Exoskeleton Standards Technical Interchange Meeting - Introduction & Objectives

January 26-27, 2017

Dr. William Billotte
Program Manager, National Security Standards Program, Special Programs Office
NIST

Mr. David Audet
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NSRDEC

PAO # U17-039

Introduction Outline

- Safety Announcement
- Background
- Objectives and Considerations
- Agenda
- National Institute of Standards and Technologies (NIST) Overview
- US Army Natick Soldier RD&E Center (NSRDEC) Overview

Meeting Background

Technology Proliferation

November 7, 2016

A Roadmap for US Robotics

From Internet to Robotics

2016 Edition

Organized By

University of California San Diego
Carnegie Mellon University
Clemson University
Cornell University
Georgia Institute of Technology
Northeastern University
Northwestern University
Oregon State University
SRI Inc.
Texas A&M University
The University of Utah
University of California Berkeley
University of Nevada - Reno
University of Southern California
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Vanderbilt University
Yale University

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National Science Foundation
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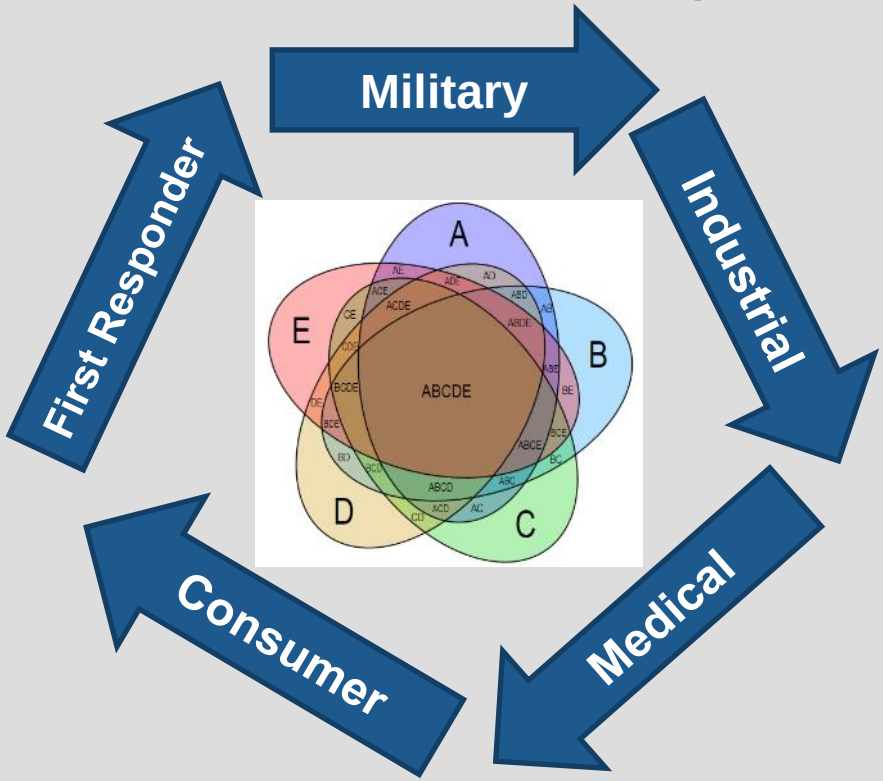
Background Considerations

- Challenge in wrapping an able-bodied human in an exoskeleton and enabling he/she to perform in a safe and effective manner.
- Industry Knocking on Government's Door (e.g. NIOSH, DoD)
- Significant investments from DoD, venture capital, and internal R&D
- Varying levels of data provided by developers to substantiate claims
- Need to Establish Taxonomy/Terminology
- Need to Establish Standards / Technology Assessment Consensus – Different Types of Systems, Tasks, and Metrics

Exoskeleton System User Categories

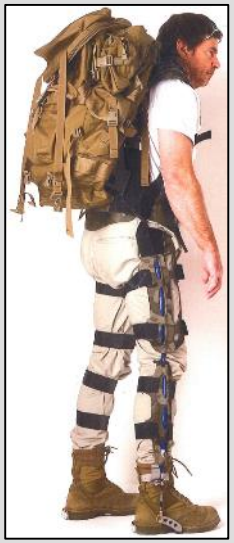
August 2016 Government Exoskeleton Meeting Revealed 5 Different User Categories



Commonalities amongst user categories?
Unique aspects of each user category?

