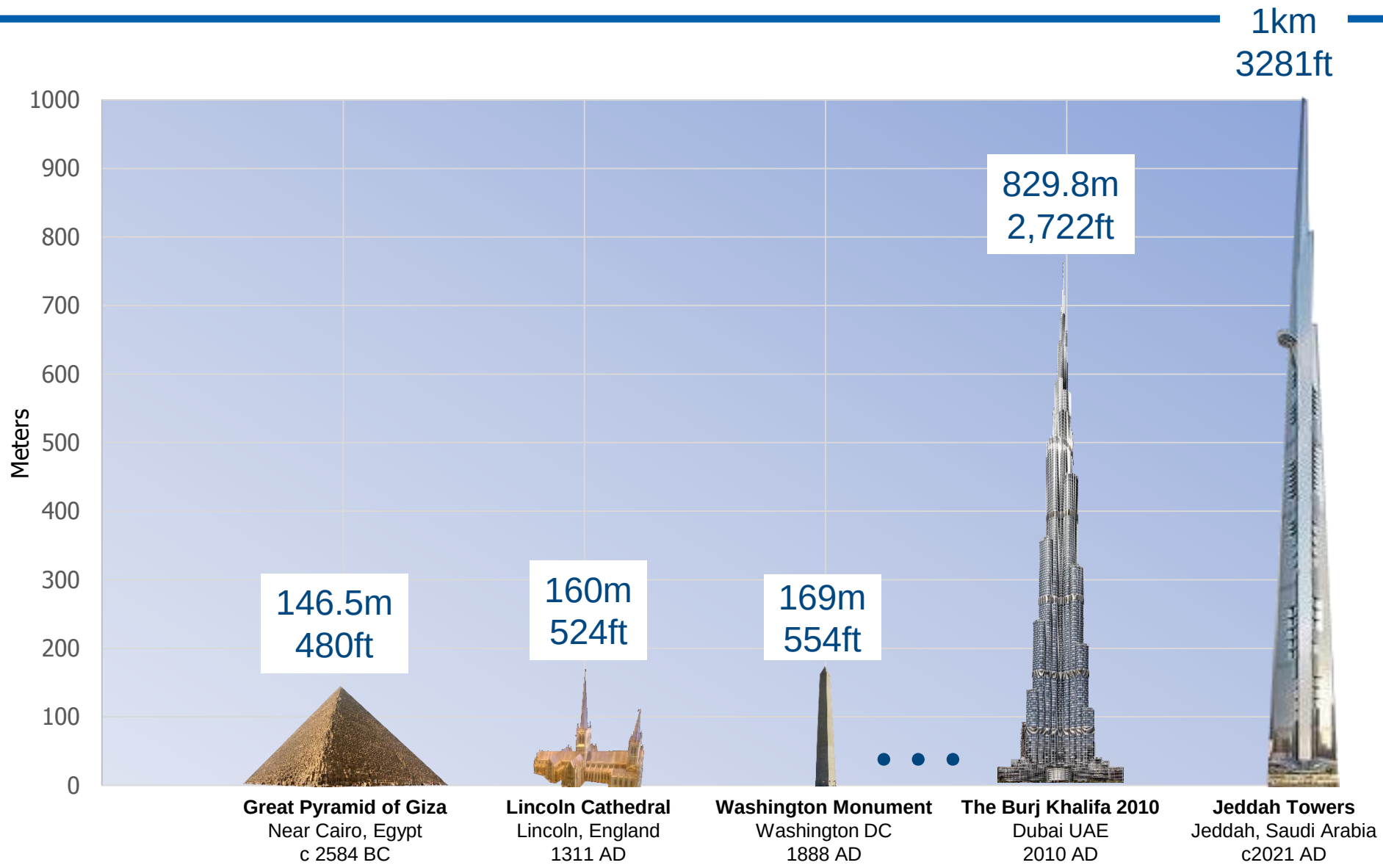


Photo: Nina Aldin Thune cc 2.5

Tallest Buildings in The World



Photos: Nina Aldin Thune cc 2.5; Justin McMurray 2016; NoClip Public Domain; Donaldytong CC BY-SA 3.0; Artists Rendition

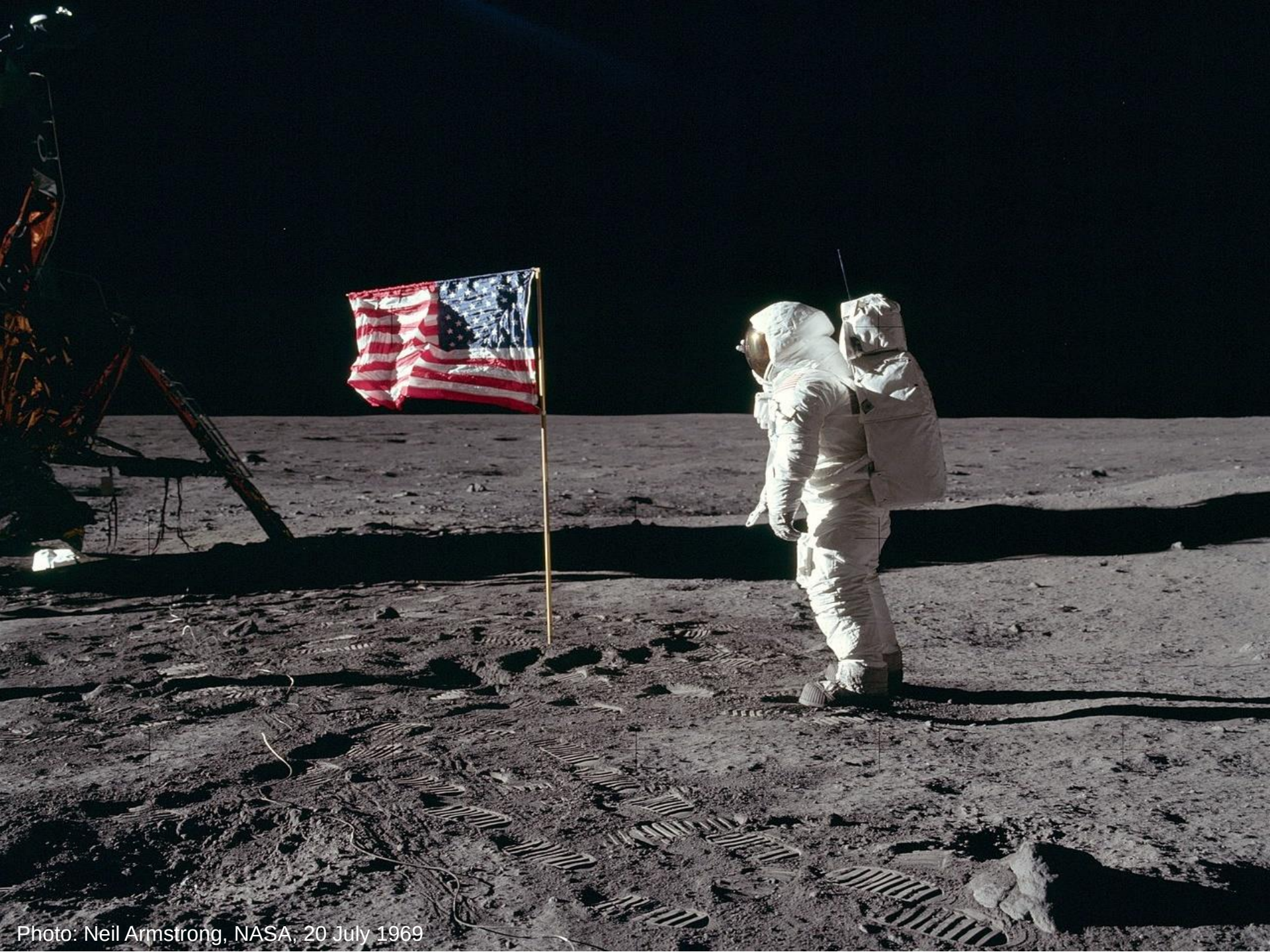


Photo: Neil Armstrong, NASA, 20 July 1969

Photo: NASA, 28 January 1986

Photo: Maximilien Brice, CERN, CC-BY-SA

Si Ramo – Systems Engineering Leadership

Photo: Company Archives, 1957

Photo: Company Archives, 1983

Photo: 1994 MMIII Launch, Public Domain

“A Multi-Headed Engineer”

