Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	145.900	125.435	-	125.435	130.599	129.536	127.716	126.940	0.000	786.126
AN1: *Narrowband SATCOM Technology*	-	0.000	4.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000
AY6: *Soldier Squad Small Arms Armaments Technology*	-	0.000	18.345	13.122	-	13.122	12.404	15.901	15.131	15.132	0.000	90.035
AY8: *Small Arms Fire Control Technology*	-	0.000	0.000	1.898	-	1.898	4.224	2.120	0.000	0.000	0.000	8.242
AZ2: *Body Armor & Integrated Headborne Technology*	-	0.000	8.427	6.575	-	6.575	6.747	6.922	7.021	6.022	0.000	41.714
AZ5: *Soldier Protection Technology - Vulnerability*	-	0.000	8.104	12.248	-	12.248	12.659	14.149	14.317	14.318	0.000	75.795
AZ9: *Soldier Protection Advanced Tech - Detectability*	-	0.000	4.500	3.391	-	3.391	5.472	5.498	5.559	5.559	0.000	29.979
BB4: *Dismounted Soldier Survivability Materials*	-	0.000	4.946	3.093	-	3.093	3.863	3.955	4.013	4.013	0.000	23.883
BB5: *Physical Augmentation: Tech for Human Interactions*	-	0.000	1.500	1.499	-	1.499	1.499	1.499	1.516	1.531	0.000	9.044
BB7: *Exoskeleton: Technology for Man-Machine Interface*	-	0.000	1.600	1.599	-	1.599	1.631	0.000	0.000	0.000	0.000	4.830
BB9: *Human Performance Tech for Mobility & Lethality*	-	0.000	2.500	2.997	-	2.997	2.997	0.000	0.000	0.000	0.000	8.494
BC2: *Next Gen Mobility & Lethality Tech for Warfighters*	-	0.000	5.678	7.514	-	7.514	7.820	2.594	2.623	2.649	0.000	28.878
BC3: *Soldier Decision Making & Comms Performance Tech*	-	0.000	10.759	4.408	-	4.408	4.517	4.627	4.712	4.762	0.000	33.785
BC6: *Human Perf - Tech for Warfighter Enhancement*	-	0.000	2.676	3.023	-	3.023	3.392	1.418	1.376	1.390	0.000	13.275
BC7: *Training Technology (Other than STE)*	-	0.000	0.000	14.155	-	14.155	14.421	14.690	14.830	14.782	0.000	72.878

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*							
BD1: *Adv Soldier Sensors/ Displays Tech for Dismounts*	-	0.000	4.967	11.467	-	11.467	12.059	16.118	16.298	16.300	0.000	77.209
BD6: *Soldier Sys Interfaces/ Integration- Sensor Tech*	-	0.000	1.124	1.119	-	1.119	0.920	0.966	0.796	0.804	0.000	5.729
BD8: *Soldier & Sm Unit Tactical Energy Tech*	-	0.000	9.145	9.043	-	9.043	9.154	11.424	11.574	11.691	0.000	62.031
BE1: *Support Technology to Mission Command*	-	0.000	0.726	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.726
BE3: *Joint Service Combat Feeding Technology*	-	0.000	3.996	4.109	-	4.109	4.073	4.764	4.817	4.817	0.000	26.576
BE6: *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	-	0.000	2.745	6.317	-	6.317	3.021	3.153	3.555	3.591	0.000	22.382
BE8: *Synthetic Training Environment (STE) Technology*	-	0.000	15.438	14.133	-	14.133	16.207	15.787	15.963	15.964	0.000	93.492
BP9: *Soldier Lethality Technologies (CA)*	-	0.000	30.626	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.626
BR9: *Personnel & Airdrop Safety Technology*	-	0.000	4.098	3.725	-	3.725	3.519	3.951	3.615	3.615	0.000	22.523

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602308A Advanced Concepts and Simulation
* 0602618A Ballistics Technology
* 0602623A Joint Service Small Arms Program
* 0602624A Weapons and Munitions Technology
* 0602705A Electronics and Electronic Devices
* 0602709A Night Vision Technology
* 0602712A Countermine Systems
* 0602716A Human Factors Engineering Technology
* 0602786A Warfighter Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602143A *I Soldier Lethality Technology*

