

## HARNESSING TECHNOLOGY Jor the WARFIGHTER

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### 2017 NDIA Joint Service Power Expo DoD Approaches for Future Battery Technology

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HARNESSING THE POWER OF TECHNOLOGY FOR THE WARFIGHTER

#### **JSPE 2017**



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#### "More Power, More Energy, More Progress"



#### We sure could use some new elements...

The Elements Uub 😤 112 Uut 😤 113 Uua 😤 114 Uup 😤 115 Uuh 😤 116 Uuo 😤 118 62 Eu 64 Th 65 Dv 66 Ho Pu 🍄 94 Am 🍄 95 Cm 🍄

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From: flinnsci.com

The old ones we know and love (well, kind of)...

The new ones tend to be unacceptably radioactive...

#### Otherwise, anything better is a difficult materials problem...

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#### Even when we find new ones, not so helpful...

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#### "Island of Stability"

CRANE



#### What does it take to get a better battery?

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#### User's want better capability...

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Weapon systems are specified, designed, developed, prototyped, tested and acquired for achieving a capability...

#### But, if you also need better energy storage...





#### Now, just have to pay for it all...

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#### **Commercial industry has similar problems...**

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From: Electrek.com

#### Tesla Gigafactory Enables Favorable Economies of Scale...

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#### For better batteries, size matters...

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#### Solar Energy, Same Story...

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#### **Solar on Fire**

As prices have dropped, installations have skyrocketed.





#### How much DoD funding do we have?

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#### Short answer – nowhere near enough.

### MIT: '500M\$ to achieve manufacturing capability'

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#### CRANE Eagle Picher (1954) EaglePicher Technologies Westinghouse Northrop Gould Argonne Nat'l Lab (1972) Thermal battery → (1988) Grumman (1996) ENSER Corp manufacturers are Martin Marietta LMCO GE (1973) (1992)(1996)**ENERSYS** an example... Catalyst Research Corp (CRC) SAFT acquires CRC Div. of MSA (1947) thermals (1989) **KDI - SCORE** Advanced SAFT acquires SCORE (1966) • Thermal SCORE (1981) (1971) (1992) SAFT ends production, Batteries R&D only. and ... Resumes production (2006) Mine Safety Appliance (MSA) Missiles & (1954 in UK) 🗕 Space ASB (Fr) acquires MSA thermal Batteries battery, creates MSB (1996) SAFT France (1954) ASB Aerospatiale (1965) Aerospatiale Missiles & SAFT merge thermal battery activities, create ASB (1994) RAFAEL First Missile Activity – (1953) RAFAEL - ADA Began design & Became Gov't production ~ (1985) owned (2002) Eureka Williams (1955) Ceased (1980) Wurlitzer Co. (1954) --• Ceased (1971) 1940 1970 1990 2000 1950 1960 1980

#### Used to buy more batteries...

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WARFARE CENTERS

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#### And, we used to have more Primes...

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WARDARE CENTERS



#### What funding do we have?

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Increasing Technical Maturity



#### SBIR/STTR to "Seed" Success...

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TABLE 3-1 Phase I Awards													
Number of Phase I Awards													
Year	DHS	DoC	DoD	DoE	DoT	ED	EPA	HHS	NASA	NRC	NSF	USDA	Total
1992		19	1,078	196	29	23	41	636	346	17	169	45	2,599
1993		19	1,292	167	49	29	34	659	384	8	255	55	2,951
1994		39	1,394	209	33	20	35	596	413	12	307	62	3,120
1995		72	1,245	196	20	27	47	666	309	8	295	72	2,957
1996		38	1,367	167	30	18	27	560	349		249	62	2,867
1997		63	1,519	194	29	50	35	764	339		252	72	3,317
1998		45	1,276	204	21	41	37	725	344		211	77	2,981
1999		33	1,398	185	17	40	47	931	290		243	84	3,268
2000		40	1,380	292	25	0	58	1,233	287		320	125	3,760
2001		37	1,606	310	38	55	54	1,293	307		291	127	4,118
2002		54	2,308	328	19	72	63	1,339	267		342	125	4,917
2003		53	2,319	323	15	31	51	1,393	312		510	122	5,129
2004	97	65	2,078	257	12	54	43	1,135	291		236	101	4,369
2005	80	34	2,364	259	8	22	38	862	297		152	92	4,208
Total	177	611	22,624	3,287	345	482	610	12,792	4,535	45	3,832	1,221	50,561

SBIR investments represent the largest "open" development fund for DoD...