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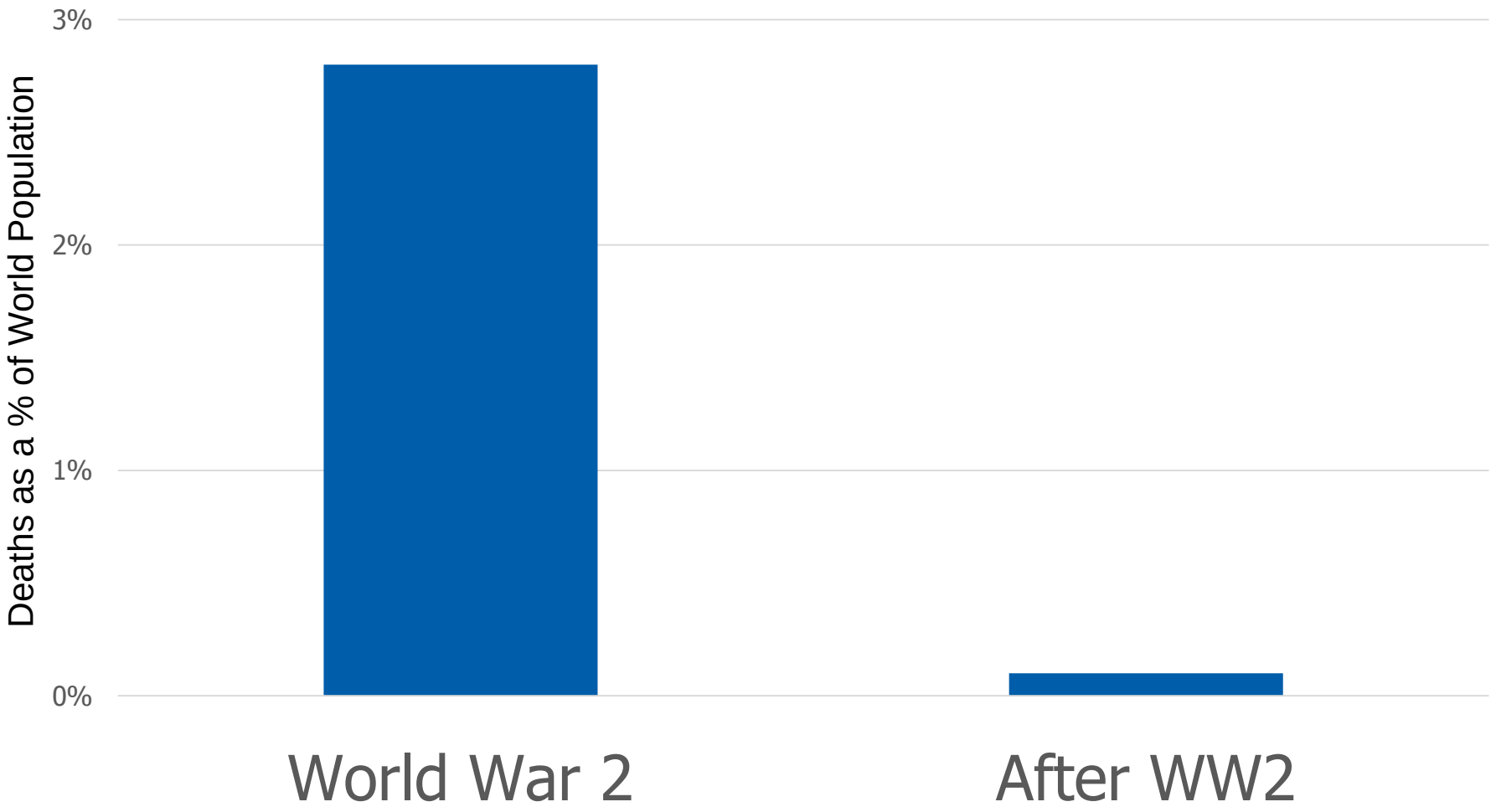
The Nuclear Age has dramatically reduced the Deaths due to Major Power Wars



Data source: Lt Gen Jack Weinstein, http://www.icasinc.org/2016/2016f/2016fjbw.html

Which Animal Are You Most Afraid of?

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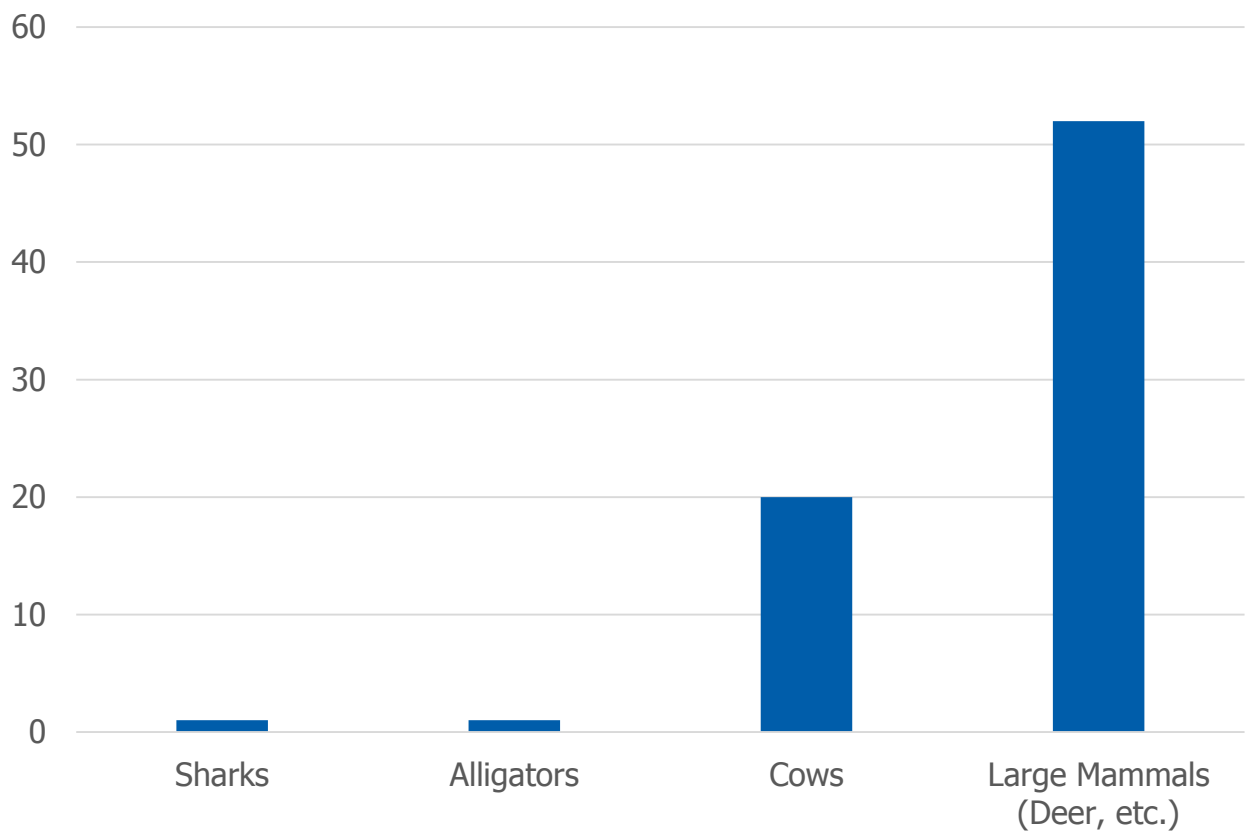
Photo: Hermanus Backpackers / cc-by-2.0