A. Mission Description and Budget Item Justification

This PE conducts fundamental research on Soldier Lethality technologies to develop an integrated Soldier and Squad architecture of equipment and systems that improve Soldier and Small Combat Unit survivability, sustainability, mobility, combat effectiveness, and individual cognitive and physical readiness. To address the challenges of integrating multiple technologies and sub-systems, research conducted in this PE, significant Science and Technology applied research investments in all areas of Soldier Lethality, focus on how to improve the effectiveness of the technologies a Soldier utilizes and apply systems-level practices to mitigate constraints from size and weight of the equipment. Research areas encompass individual and crew-served weapon designs and technologies as well as applied research in lightweight and transparent armor materials to mitigate effects from blast and ballistic threats, counter explosive hazard detection, counter-sensor capabilities, and signature management of weapons, equipment, personnel and high value targets. This PE investigates, develops and designs materials, technologies, methodologies and system models required to experiment and optimize Soldier lethality and survivability through investments in mobility, human-agent teaming, and improved situational awareness interfaces and display technologies as well as to provide Soldier-borne power and energy materials and components that support multiple Soldier-borne systems. This PE also investigates Warfighter training technologies and develops the underpinning technologies to establish architecture standards and interfaces necessary for creating realistic synthetic environments to create a single, interconnected synthetic training system to enable Army units and leaders to conduct realistic multi-echelon / multi-domain combined arms maneuver and mission command training, increasing proficiency through repetition. Human Factors Engineering projects conduct applied research to design weapon systems standards, guidelines, handbooks, and Soldier training curriculum and tools.

Results of these efforts are transitioned within the Army Futures Command, the Program Executive Offices, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

Work in this PE complements PE 0603118A (Soldier Lethality Advanced Technology).

All FY21 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this PE is performed by the United States Army Futures Command (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	115.274	126.345	-	126.345
Current President's Budget	0.000	145.900	125.435	-	125.435
Total Adjustments	0.000	30.626	-0.910	-	-0.910
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	30.626			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-0.910	-	-0.910

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: BP9: *Soldier Lethality Technologies (CA)*		
Congressional Add: *Medical simulation and training*	-	3.626
Congressional Add: *Active and passive camouflage concealment and deception*	-	3.000
Congressional Add: *Human systems integration*	-	10.000
Congressional Add: *Expeditionary mobile base camp technology*	-	2.000
Congressional Add: *SOCOM communications capability*	-	2.500
Congressional Add: *Soldier Lethality Technologies Program Increase*	-	5.000
Congressional Add: *Harnessing Emerging Soldier Lethality Technology Research*	-	4.500
Congressional Add Subtotals for Project: BP9	-	30.626
Congressional Add Totals for all Projects	-	30.626

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) AN1 / *Narrowband SATCOM Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN1: *Narrowband SATCOM Technology*	-	0.000	4.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

In FY21 this Project is being realigned to:
PE 0602146A Network C3I Technology
* Project BZ6 Narrowband SATCOM Technology
PE 0603463A (Network C3I Advanced Technology)
* Project AN2 Narrowband SATCOM Advanced Technology

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to enable gateway communications across disparate Narrowband Satellite Communications (SATCOM) networks, enabling resiliency in contested environments. The Narrowband SATCOM network is the largest tactical network operated by the Army to provide situational understanding across all echelons. This Project investigates technologies and protocols to enable risk mitigation solution sets and awareness through adaptive learning capabilities. FY20 realignments are due to financial restructuring in support of Army Modernization Priorities.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN2 (Narrowband SATCOM Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Narrowband Satellite Communication Technology	-	3.819	-
Description: This research effort designs and develops technologies to enable gateway communications across disparate Narrowband SATCOM networks, enabling resiliency in contested environments. The Narrowband SATCOM network is the largest tactical network operated by the Army to provide situational understanding across all echelons. This project investigates technologies and protocols to enable risk mitigation solution sets and awareness through adaptive learning capabilities.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AN1 / *Narrowband SATCOM Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Design and develop an agile, network-defined architecture to enable core network transport capabilities that can interface with, and control traditional and non-traditional Narrowband networks; and develop and mature functional components required to integrate assured, resilient network transport operations in a mobile, congested and contested environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned to support the Network CFT in PE 0602146A (Network C3I Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.181	-
Accomplishments/Planned Programs Subtotals	-	4.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) AY6 / *Soldier Squad Small Arms Armaments Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AY6: *Soldier Squad Small Arms Armaments Technology*	-	0.000	18.345	13.122	-	13.122	12.404	15.901	15.131	15.132	0.000	90.035

