

Wearable Robotics Landscape and Opportunities

Defense Trends & Outlook

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*Help shape a global future leveraging technology in a purposeful and synergetic fashion to **improve quality of life** and accelerate the advent of **transformative human capabilities**.*

Fueling the Growth

- Desire to retain advantage over other militaries and reduce long-term costs of injury
- Changing demographics globally with long-lived populations
- Foundational technology enablers are available.
- Increasing activity and funding especially in Europe and Asia.
- Public curiosity and comfort with wearable technology

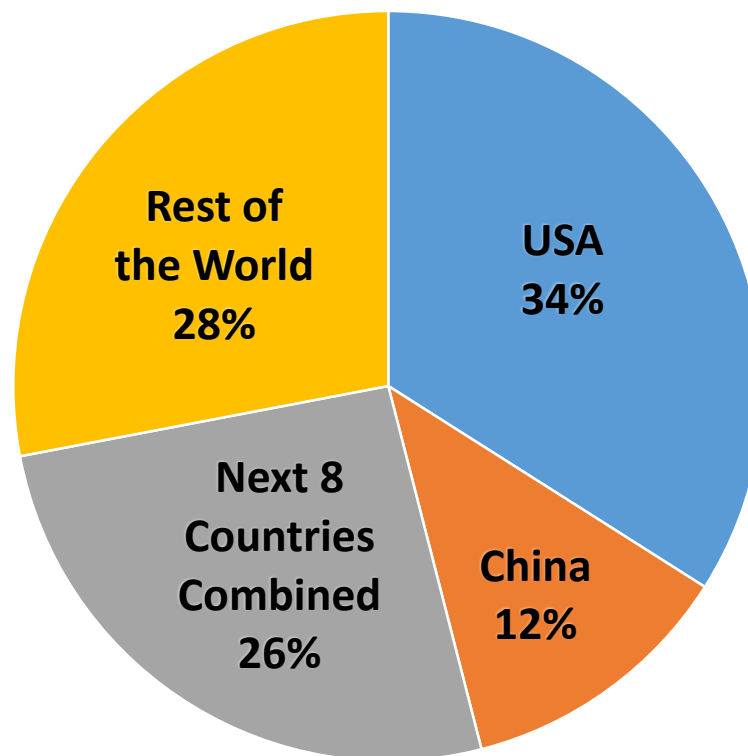


Fueling the Growth



Global Share of Defense Spending in 2014

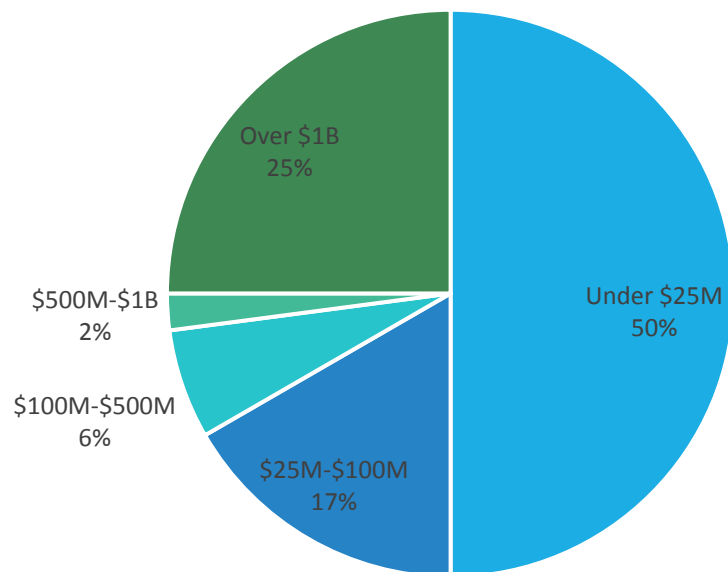
World Ranking 2014	Country	% of World Defense Outlays
1	USA	33.9%
2	China	12.0%
3	Russia	4.7%
4	Saudi Arabia	4.5%
5	France	3.5%
6	UK	3.4%
7	India	2.8%
8	Germany	2.6%
9	Japan	2.5%
10	Korea	2.0%



Snap Shot of 48 Companies

- Half are still in the start-up mode with valuations that are less than \$25M.
- One-quarter are large global companies such as Daewoo and Lockheed-Martin, who have made their names in other business lines and are interested in getting into the exo-skeleton market.
- Many of the remaining quarter started as small firms spun out of research or university organizations that were bought-up by larger companies.