Photo: Public Domain

Photo: Public Domain, USDA

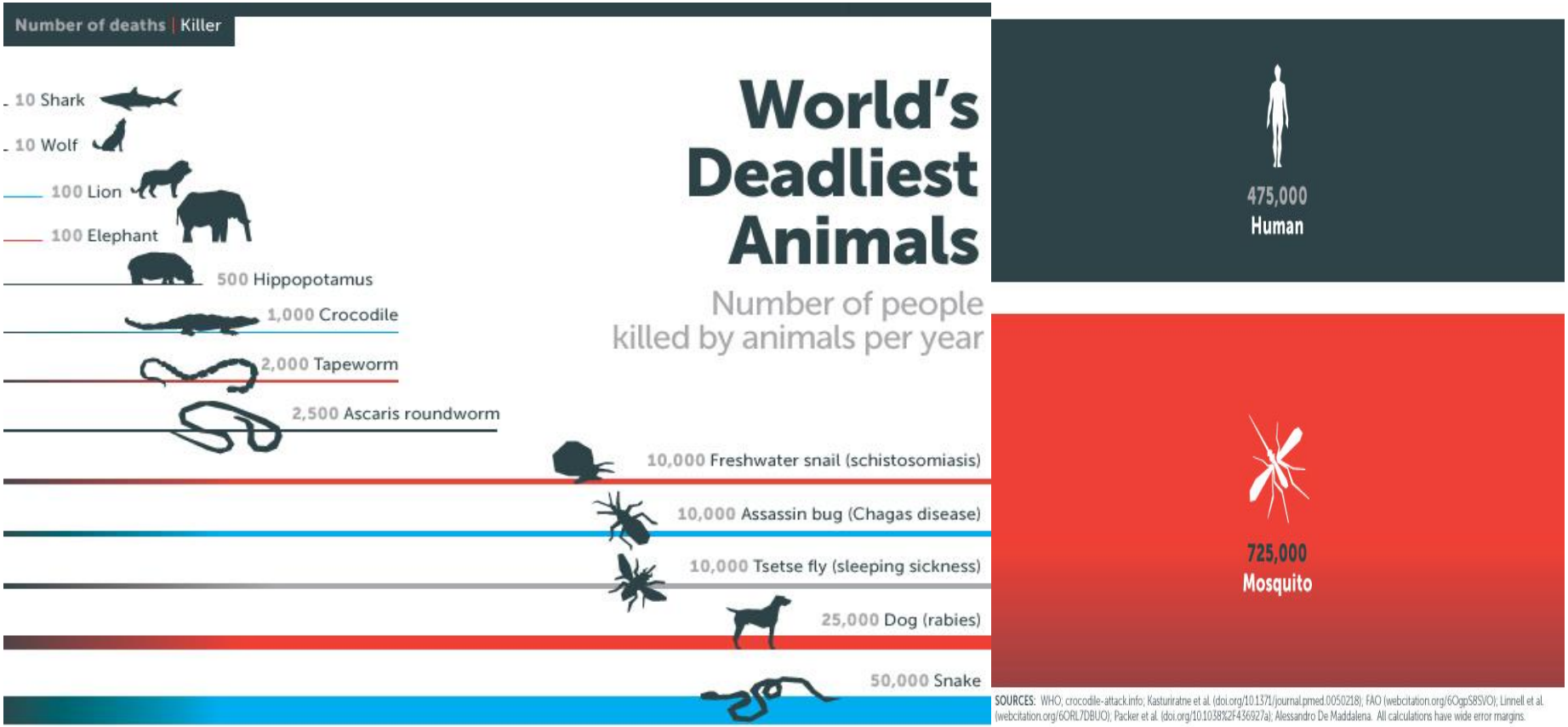
Photo: Clement Bardot / CC-BY-SA-4.0

Average Annual US Fatalities



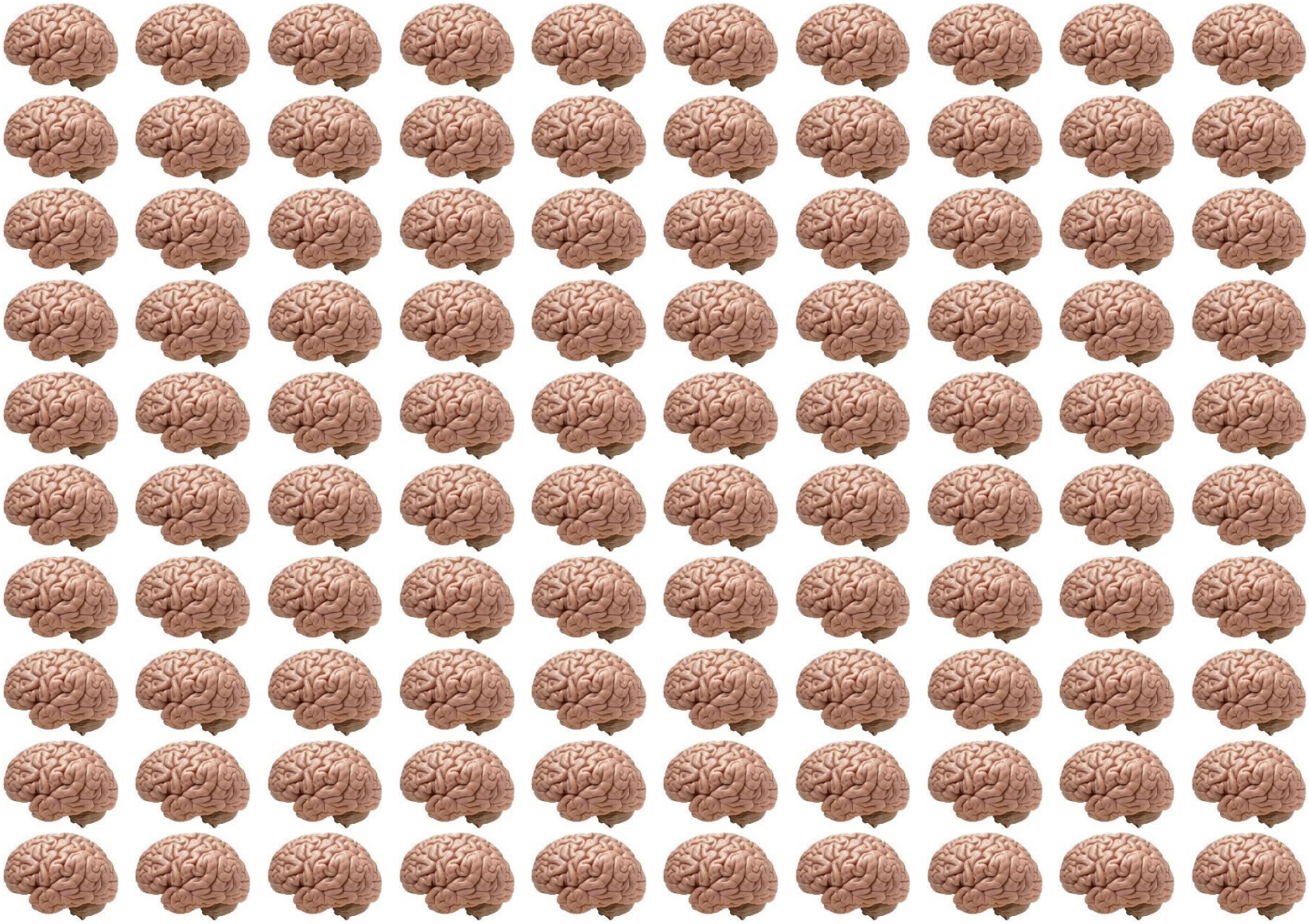
Source: Washington Post Analysis of CDC Data, June 2015