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
PE 0602623A Joint Service Small Arms Program
* Project H21 Joint Service Small Arms Program (JSSAP)
PE 0602618A Ballistics Technology
* Project H80 Soldier Protection Technology - Vulnerability
PE 0602716A Human Factors Engineering Technology
* Project H70 Human Factors Engineering System Development

A. Mission Description and Budget Item Justification

This Project investigates individual and crew-served weapon designs and technologies that enhance the fighting capabilities and survivability of the dismounted Warfighter in support of all of the Services. In addition, it conceives and advances weapon concepts based on innovative ballistic and advanced incapacitation technologies that will enhance the defeat of hard and soft infantry targets at extended ranges based upon the Joint Service Small Arms Technology Development Strategy (JSATDS). The Project will continue to support technology needs from the all Services to include the Next Generation Family of Weapons. In addition, this Project will develop the technology/weapons concepts that will upgrade medium and heavy support weapons at echelons. Finally, this Project will perform research directed toward non-kinetic modalities to incapacitate combatants.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0601102A (Defense Science Research) / Project AA7 (Mechanics and Ballistics), PE 0603118A (Soldier Lethality Advanced Technology), and PE 0602141A (Lethality Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier/Squad Lethality Technology	-	2.072	4.103
Description: This effort conceives and investigates advanced weapons concepts based on innovative ballistic technologies that will enhance the defeat of hard and soft infantry targets at extended ranges to ensure overmatch in Soldier and Squad lethality. This effort will also perform research directed toward non-ballistic modalities to incapacitate combatants.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Identify novel lethal mechanisms for future weapons concepts and technical approaches to for increased lethality at reduced energy for behind armor/barrier threats; identify and characterize technology concepts to enable a 50% reduction in dispersion for complex design projectiles; identify and demonstrate mechanisms for incapacitation through synthetic motor control in animal models. ***FY 2021 Plans:*** Will continue to identify novel lethal mechanisms for future weapons concepts and technical approaches for increased lethality at reduced energy for behind armor/barrier threats; utilize state of the art instrumentation to further characterize technology concepts to enable a reduction in dispersion for complex projectiles; determine benefits in capability for novel weapons systems for increased performance of heavy small caliber weapons as well as precision systems; and assess biological effects and incapacitation potential of advanced high powered microwave and acoustic directed energy technologies in small and large animal models. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602141A (Lethality Technology) / AH5 (Projectile and Multi-Function Warhead Technologies) for additional research into weapon systems mechanisms.			
Title: Human-Agent Interactions for Intelligent Squad Weapons ***Description:*** This effort investigates enhanced target acquisition, situational awareness, and shooting performance through Soldier-centered integration of intelligent technologies and distributed information in augmented squad weapons. Enhances operational performance of individuals and teams of Soldiers through novel weapon and human-agent interaction technologies. ***FY 2020 Plans:*** develop techniques to improve the Automated Target Recognition (ATR) training algorithms based on Soldier feedback to mitigate the severe size, weight and power (SWAP) constraints inherent in Soldier-carried weapons. ***FY 2021 Plans:*** Will develop and document knowledge products, including data analysis documentation and guidelines for Soldier/Advanced Target Recognition (ATR) interaction methods, contributing to a framework for bidirectional ATR display and interaction techniques, aimed at maximizing Soldier-intelligent fire control teamed target acquisition performance and situational awareness within the usable field of view. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	3.408	3.713
Title: Next Generation Carbine Technology (NGCT)	-	1.333	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops next generation squad weapon systems and ammunition by providing tech insertions to augment capabilities and mitigate risks. Mature small arms weapon system components and validate them through experimentation in support of the Joint Warfighter?s capability needs. Mature weapon system technology readiness levels and validate confidence of functionality in advanced operating scenarios. ***FY 2020 Plans:*** Validate recoil and shock pressures and determine metrics to compensate for increased muzzle velocity; conduct experiments on Next Generation Carbine Technology systems to ascertain probability of incapacitation effects. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Effort completes in FY20.			
Title: Next Generation Family of Ammo (NGFoA) ***Description:*** This effort designs and develops a family of ammunition for automatic rifles and carbine weapons with the objective of decreasing weight, increasing lethality and hit performance over current fielded systems; develops capabilities to defeat threat targets at extended ranges. ***FY 2020 Plans:*** Conduct propulsion research and experiments to determine pressure, time and velocity of weapon systems; develop the Next Generation Family of Ammunition Combat Tracer; mature component technologies for projectile design, soft/hard target and launch optimization, and modeling and simulation support for validation of capabilities. ***FY 2021 Plans:*** Will finalize maturation of component technologies for the next generation of small arms training rounds, training tracer projectiles, and ammunition training aides; conduct experiments with mature tracer component technologies to validate tracer design performance characteristics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decreased to support PE 06030118A (Soldier Lethality Adv Technology) / AY5 (Soldier Squad Small Arms Armaments Advanced Tech) to support demonstration of next generation ammunition technologies.	-	6.334	1.677
Title: Small Arms Enabling Technologies ***Description:*** This effort designs and develops small arms weapon systems, enablers, and ammunition technologies that will maintain decisive lethal overmatch capabilities to the Joint Warfighter. This effort matures small arms weapon system designs through experimentation in support of Joint Warfighter's capability needs.	-	4.365	3.629