Exo-Companies by Size

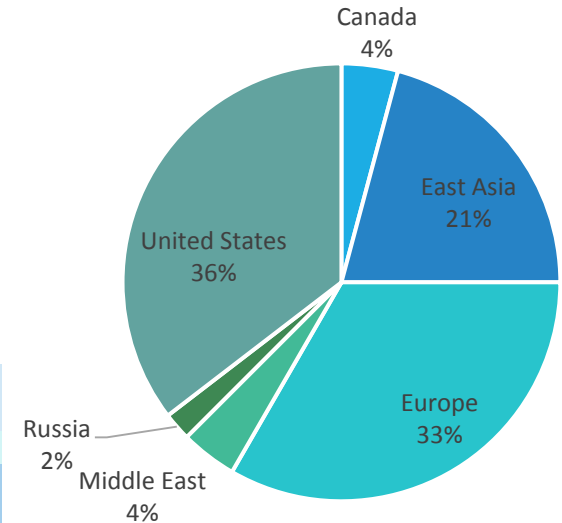


Snap Shot of 48 Companies

Cyberdyne	Japan	East Asia
DSME Daewoo	South Korea	East Asia
Panasonic		
Activelink	Japan	East Asia
Samsung	South Korea	East Asia
Kawasaki	Japan	East Asia
Toyota	Japan	East Asia
Yaskawa Electric	Japan	East Asia
Honda	Japan	East Asia
Innophys	Japan	East Asia
Hexar Systems	South Korea	East Asia
Rex Bionics	New Zealand	East Asia
Ossur	Iceland	Europe
Endolite	England	Europe
Hocoma	Switzerland	Europe
otto Bock	Austria	Europe
Festo	Germany	Europe
BAE Systems	England	Europe
RB3D	France	Europe
Againer	Latvia	Europe
AxoSuit	Romania	Europe
Kinetek - Wearable Robotics	Italy	Europe
Kinetic		
Innovations Ltd	United Kingdom	Europe
Marsi Bionics	Spain	Europe
Noonee	Switzerland	Europe
Technaid S.L.	Spain	Europe
Armon Products	Netherlands	Europe
Mawashi	Montreal	Canada
B-temia	Quebec	Canada

ReWalk	Israel	Middle East
Bama Teknoloji	Turkey	Middle East
ExoAtlet	Moscow	Russia
VQ Orthocare	California	United States
AlterG	California	United States
Sarcos	Utah	United States
IHMC	Florida	United States
CyberGlove Systems	California	United States
Equipois	New Hampshire	United States
Revision Military	Vermont	United States
Parker Hannafin	Ohio	United States
Lockheed Martin	Maryland	United States
Ekso Bionics	California	United States
Interactive Motion Technologies	Massachusetts	United States
Biom	Massachusetts	United States
Myomo	Massachusetts	United States
StrongArm Tech	New York	United States
Us Bionics	California	United States
OtherLabs	California	United States
SpringActive	Arizona	United States

Exo-Companies by Region



Regional Trend



- United States: emerging from research centers aligned with universities and from engineers in the industry deciding to step-out on their own.
- Europe: similar trend.
- East Asia: illustrates a very different trend with the majority of the action occurring in old-line, well-capitalized industry giants.
- China: ?

Functional Landscape

➤ Return function

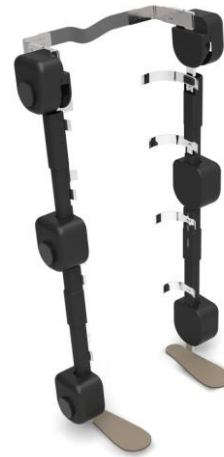
- Spinal cord injury
- Rehabilitation
- Elderly

➤ Enhance function

- Manufacturing
- Construction
- Defense and Emergency Responders

➤ Enhance Quality of Life

- Recreation



EXO-H2
Technaid
Spain

POWER LOADER
Light
Panasonic
Activelink
Japan



Clutch-Spring
Knee for Running
MIT, USA

Defense



SARCOS, XOS-2, USA



Human Universal Load Carrier, USA



Google, USA



AirLegs Exoskeleton, USA



Harvard/Wyss, USA



Powered Exos, China

Component Classification

User Input

Touch: touchscreen, pressure sensor, rocker-switch

Sound: voice recognition, sub-threshold

Gestures: accelerometer, optical tracking

Brain Activity: EEG

User Output

Haptics: vibration, device-based, surface coverage

Sound: speaker, earpiece

Display: OLED, LED, e-paper, prism, projection, see-through, quantum dots



Computing

Hardware: processor, data storage

Software: apps, artificial intelligence, local vs remote (cloud)

Sensing

Environment: Video imaging, geolocation, bio-chemical detection, velocity, elevation, temperature, wind, electrical field

Soldier: Heart rate, blood O₂/CO₂, ECG, galvanic sweat response, respiration, EEG, temperature

Interactive sensors: sound, motion, force

Communications

Standards: WiFi, 3G/4GLTE, Near-Field Communications (NFC), Bluetooth, Hard-wired