NOTE: This is a correction of the prepublication version released on July 27, 2007.

SOURCE: U.S. Small Business Administration, Tech-Net Database; and National Aeronatuics and Space Administration.

- Total DOD SBIR Investment yearly of approximately \$1B
- For every four Phase I awards, approximately one phase II award is made

From: nap.edu



#### **DoD SBIR Investments by Service**

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#### But very few are battery related...

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				Total				Total		
Solicitation	1	2	3	Topics	А	В	С	Topics		
Air Force	1	0		169	0			30		
Army	1	0	1	136	0			16		
Chem Bio	0			6						
DARPA	0	0	1	37			0	3		
Defense Health	0		0	19	0		0	8		
DLA	1	0	0	10						
Defense Microelectronics		0		1		0		1		
DTRA		0		7	0			4		
MDA		0	0	23			1	5		
Navy	4	1	0	140	1	0		26		
OSD		0		6						
SOCOM	0		0	14						
_										
All	7	1	2	568	1	0	1	93		
						-				
	( 10/ 568 SBIR )						2/93 STTR			
		0.4%					2.2%			

In 2016, had 568 SBIR topics, of which 10 were energy storage development related...



#### And some SBIRs do succeed...

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Famous SBIR Companies





Market Cap: \$15.64B



Market Cap: \$25.44B



Market Cap: \$1.5B

None received more than \$9 million in SBIR/STTR funding Total combined funding less than \$20 million



www.InteliSpark.com

But, none of the big SBIR, or STTR successes are battery companies...



#### But obviously, some things do get done...

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# "You must put your head into the lion's mouth if the performance is to be a success."

-19 February 1900, South Africa, London to Ladysmith via Pretoria, 1900.

From: richardlangworth.com



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- SBIRs/STTRs
- Rapid Innovation Fund
- Congressional Adds / Earmarks
- Angel / Industry Investments
- Program Direct Funding
- MANTECH
- Title III

### And certainly there are others...

### SBIR/STTR



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U.S. Department of Defense SMALL BUSINESS INNOVATION RESEARCH SMALL BUSINESS TECHNOLOGY TRANSFER



- Example 1: well-scoped manufacturing improvement
  - Relatively low risk, achievable within
  - Strong battery manufacturer involvement
- Example 2: "lucky" material improvement
  - Leveraged prior efforts
  - Small business had established industrial partner market



#### **Rapid Innovation Fund**

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#### **RIF Demand** Background Rapid Innovation Fund (RIF) FY 2011 - 2016 Summary Data: 486 awards to Small Businesses Established as the Rapid Innovation Program (RIP) in · Over \$1.4B Invested (FY11-16) 88% of all awards Section 1073 of the Fiscal Year 2011 National Defense · 14 Defense Component Participants (FY11-16 average) 309 awards to current or prior Small Business Innovative · 14,853 White Papers Submitted & Evaluated (FY11-16) Authorization Act (NDAA) Research (SBIR) participants 957 Full Proposals Submitted & Evaluated (FY11-15) A competitive, merit-based program 56% of all awards 553 Contract Awards (FY11-15) Accelerate fielding of innovative technologies into military FY11 FY12 FY13 **FY14** FY15 FY16 (Act. or Est.) systems Program Overview Appropriated \$439M \$225M \$250M \$200M \$250M Reauthorized in the FY 2016 NDAA until Sep 30, 2023 Available \$225M \$250M \$432M \$187M \$225N \$175M February 2017 **DoD** Participants 16 19 17 17 Re-designated as the Rapid Innovation Fund (RIF) within PE 0604775D8Z White Papers (WPs) 2.405 2.763 2,291 1,955 1.813\* the Department of Defense (DoD) Ellen Purdy Ted Bujewski Full Proposals 186 TBD 234 149 Office of Small Business Programs (OSBP) **OSD Research & Engineering** Awards 175 86 104 85 103 Email: theodore.j.bujewski.civ@mail.mil - Small Biz 93% 84% TBD Email: Ellen.m.purdy.civ@mail.mil 90% 85% 86% Bottom Line Goal: Transition Small Business - SBIR (Current / Prior) 54% 65% 52% 60% 63% Phone: 571-372-7545 Phone: 571-372-6256 Technologies into Defense Acquisition Programs Avg. Award (SM) 2.2 2.1 2.1 2.1 2.2 TBD WPs Submitted to Requirements for: Army (442), Navy (611), Air Force (428) & Defense Agencies (33) Distribution Statement A. Approved for public release Distribution Statement A. Approved for public release Distribution Statement A. Approved for public release