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Investigate the advanced weapon operating technologies (recoil, accuracy, signature, materials, controllability, maintainability, materials, and coatings); conduct experiments on Small Arms Remote Weapon Stations to include component technology in the areas of advanced target recognition, next generation weapon system and lightweight stabilized mounts to enable an increase in the probability of hit on a target. ***FY 2021 Plans:*** Will investigate emerging small arms technologies to develop remote powered armament systems, advanced target recognition and aim augmentation, alternate barrel materials and coatings, signature reduction technologies, etc.; continue investigation of small arms remote armament component technologies for increasing the overall probability of hit. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.833	-
Accomplishments/Planned Programs Subtotals	-	18.345	13.122

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) AY8 / *Small Arms Fire Control Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AY8: *Small Arms Fire Control Technology*	-	0.000	0.000	1.898	-	1.898	4.224	2.120	0.000	0.000	0.000	8.242

Note

In Fiscal Year 2021 (FY21), this Project is realigned from:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BB4 Dismounted Soldier Survivability Materials
PE 0603118A Soldier Lethality Advanced Technology:
* Project AZ8 Soldier Squad Small Arms Armaments Adv Tech
* Project BB3 Dismounted Soldier Survivability Equip/Tech Integ
* Project BB6 Physical Augmentation: Adv Tech for Field Demo

A. Mission Description and Budget Item Justification

This Project designs and develops enabling technology for advanced small arms fire control in order to achieve lethality overmatch by supporting target prioritization, enhancing processing of information from multiple sources, and investigating aim assistance tools which remove Soldier aim error. This Project specifically supports the Army Science and Technology Soldier Lethality modernization priority.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT) efforts. All FY21 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

This Project complements work done in PE 0603118A (Soldier Lethality Advanced Technology) / AY7 (Small Arms Fire Control Advanced Technology).