World's Deadliest Animals



Don’t Believe Everything You You Think

100 Psychological Studies Repeated



Source http://science.sciencemag.org/content/349/6251/aac4716 , 2015

Photo Credit: -DJ- cc2.0

39% Achieved the Same Result

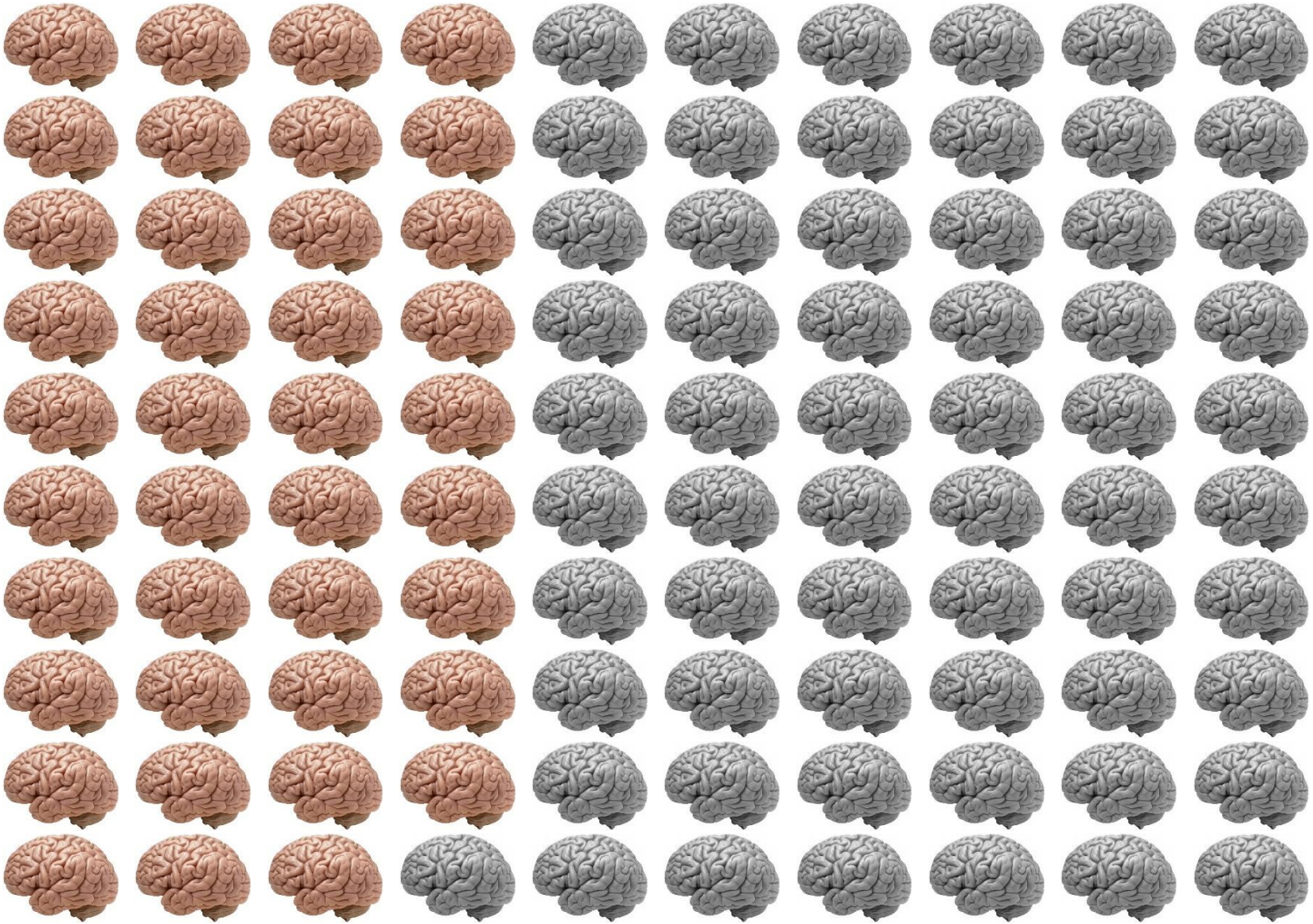


Photo Credit: -DJ- cc2.0

In God We Trust,

All Others Bring

Peer Reviewed

Data

The Future of SE

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Interconnected & Increasingly Software Driven