Infrastructure: Internet, intranet, device-to-device, vehicle

Power

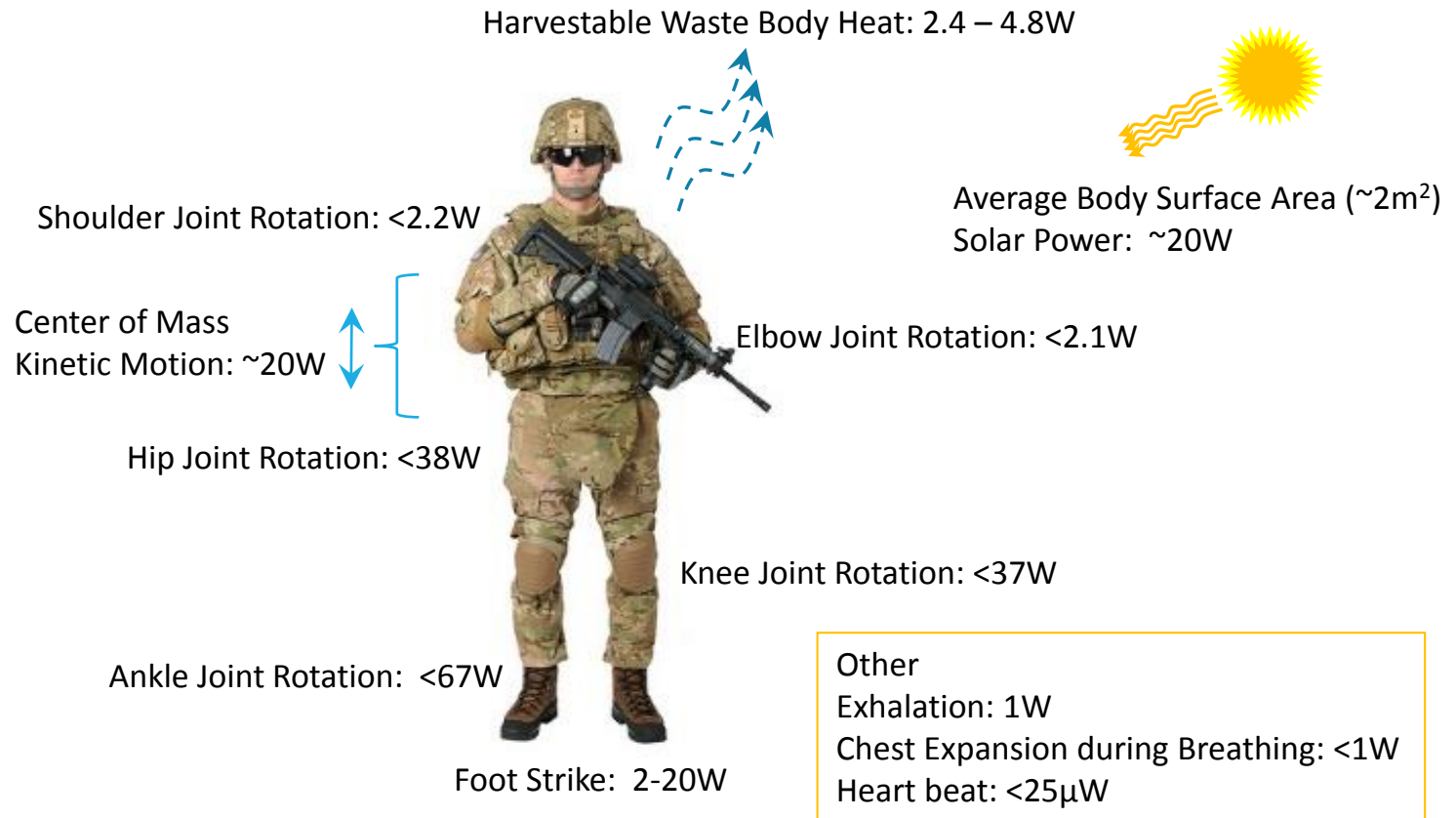
Storage: Batteries, super-capacitance, fuel cells

Harvesting: thermal, solar, piezo-electric, radio frequencies

Charging: wired or wireless

Energy Harvesting Sources

Max Theoretical Limits



Opportunities

Regional diversity creates opportunities for overseas collaboration

- Asia – large corporation sponsored research and development
 - Productivity focused
- Europe – start-ups emerging from academic research
 - Government-Academia-Industry collaboration
 - Productivity and Growth focused
- USA – starts-ups emerging from academic research
 - Strong angel/venture/growth capitol
 - Growth focused in manufacturing and health industries
 - Strong R&D support by Dept of Defense for defense-related uses

Functional diversity leads to excellent Dual-Use opportunities

- Spinal cord injury – leaders emerging, convergence
- Defense – Supporting R&D, awaiting commercial off the shelf
- Assistive/Elderly – need is increasing, opportunities exist
- Industrial – most promising near term opportunities
- Recreational – divergence, hyper-growth potential

Summary

- Challenges: High SWaP-C for full load-path-to-ground systems.
- The need for wearable robotic technology is growing.
- Much of the current innovation is happening with unknown inventors and small businesses across the globe.
- There is both regional and functional diversity in the market.
- WearRA can assist inventors and small businesses explore new opportunities and support their success. We are also connecting gov't need with industry leaders.
- Visit www.wearablerobotics.com and join us at WearRAcon16, Feb 2016, Phoenix, Arizona.
 - Leaders of industry will attend
 - US Dept of Commerce NIST sponsored “Standards and Test Methods” workshop

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