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Adv. Fire Control Tech	-	-	1.898
Description: This Project investigates software and hardware mechanisms to enable enhanced kill chain processes on small arms platforms. This includes investigating artificial intelligence and neural network hardware, conducting experiments on both Commercial and Government Off-The-Shelf (COTS and GOTS) artificial intelligence and machine learning algorithms, and validating Soldier accuracy performance models. It also includes investigation of lightweight optical components and determines viability of weight reduction and balancing approaches.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY8 / *Small Arms Fire Control Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will refine technical requirements based on capability needs; investigate existing artificial intelligence and machine learning algorithms on COTS & GOTS; determine implementation and validation approaches as well as research of human-system integration and pairing; and mature components of polymer lens and housing technologies, and three-dimensional printing solutions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increased from PE 0603118A (Soldier Lethality Advanced Technology) / BB6 (Physical Augmentation: Adv Tech for Field Demo), AZ8 (Soldier Squad Small Arms Armaments Adv Tech), BB3 (Dismounted Soldier Survivability Equip/Tech Integ), and PE 0602143A (Soldier Lethality Technology) / BB4 (Dismounted Soldier Survivability Materials) to address fire control acceleration in support of Army Modernization Priorities in this area.			
Accomplishments/Planned Programs Subtotals	-	-	1.898

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) AZ2 / *Body Armor & Integrated Headborne Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
AZ2: *Body Armor & Integrated Headborne Technology*	-	0.000	8.427	6.575	-	6.575	6.747	6.922	7.021	6.022	0.000	41.714

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing & Equipment Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops materials for Soldier-borne protective equipment, such as body armor and combat helmets, to increase protection from ballistic, blast, and blunt impact threats. This Project also investigates and executes systematic studies to mature and develop materials, devices, systems and methods that enable the identification of protective solutions against ballistic, blast and directed energy threats. Included are investigations of emerging technologies, novel materials, and test methods and integration of personnel armor, combat helmets, hearing protection, eyewear, and other personal protective equipment items.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Body Armor & Integrated Headborne Technology	-	8.044	6.575
Description: This research effort supports the investigation of novel materials, component designs, and material modeling to design and develop technologies that protect Soldiers against ballistic, blast, and directed energy threats. This effort utilizes a cross-disciplinary, human-focused approach to develop technologies which optimize tradeoffs in ballistic and blast protective component design. This effort addresses the Army challenge of easing overburdened Soldiers in small units and aligns to Soldier protection modernization priorities.			
FY 2020 Plans: Advance research toward material and technology development in support of an integrated single lens substrate for use in a Soldier vision protection systems that improves variable light transmission lenses with laser flash and dazzle protection, investigate high hardness coatings, as well as experiments on alternative technologies to mitigate lens deterioration and extend operational life; will mature the performance envelope of a repeatable laboratory test method that is capable of evaluating the performance of head-borne equipment in a simulated near free-field blast overpressure environment; develop modeling and analysis tools to quantify the terminal ballistic loading of small arms threats to the combat helmet and head to assist the scaling			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ2 / *Body Armor & Integrated Headborne Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
of head injury criteria to inform future helmet performance and injury biomechanics; systematically investigate material composite pre-stress processing methods to increase ballistic material mechanical properties during composite laminate processing to enhance ballistic performance. ***FY 2021 Plans:*** Will mature components of an integrated single lens substrate for use in Soldier vision protection system that includes anti-fog, variable light transmission, and lenses with laser flash and dazzle protection capabilities; conduct analytical and laboratory studies to physically validate the performance of high hardness and anti-fog coatings to protect and extend the operational life of various Soldier-borne display technologies; validate the operating performance capability of the advanced blast simulator and its correlation to free field blast overpressure conditions from artillery and antipersonnel threats as a means to systematically study headborne equipment in a controlled blast environment; validate material composite pre-stress processing methods and investigate its use with multiple material substrates as a means to enhance the ballistic performance of multiple end-items. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort was realigned to PE 0603118A (Soldier Lethality Advanced Technology) / AY9 (Body Armor & Integrated Headborne Adv Tech) to support the acceleration of next generation headborne protection system demonstration.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.383	-
Accomplishments/Planned Programs Subtotals	-	8.427	6.575

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) AZ5 / *Soldier Protection Technology - Vulnerability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AZ5: *Soldier Protection Technology - Vulnerability*	-	0.000	8.104	12.248	-	12.248	12.659	14.149	14.317	14.318	0.000	75.795