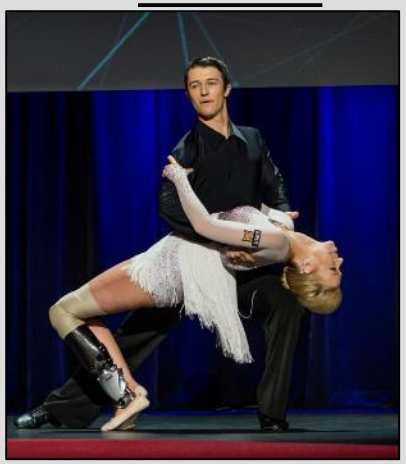
User Categories for This Meeting

Military



Industrial

Medical



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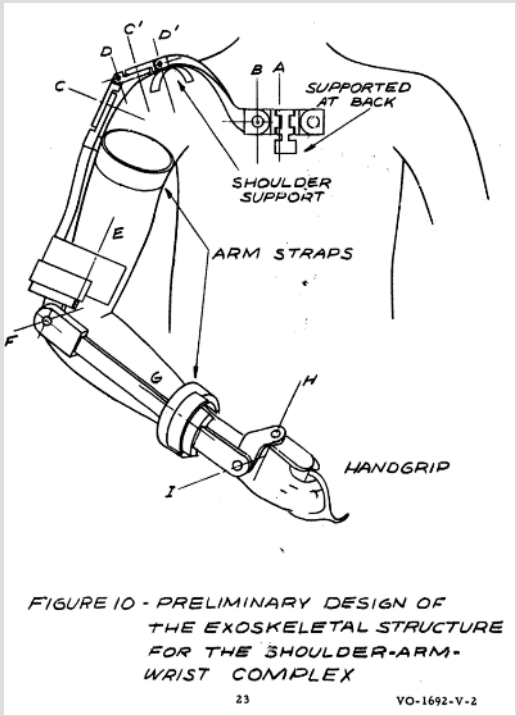
Exo System Standards & Related Collaborative Work

Existing Standards & Other Related Work	Military	First Responder	Industrial	Medical	Consumer
ISO TC299 Robotics (e.g. ISO13482)	x	x	**X**	x	x
ASTM - Response Robots	x	**X**	x		
NIST Collaborative Robot Tests			**X**		
RoboMate - Industrial Robots			**X**		
Army (NSRDEC & ARL-HRED) – Military Systems	**X**	x	x		
Navy - Industrial Human Aug. Systems (iHAS)			**X**		
Department of Energy – Office of Nuclear Energy			**X**		
Veterans Health Administration Office of Research and Development	**X**			**X**	

Any major efforts missing?...

Overarching Meeting Objectives

- Bring together experts from the industrial, military, and medical communities to discuss the latest developments in exoskeleton standards
- Identify gaps in current exoskeleton standards—including terminology, test methods, and performance metrics - in the industrial, military, and medical sectors
- Facilitate the involvement of all interested parties in these developments
- Build relationships among key stakeholders



Cornell Aeronautical Laboratory under Contract No. NONR-3830(00), sponsored by the Office of Naval Research of the Department of the Navy. The time period covered is from 16 April 1962 to 15 February 1963.