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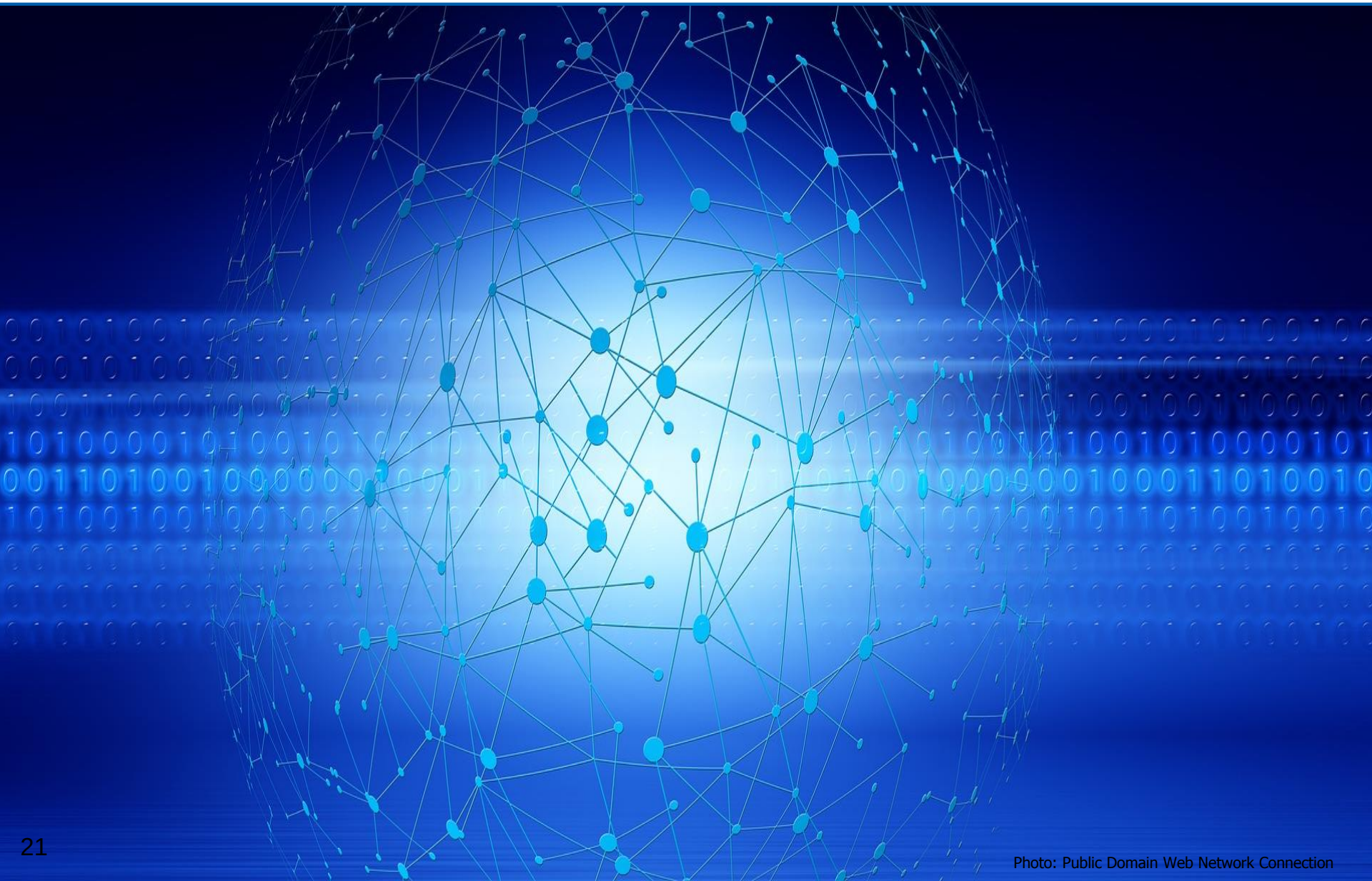

Photo: Public Domain Web Network Connection

Systems Will Be Increasingly Automated/Machine Learning

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Missile Classification

Machine Learning

- Unsupervised Learning
  - Dimensionality Reduction
    - Meaningful Compression
    - Structure Discovery
    - Big data Visualistaion
    - Feature Elicitation
  - Clustering
    - Recommender Systems
    - Targetted Marketing
    - Customer Segmentation
- Supervised Learning
  - Classification
    - Image Classification
    - Customer Retention
    - Idenity Fraud Detection
    - Diagnostics
  - Regression
    - Advertising Popularity Prediction
    - Weather Forecasting
    - Population Growth Prediction
    - Market Forecasting
    - Estimating life expectancy
- Reinforcement Learning
  - Real-time decisions
  - Game AI
  - Robot Navigation
  - Skill Acquisition
  - Learning Tasks

Source: Laura Richardson

Example: Neural Networks for Missile Classification

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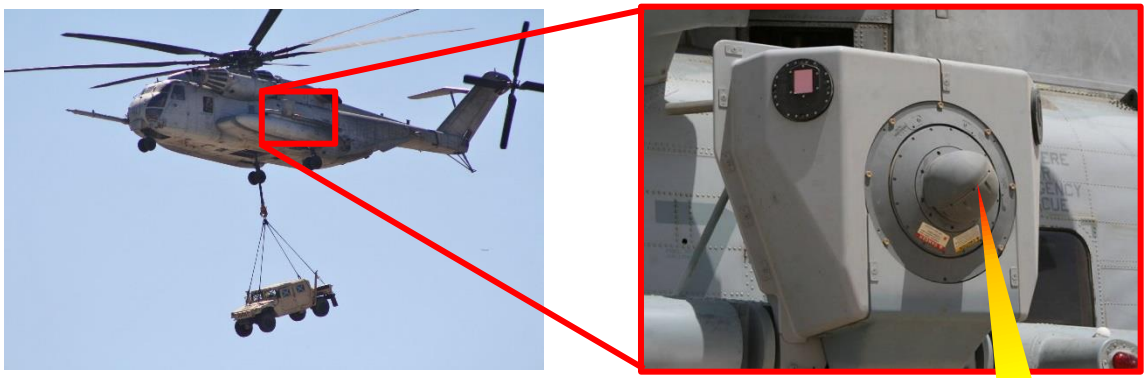
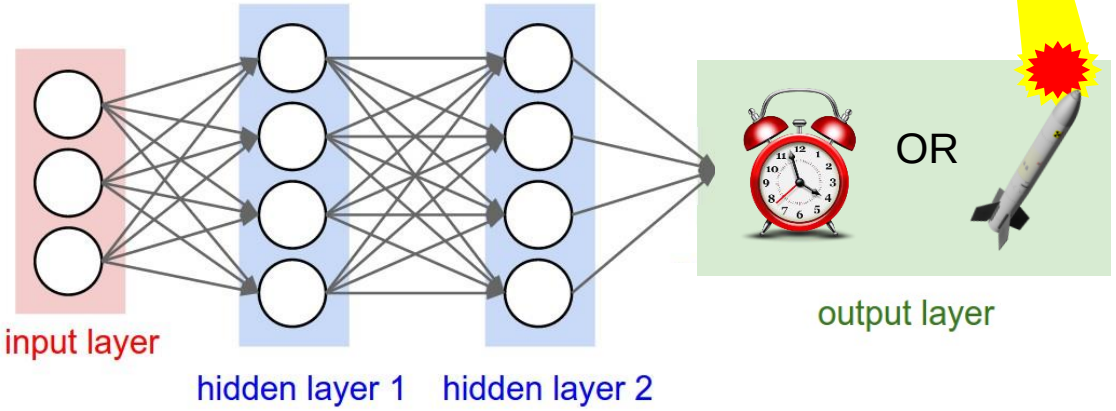
STEP 1:
Detect object