- Began in 2011, relatively new program
- Example 3: small business had degree of SBIR success
  - Improvement to batteries compelled further investment
  - DoD championed the transition effort



- Was a resource that helped traverse that valley o' death
  - Contributed \$10M's each year
  - Was targeted for specific interests
- Example 4: Battery manufacturers improved processes
  - Aligned to program requested battery improvements
  - Funded efforts that otherwise would be difficult to do, and were out of range of most other funding programs
  - There are many more examples...

### Those days are probably long gone...



- Angel (private) investments in DoD-specific batteries do not meet their criteria for payback and rate of return
  - DoD has leveraged angel investments in commercial batteries that can be used in DoD applications, only ~4% energy-related
  - Acquisitions by private investors can help DoD as well
- Best case for DoD is when industry self-invests in better batteries, better materials, better manufacturing
  - Usually done because volume of DoD acquisition justifies it
  - But, investment scales with acquisition volume

#### <u>These are rare...</u>



- There are multiple, successful examples of battery improvements funded directly by beneficiary programs
- In most cases, the presumed risks and initial funding required were thought acceptable
  - Initial results were favorable enough to convince "ok"
  - Timeline for achieving production was "reasonable" under the program overall schedule
- These efforts tend to be "incremental" type energy storage improvements



#### MANTECH

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t of \$800K with Ultraille Corp. and EaglePich impared to LiSO, BA-5590 and 40% increas-



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PROBLEM / OBJECTIVE				The Challenge:
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ntation and Technology Transfer: technology was applemented on masserom system and demonstration program for	FUNDIN Army MonTeck	1G \$22.64		Impact: • introduced the rest generation technology to military batteries • Educationed a U.S. source for a lighter battery to lessen the soldier carried load during
m. Specific implementations benefiting from	TIME LINE / MIL	LESTONE		<ul> <li>110% increase in energy capacity compared to LiSO<sub>2</sub> BA-5500 and 40% increase</li> </ul>
agained Target Acquisition System (ITAS); Jeniol System, Joan Lightneegier Tactical	Start Date End Date	July 2004 April 2011		<ul> <li>Half-size battery is 31% lighter with 7% more energy than BA-5590 and 50% in that BA-5190</li> </ul>
JLTV) demonstrator; Navy SEAL Delayery SDV; Hyaoskeeping Press Supply (HEPS);	PARTICIPA	INTS		<ul> <li>Increased shelf life from 5 years to 15 years</li> <li>Increased industrial rose second sector is additional support conshibit</li> </ul>
t Stelke Fighter (FSF); NASA LEO Sateläter; På Falcon hyperomic airradt	US Army RDECOM Task-Aster Development, & Engineering Co	marters Research, sater (TAEDEC)		of the most common form factor batteries
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- Example 5: Battery manufacturer unable to get required production rate -- MANTECH investment scaled up fabrication processes
- Example 6: Augmented battery manufacturer efforts to make a producible, improved battery

#### Title III



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- Title III investments have successfully achieved better batteries with multiple projects
  - Focused on manufacturing improvements
  - Prefers "established" technology readiness
- Must meet certain criteria for eligibility

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- Technology can be developed, transitioned within one program's available funding
- Plan transitioning to leverage COTS and other investments suited for each of the various tech stages
- Select technology with "low enough" risk that a program office is willing to fund the transition to production
- Favorable cost vs. benefit
- Technology must have strong champions (difficult!)

#### Oh, and be "lucky"...



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### "We can no longer afford, strategically or fiscally, to let the perfect be the enemy of the good—or the good enough when it comes to critical war fighting capability."

- Admiral Jonathan Greenert (Chief of Naval Operations, 2012)

From: dau.mil



#### A final note on "good intentions"...

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#### THANK YOU!

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