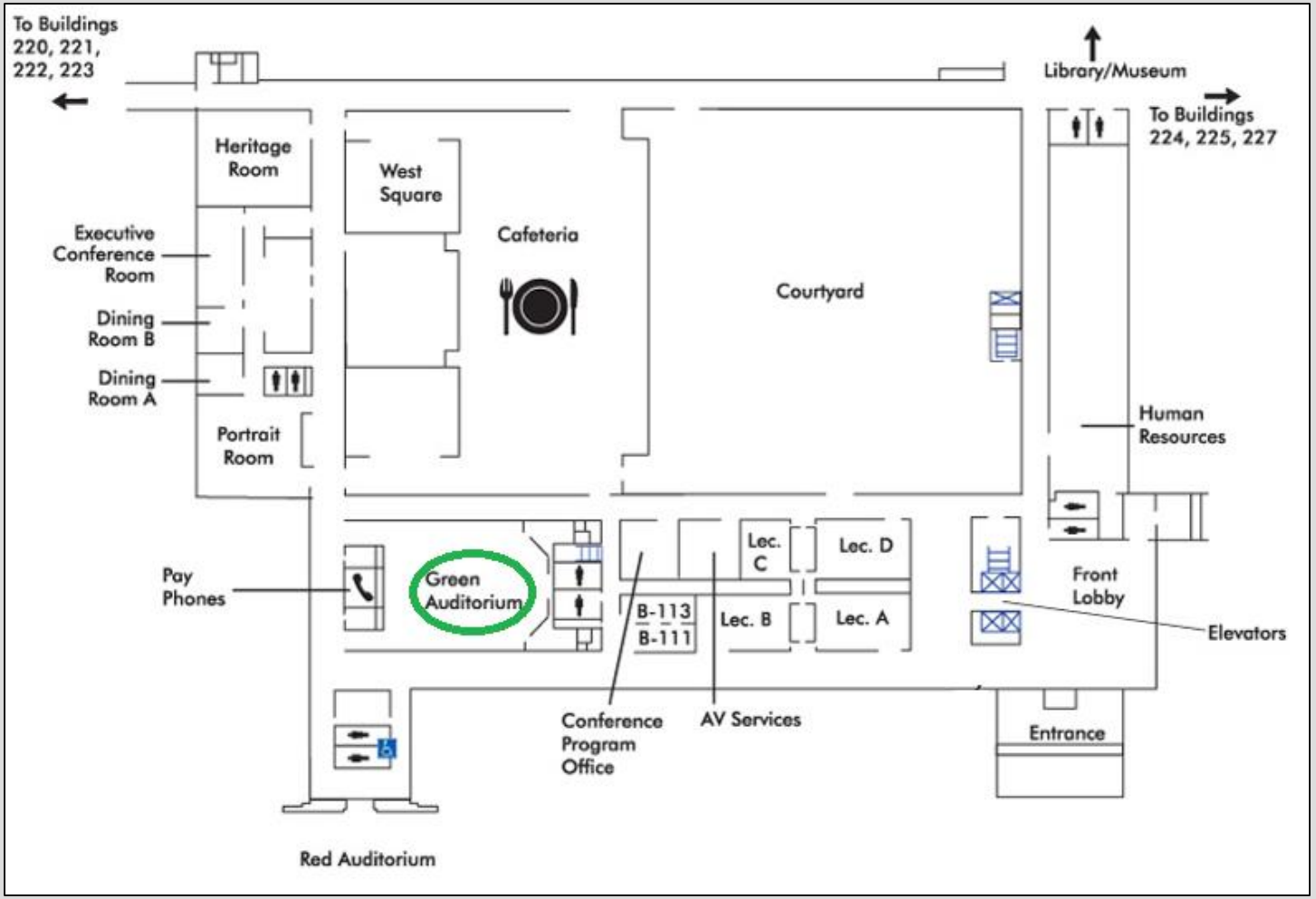
Ideal Outcomes

- List of the hurdles facing researchers, industry and users
- List of priorities for the development of exoskeleton standards and test methods
- List of people willing to work on the identified priorities (sign-up sheets)
- Feedback on this event and suggestions for future events
- Community kickoffs (military, industry, medical, first responder, consumer)

Cornell Aeronautical Laboratory under Contract No. Nonr-3830(00), sponsored by the Office of Naval Research of the Department of the Navy. The time period covered is from 16 February 1963 to 15 March 1964.

Admin Remarks

- Fire Exit/Safety and Bathroom & Café Locations (Below)



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Rules of Engagement

- Participate! (Especially during Unique Aspect Characterizations and Open Discussions) – A rising tide lifts all boats and everyone's opinion is valued.
- Everyone is respectful of each other and no one monopolizes the floor or time.
- Save questions until the end of each briefing.
- Use flipcharts to capture questions and ideas, especially those that are off-topic of the current conversation.

- Lecture Room B is available for sidebar discussions.
- Attendance list & briefings will be available.
- Enjoy!

Meeting Agenda

January 26th

8:45 – 9:15 am: Arrival / Sign-in
9:15 - 10 am: Welcome, Introduction, & Objectives (NIST – Dr. William Billotte & US Army NSRDEC – Mr. David Audet)
10 - 10:20 am: Exo Terminology & Taxonomy (ARL-HRED – Dr. Jennifer Neugebauer & NIST – Mr. Roger Bostelman)