STEP 2:
Feed object features through neural network



STEP 3:
Defeat threat

Source: Laura Richardson, Advanced Threat Warner IRCM

Virtual Based with Rapid Prototyping

Source: Rob Noneman

Multi-Disciplinary Design Analysis & Optimization Driven Design

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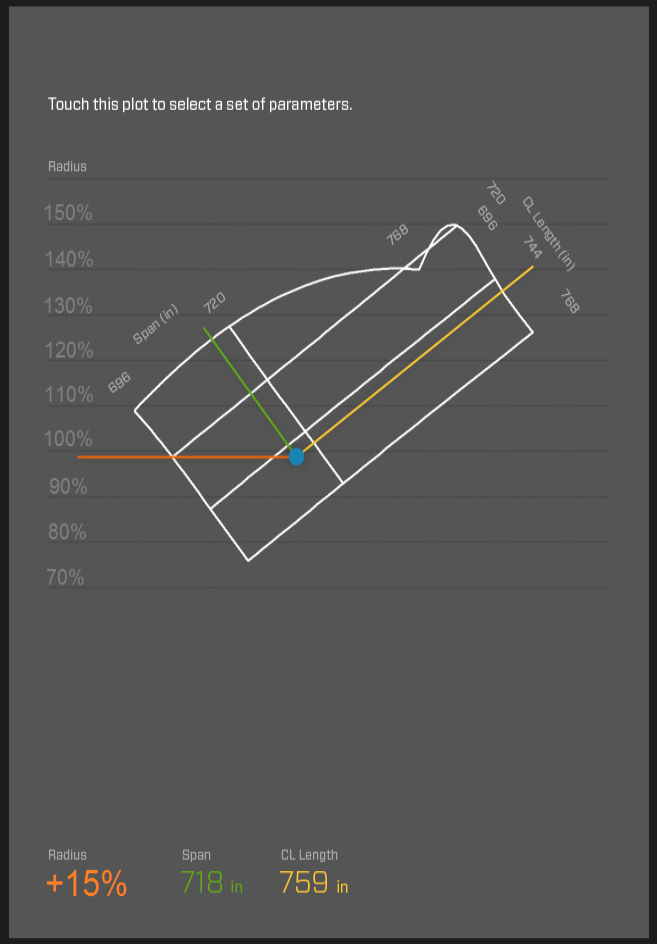
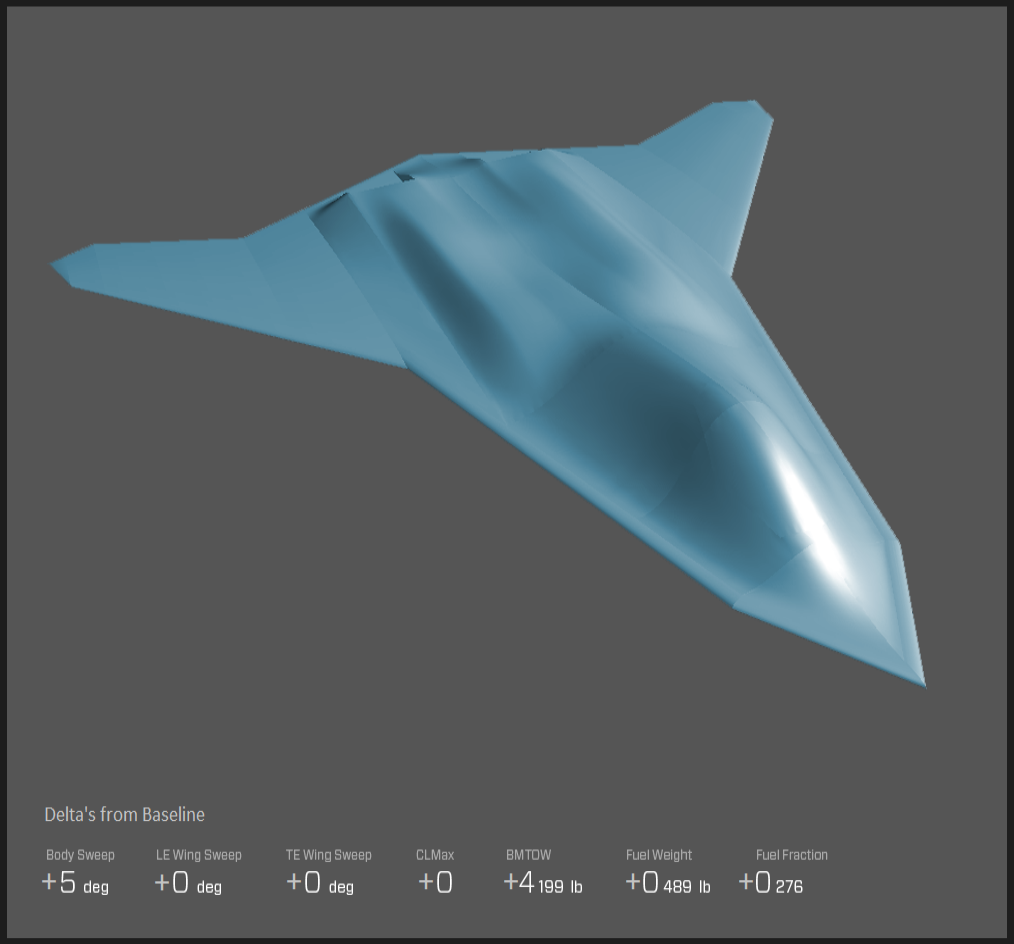
MULTI-DISCIPLINARY DESIGN ANALYSIS & OPTIMIZATION