10:20 – 10:50 am: Existing Related Standards (Hocoma – Mr. Burkhard Zimmermann)

10:50 - 11:05 am: Break

11:05 - 11:35 am: Standards Development Process – Best Practices (NIST – Mr. Warren Merkel)
11:35 am - 12:05 pm: Standards Development Process – ASTM Respond. Robotics Case Study (DHS – Mr. Philip Mattson)
12:05 - 12:30 pm – Medical User Representative Introduction (Christopher Reeves Foundation – Mr. Chris Tagatac)

12:30 - 1:30 pm: Lunch Break

1:30 – 4:15 pm: Military Applications Session – Facilitator: NSRDEC – Mr. David Audet

- 1:30 -1:55 pm: User Representative Introduction (Army Maneuver Center of Excellence – CPT Brian Giroux)
- 1:55 - 2:45 pm: Ongoing Related Standards Work (NSRDEC, ARL-HRED)
- 2:45 - 3:45 pm: Unique Aspect Characterization (e.g. Terminology, Taxonomy, Environments, Use Cases, Metrics, Measurement Tools, Test Methods, Stakeholders) (NSRDEC – Mr. Greg Kanagaki / ALL)
- 3:45 – 4:15 pm: Open Discussion & Generating Prioritized List (ALL)

January 27th

8 - 8:15 am: Arrival / Sign-in
8:15 - 8:30 am: Day 1 Recap
8:30 - 11:15 am: Industry Applications Session – Facilitator: NIST – Mr. Roger Bostelman

- 8:30 - 8:50 am: User Representative Introduction (United Steelworkers – Mr. Jim Key)
- 8:50 - 9:20 am: Insurance (CNA Insurance – Mr. John Mizurak)
- 9:20 - 9:50 am: Ongoing Related Standards Work (NIST – Mr. Roger Bostelman)
- 9:50 - 10:50 am: Unique Aspect Characterization (e.g. Terminology, Taxonomy, Environments, Use Cases, Metrics, Measurement Tools, Test Methods, Stakeholders) (NIST – Mr. Roger Bostelman / ALL)
- 10:50 - 11:15 am: Open Discussion & Generating Prioritized List (ALL)

11:15 am - 12:15 pm: Lunch Break

12:15 – 2:40 pm: Medical Applications Session – Facilitator: FDA – Dr. Devjani Saha

- 12:15 - 12:45 pm: FDA Intro & Medical Exo Process Overviews (FDA – Dr. Vivek Pinto; Dr. Devjani Saha)
- 12:45 - 1:15 pm: Ongoing Related Standards Work (FDA – Mr. Ian Broverman; Dr. Eric Franca)
- 1:15 - 2:10 pm: Unique Aspect Characterization (e.g. Terminology, Taxonomy, Environments, Use Cases, Metrics, Measurement Tools, Test Methods, Stakeholders) (FDA – Dr. Devjani Saha / ALL)
- 2:10 – 2:40 pm: Open Discussion & Generating Prioritized List (ALL)

2:40 - 3:15 pm: Summary & Path Forward (NIST & NSRDEC)

You are in Great Company

- 150+ Attendees
- ~100 Organizations (44 Ind., 35 Govt. 19 Acad.)
- 8 Countries

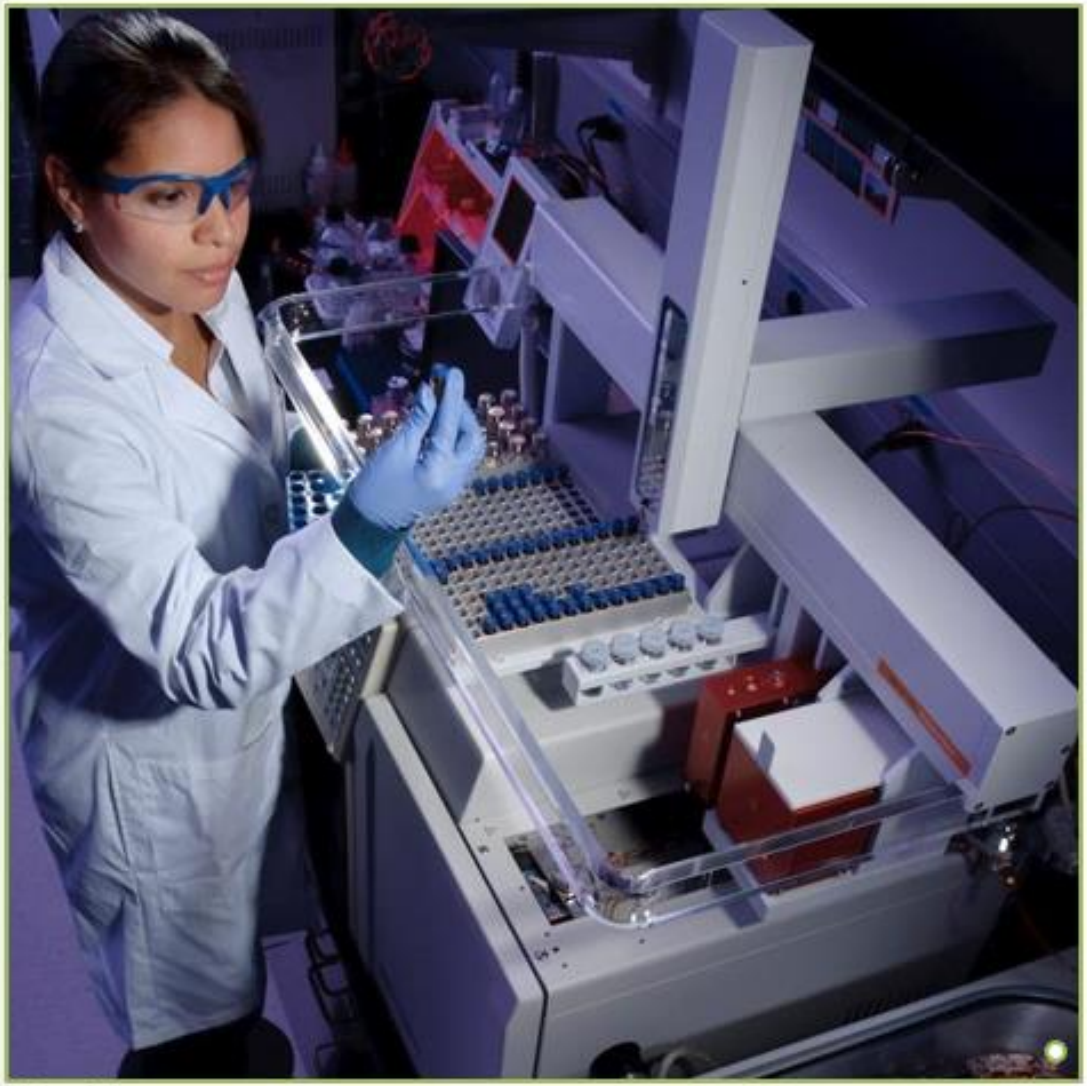
3M	John Deere	Sandia National Laboratories
Air Force Research Labs	Johns Hopkins Applied Physics Lab	Sarcos Corp.
Atomic Energy Workers Council	Kessler Foundation	Savannah River National Laboratory
Auburn University	Lean Steps Consulting, Inc.	Sejong University
B-Temia	Lockheed Martin Missiles and Fire Control	SRI International
Bionic Power Inc.	Los Alamos National Laboratory	StrongArm Technologies
Boeing Company	M Squared Associates, Inc.	The Catholic University of America
CDC/NIOSH	Massachusetts Institute of Technology	U.S. Department of Homeland Security
CNA Insurance	Mawashi Science & Technology	U.S.-Israel Binational Industrial R&D (BIRD) Foundation
CYBERDYNE Inc.	MIT Lincoln Laboratory	
Decypher Technologies	Myomo Inc	UMass Lowell NERVE Center
Defence Research and Development Canada	NASA-JSC	Unconventional Concepts, Inc.
Department of Energy	National Center for Medical Rehabilitation Research	United States Military Academy - West Point
Department of Veterans Affairs	National Institute of Standards and Technology (NIST)	United Steel Workers
Dephy		University of Maryland
Dong-Eui University	National Institute on Aging	University of Colorado Denver
Draper Laboratory	National Institutes of Health	University of Houston
Ekso Bionics, Inc.	National Science Foundation	University of Maryland - College Park
Equipois	Naval Safety Center Liaison Office	University of Michigan
Eureka Global Solutions LLC	NCMRR/NICHD/NIH	University of Pittsburgh
Exoskeleton Report	New Stone Soup VT LLC	University of Texas at San Antonio
FDA	NextGen Aeronautics, Inc.	US Army Medical Research and Material Command
Fluor Government Group	NIOSH	
Ghana Atomic Energy Commission	Northwestern Univ. / RIC	US Army NSRDEC
Ghana Standards Authority	NSWC Carderock	US Army Research Laboratory
Harvard University	NYU Hospital for Joint Diseases	US Department of Labor - OSHA
HFK Systems LLC	Parker Hannifin Corporation	US Special Operations Command
Hocoma AG	Prescient Edge Corporation	USAF
Honda R&D Americas, Inc.	Project Manager Soldier Warrior	USAF AFRL
Humotech	Puget Sound Naval Shipyard	USAF/ Booz Allen Hamilton
iFlex Technology	RDECOM HQ	USARIEM
IHMC	ReWalk Robotics Inc.	VA National Center for Patient Safety
Iowa State University	Roam Robotics	Victoria University
	Saint-Gobain	Wearable Robotics Association