Parameters



Outputs



Open Architecture & Modularity

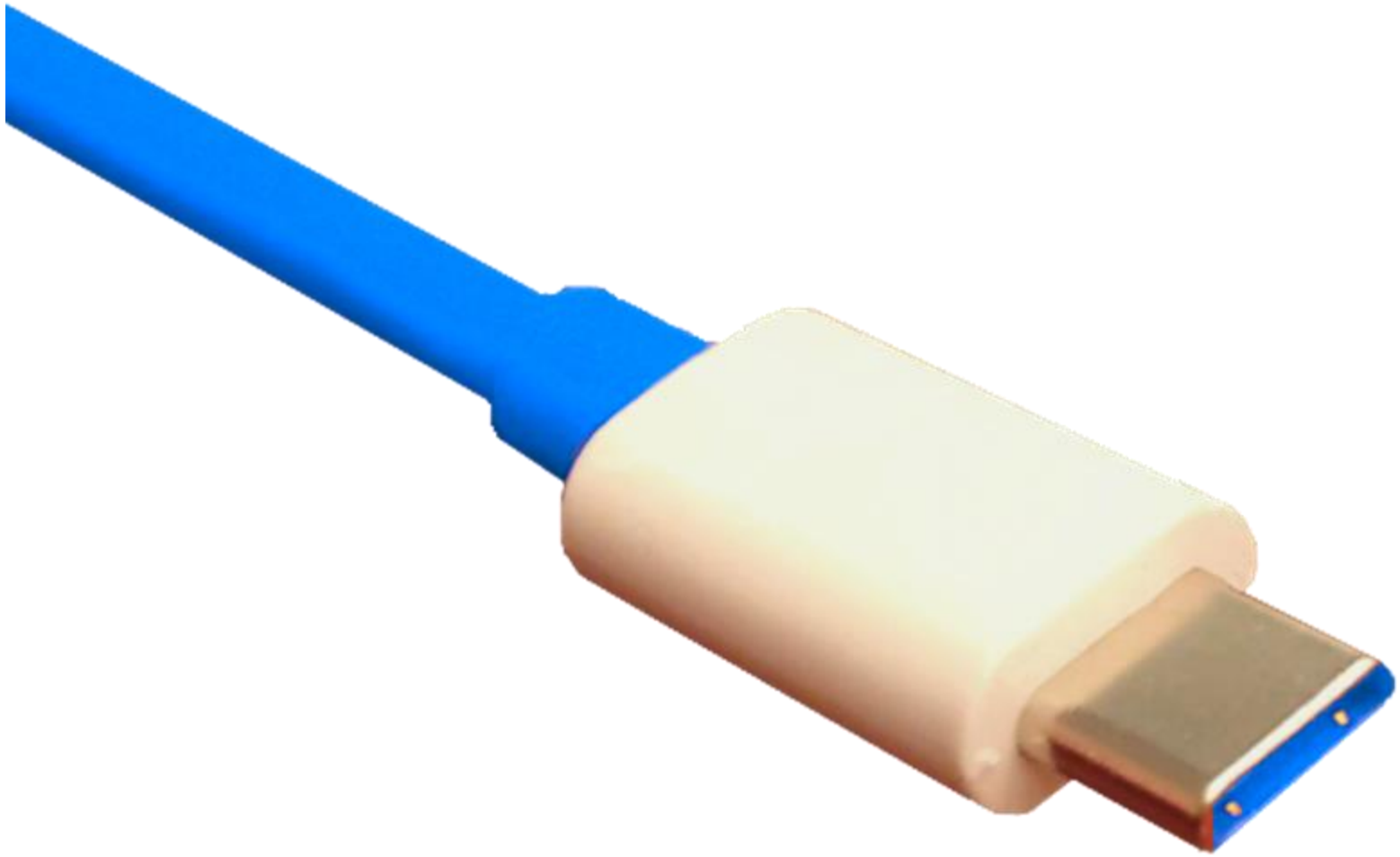
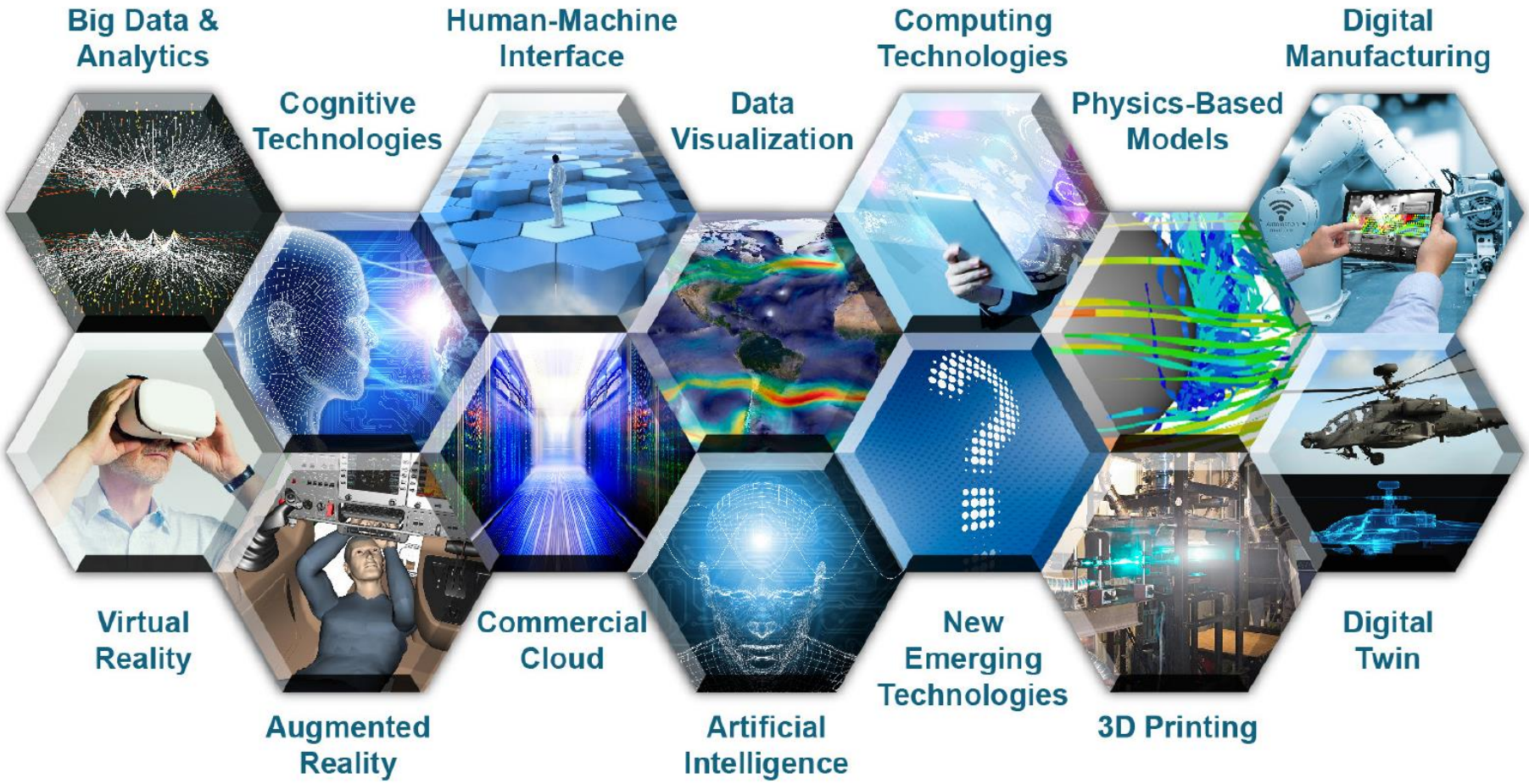


Photo: Xxmarijnw, Public Domain

Technology Innovation Examples



Source: Dod Digital Engineering Strategy June 2018, Approved for public release, distribution unlimited

DoD Digital Engineering Strategy

Source: Dod Digital Engineering Strategy June 2018, Approved for public release, distribution unlimited