Welcome and Overview of NIST

William Billotte, Ph.D.
National Security Standards Program
Special Programs Office

NIST Overview Video: https://www.youtube.com/watch?v=2j9BGVKbzS4

NIST's mission



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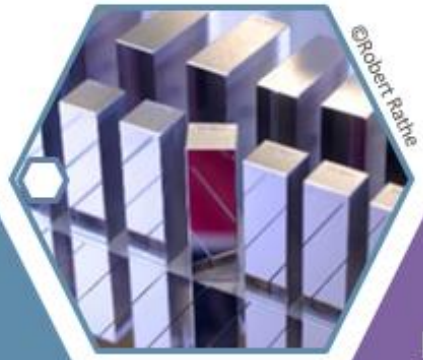
Measurements Standards Technology

NIST's impact



Quality and uniformity

Manufacturing and services

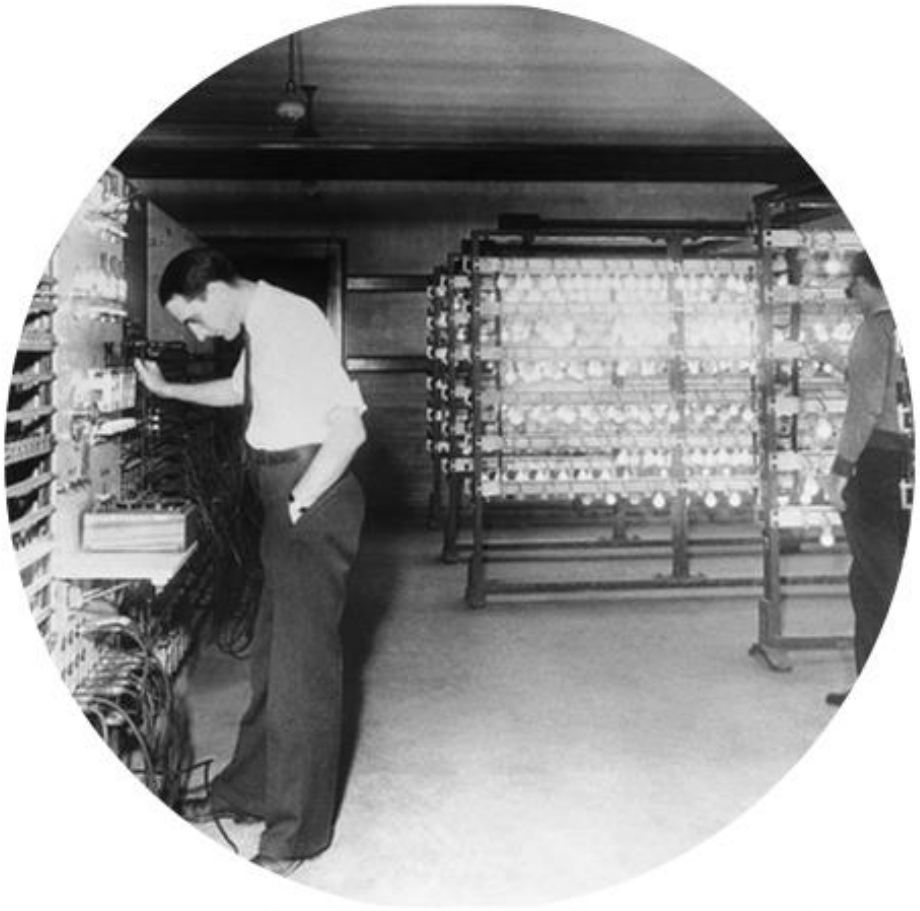

G. Hooijer/ shutterstock

Public safety and security

Trade and commerce


John Sartin/ shutterstock

Importance of standards and measurement



Standards for electrical industry

Instruments calibrated overseas

Consumer products unreliable

Measurement infrastructure for commerce

Basic Stats and Facts

Gaithersburg

Boulder

JILA, JQI, HML, IBBR, ChiMaD, NCCoE, JIMB

NIST Programs

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NIST Laboratories

- Provide measurement solutions

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Hollings Manufacturing Extension Partnership

- Helps smaller manufacturers compete globally

Sharp

Baldrige Performance Excellence Program

- Promotes and recognizes performance excellence

NIST's national user facilities

©Robert Rathe

CNST

- Nanotechnology tools for fabrication and measurement

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NCNR

- Neutron flux and scattering beam lines

NIST Priority Research Areas

Advanced manufacturing

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IT and cybersecurity

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Healthcare

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Forensic science

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Community resilience

USGS

Cyberphysical systems

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Advanced communications

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Natick Soldier Research Development and Engineering Center Overview

Mr. David Audet
Branch Chief, Mission Equipment & Systems Branch, NSRDEC

26 Jan 2017

Natick Soldier RD&E Center

The Soldier's RDEC – Ensuring dominance through superior scientific and engineering expertise

Providing the Army with innovative science and technology solutions to optimize the performance of our Soldiers.

Our Lifecycle Contribution

Science & Technology

Collaborate with

Development & Engineering

Aid development for

Sustainment & Support

With consideration for

RDECOM Organization

GEN David G. Perkins
CG TRADOC

GEN Gustave F Perna
CG AMC

Ms. Steffanie B. Easter
Senior Official
Performing the Duties of
ASA(ALT) & AAE

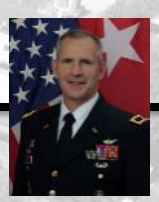
U.S. ARMY RDECOM®

MG Cedric T. Wins
CG RDECOM

CSM James P. Snyder
CSM RDECOM

Mr. Jyuji D. Hewitt
Deputy Director RDECOM

COL Raymond K. Compton
Chief of Staff, RDECOM



BG Anthony Potts
DCG RDECOM

- RFEC Atlantic
- RFEC Pacific
- RFEC Americas

AMRDEC
Aviation & Missile Research, Development & Engineering Center

ARDEC
Armaments Research, Development & Engineering Center

CERDEC
Communications-Electronics Research, Development & Engineering Center

ECBC
Edgewood Chemical Biological Center

NSRDEC
Natick Soldier Research, Development & Engineering Center

TARDEC
Tank Automotive Research, Development & Engineering Center

ARL
Army Research Laboratory

NSRDEC Organization

Director

Mr. Douglas Tamilio

Military Deputy

COL Charles May

Chief Scientist

Dr. Charlene Mello

Chief Counsel

Mr. Tom Goonan

Chief of Staff

Mr. Jay Connors

Deputy Director

Mr. Craig Rettie

Soldier/Squad Portfolio Director

Mr. David Carney

Aerial Delivery Directorate

Mr. Richard Benney

Combat Feeding Directorate

Mr. Stephen Moody

Expeditionary Basing & Collective Protection Directorate

Ms. Claudia Quigley

Warfighter Directorate

Mr. Andrew Mawn

Senior Research Scientist Soldier Nanomaterials

Dr. Ramanathan Nagarajan

Senior Research Scientist Behavior and Performance

Vacant

Senior Research Scientist Biological Anthropology

Vacant

Natick Soldier Systems Center

78 Acres

459,000 Sq. Ft. of Lab Space

Total 174 Acres
(including 75 Family Housing units)

NSSC Partners

Research & Technology Collaborators

Product/Project Managers Development Partners

Only Active Army Installation in New England
Birthplace of the Army

Mission Areas

- Performance Nutrition
- Joint Foodservice Equipment
- Mission-tailored rations

Joint Service Combat Feeding

- Small Unit Sustainment System
- Airbeam Shelters
- Force Provider Subsystems
- Mortuary Affairs

Expeditionary Basing/Collective Protection

Soldier and Squad Performance Optimization

Warfighter Protection, Survivability, and Optimization

- Body Armor
- Helmets
- Uniforms
- Boots
- LEAP-A
- Knowledge to Schoolhouses

Aerial Delivery

- JPADS
- Helicopter Sling Load
- T-11 Engineering Support

Aerial Delivery

- Personnel Parachuting Systems
- Cargo Airdrop Systems

S&T Thrust Areas:

- Precision Airdrop
  (sensors, guidance & control systems)
- Integrated Logistics Aerial Resupply
- Modeling and Simulation
- Parachutist Safety
- Test Instrumentation
- Materials Research

Warfighter Directorate

Development & Engineering Competencies

- Combat Clothing & Individual Equipment
- Chemical/Biological Protective Ensembles
- Load Carriage Systems
- Camouflage & Concealment
- Soldier & Small Unit Power/Data Systems
- Mission Information & Planning Systems
- Situational Awareness Tools (micro-UAVs)
- Human Factors
- Prototyping & Testing

S&T Thrust Areas

- Multifunctional Materials
- Biological Sciences
- Protective Materials & Systems
- Human Sciences (Physical and Cognitive)
- Human Anthropometry

DoD Combat Feeding

- Combat Rations
- Field Food Service Equipment
- Combat Feeding Systems

S&T Thrusts Areas:

- Food Service Equipment Engineering
- Applied Nutrition & Nutritional Biochemistry
- Food Protection, Defense & Microbiology
- Food Engineering, Preservation & Stabilization
- Food Packaging & Polymer Science
- Product Development, Technical Evaluation & Ration Design

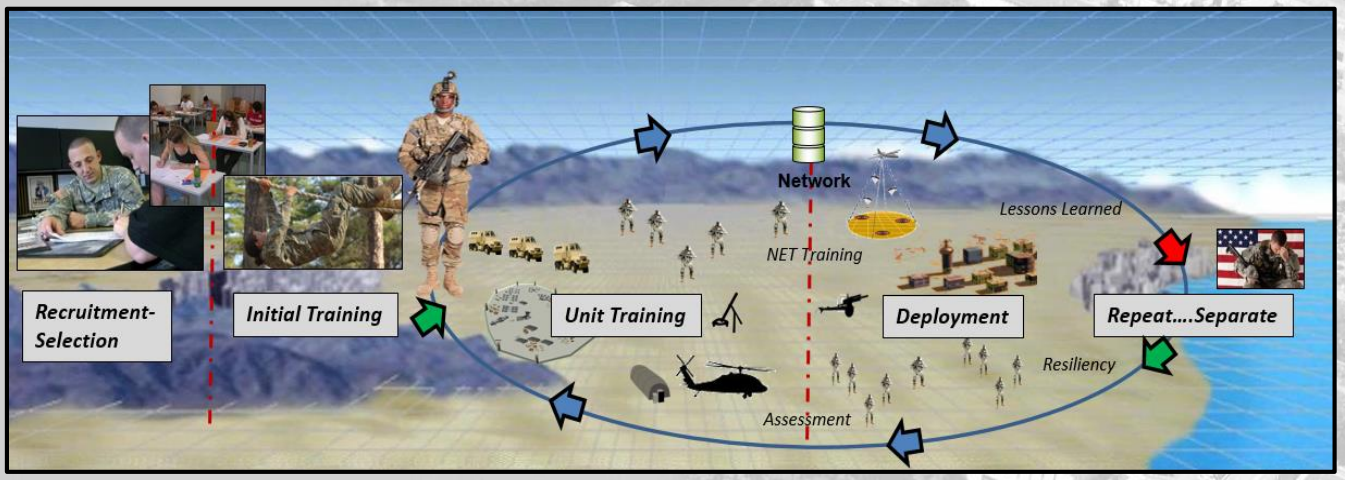
Contingency Basing (Expeditionary)

- Softwall Shelters
- Rigidwall Shelters
- Integrated Expeditionary Base Camp Systems

S&T Thrust Areas

- Barrier Materials
- Structures
- Thermal Management
- Energy Management
- Finite Element Analysis
- Ballistics

Soldier & Squad Performance Optimization Strategy



Purpose:

Align with the Army Operating Concept and the Human Dimension Strategy to build a scientific and technical core focused on the optimization of the cognitive, physical, and social abilities of Soldiers & Small Teams that enables them to adapt to operational complexities and maintain the decisive edge in the face of an uncertain future

Product:

An executable strategy that promotes innovative and collaborative S&T initiatives across the Army to deliver cutting edge knowledge, equipment and enabling technologies (materiel and non-materiel) that cultivates the optimal Soldier-as-a-System who is cognitively, physically and socially dominant.