The World is Making Progress

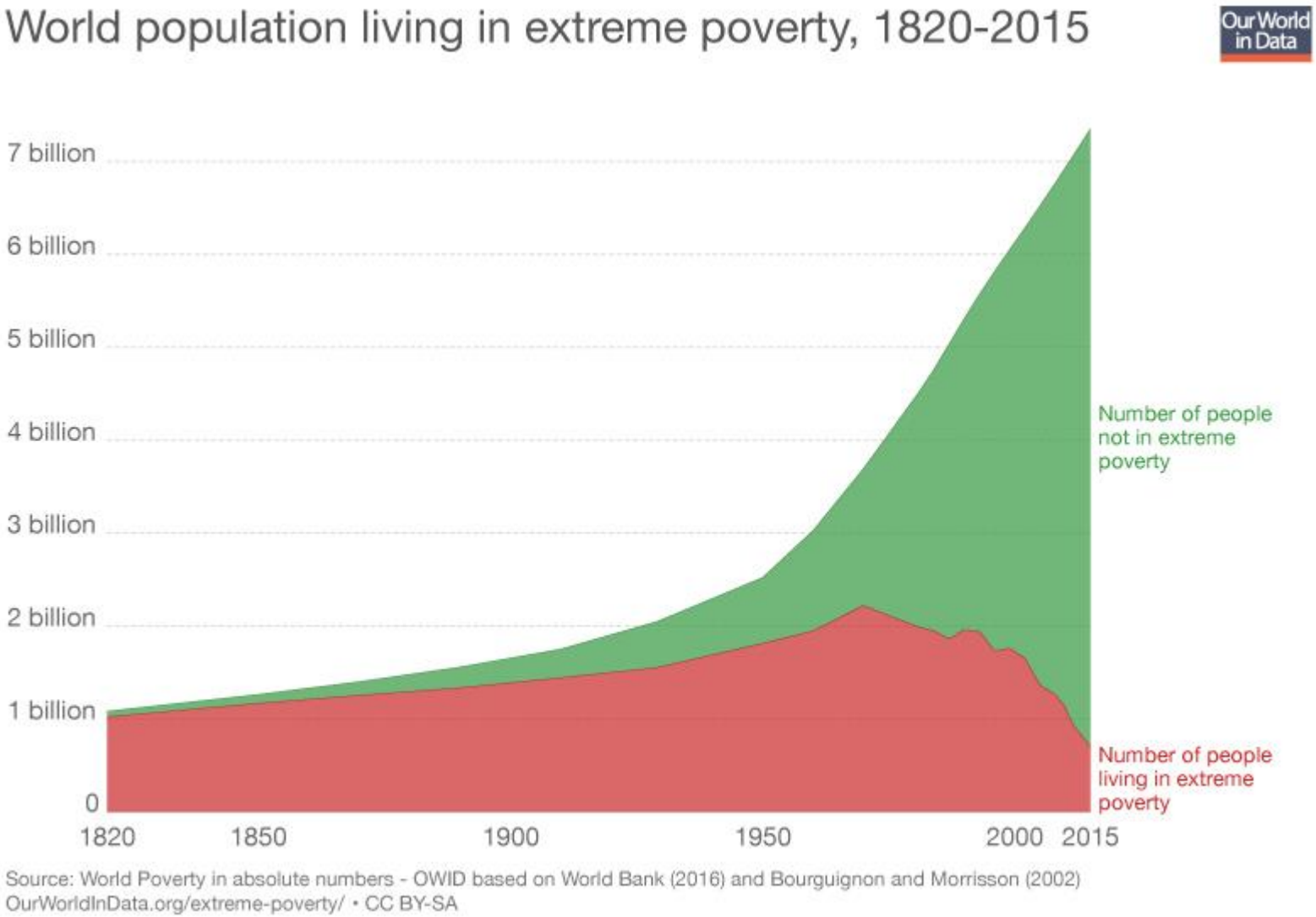


Chart: Our World In Data, CC BY-SA 2.0

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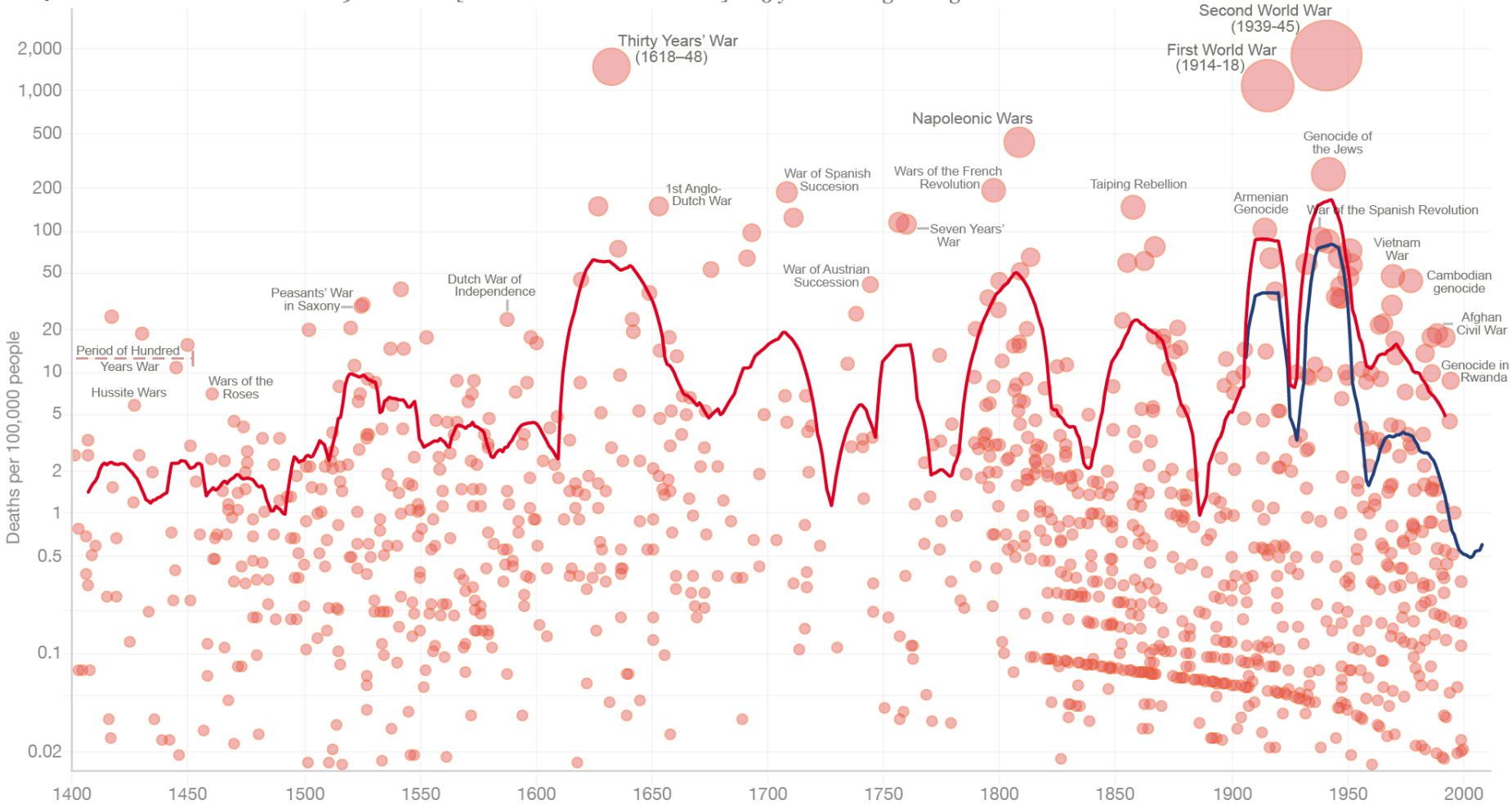
Global deaths in conflicts since 1400

Our World in Data

Each circle represents one conflict [Data from the *Conflict Catalogue* (1400–2000)]
The **size** represents the absolute number of fatalities (military + civilian)
The **position** on the y-axis represents the death rate (military + civilian)
Total death rate* for 1400–2000 [Data from the *Conflict Catalogue*] – 15 year moving average
Battle death rate† for 1900–2016 [Data from PRIO and UCDP] – 15 year moving average



Data sources: Conflict Catalogue by Peter Brecke, PRIO Battle Deaths Dataset (v3.1 after 1945 and v2.0 prior), and UCDP v17.2. World population data from HYDE and UN.

Notes: All death rates are calculated as the number of deaths relative to world population at the time (deaths per 100,000)

* The Conflict Catalogue figures includes civilian and military deaths. In many instances it counts deaths occuring indirectly – from starvation, disease etc. However, the extent to which these are included will vary significantly between conflicts, due to uncertainty in the underlying historical sources.

† The PRIO/UCDP definition of battle deaths refers to those caused directly by armed violent conflict (they exclude deaths from disease, starvation, and also executions of prisoners). The figures include civilian deaths occuring in battles, but not where civilian populations were intentionally and specificaly targeted (i.e. deaths of civilians caught in crossfire are included, but deaths in genocides are excluded).

This visualization is available at OurWorldinData.org. There you find more research and visualizations on conflict and global development.

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