Warfighter Payoff:

Soldiers equipped with the essential and optimally integrated knowledge, skills, abilities, equipment and technologies that will empower them to achieve superior individual and team performance

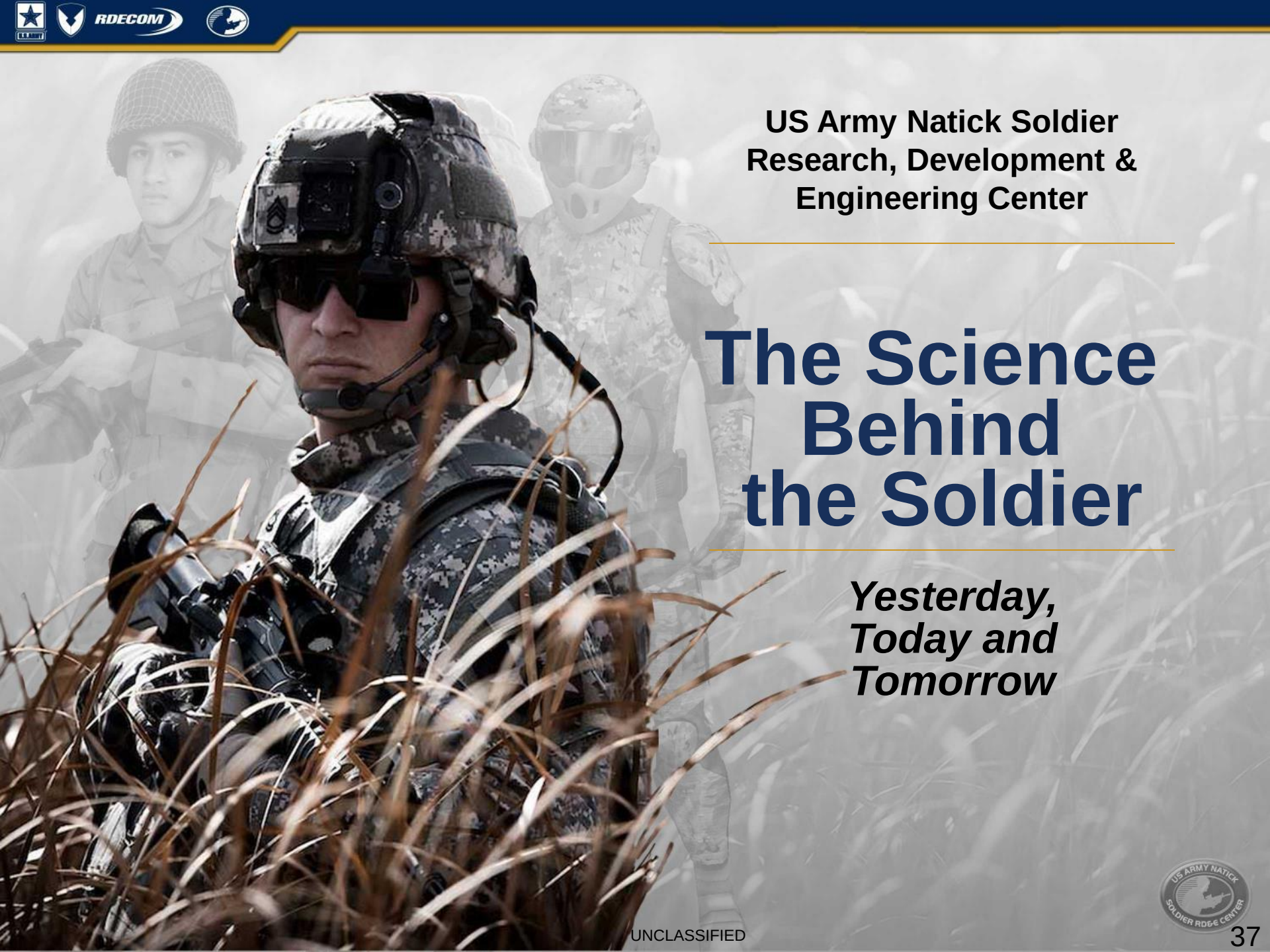
Requirements/Capability Gap Focused

- **Army Big 6+1 Capabilities Initiative**
  - Advancing human science for cognitive, social, and physical development
  - Emphasizing engineering psychology
  - Emphasizing human factors engineering
- **Aligned with TRADOC, AWFC, AOC, capability gaps**

Optimizing the Human Performance of Soldiers and Squads

- Human Research Volunteers
- Unburden – “Lighten the Load”
- Increase Protection
- Quality of Life
- Optimize Nutrition

Sampling of Partners



US Army Natick Soldier
Research, Development &
Engineering Center

The Science Behind the Soldier

Yesterday, Today and Tomorrow