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project H84 Materials
PE 0602618A Ballistics Technology
* Project H80 Survivability and Lethality Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops materials, methods, and models that enable design and integration of emerging material technologies into lightweight, flexible and modular Soldier equipment to protect against the range of existing and emerging threats for head, torso, and extremity protection. Specific research thrusts include the development of materials and mechanisms to enhance ballistic protection; computational models and associated experiments to provide a fundamental understanding of material properties and failure mechanisms, as well as correlation to ballistic/blast/blunt impact performance of Soldier personal protective equipment (PPE) and improved fibers, composite, and ceramic materials. Specific technologies include experimental helmets that reduce impact and blast loading to the head, Soldier torso protection systems to increase protection from ballistic and blunt impacts, and novel fibers and fabrics that provide additional survivability mechanisms.

Work in this Project supports key Army needs and is fully coordinated with several PEs to include PE 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology); and leverages the technical research of several PEs to include PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics) and 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier Protection Technologies	-	4.009	4.211
Description: This effort develops integrated lightweight, flexible, and modular protection equipment that is tailored to support the 'Soldier as a system' approach for defeat of emerging threats. Research areas encompass high fidelity ballistic impact injury models for hard and soft tissues, novel ceramic architectures to include graded and hierarchically structured ceramics, and novel fiber solutions for backing materials to deliver Soldier protection systems to meet emerging ballistic and signature management			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
threats. This effort supports small caliber lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology). ***FY 2020 Plans:*** Perform computational/experimental analysis of disruption mechanisms against legacy bullet technologies; simulate helmet/pad/head interaction for various loading scenarios; investigate soft tissue and hard tissue injury mechanisms; explore new concepts in limb protection from blast events; develop armor model to explore behind armor blunt trauma metrics. ***FY 2021 Plans:*** Will design and develop armor mechanisms to protect dismounted Soldiers from emerging ballistic threats through experimental and computational analysis; increase head protection through determination of advanced mitigation techniques; investigate thoracic soft tissue and hard tissue injury mechanisms; continue to explore new concepts in limb protection from blast events; validate armor model for behind armor blunt trauma metrics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Soldier-Borne Composite Materials ***Description:*** Utilizing understanding of fibers, fabrics, and composite materials, conduct applied research of emerging lightweight materials and structures to enable affordable designs for head, torso, and extremity protection systems. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new schemes to enhance Warfighter survivability. This effort supports Soldier Protection Technologies bullet. ***FY 2020 Plans:*** Demonstrate efficient and complete synthesis of novel fibers and films for soft body armor and head protection solutions; demonstrate computational framework of multi-physics-based helmet process models that simulate the thermoforming of compound curvature geometries providing process-induced microstructure and process histories that serve as critical input into ballistic impact simulations. ***FY 2021 Plans:*** Will explore the processing and layout of novel fibers and films as a composite for potential soft body/torso armor and head protection (helmets); and investigate computational methodology processes and the resulting structure-performance relationships of composites for helmets. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	2.556	2.310

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: Soldier-Borne Advanced Protection Materials ***Description:*** Utilizing understanding of protection materials such as armor ceramics and associated failure mechanisms, conduct applied research of emerging armor materials to enable affordable design of lightweight ballistic protective systems for the future Soldier. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new lethal mechanisms/ protection schemes for the individual Warfighter. This effort supports Soldier Protection Technologies bullet and small caliber lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology), ***FY 2020 Plans:*** Develop processing pathways to fabricate armor ceramic with novel multiscale heterogeneity and characterize ballistic performance; create experimental technique to characterize ceramic blends and ceramic failure to include the fragment size distribution and the subsequent flow of damaged material under tri-axial states of stress. ***FY 2021 Plans:*** Will explore novel ceramics and ceramic structures for ballistic applications; develop processing pathways for multiscale architectures and assess their ballistic performance; research experimental techniques to assess failure mechanisms for multiscale architectures under ballistically-relevant states of stress. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.171	2.730
Title: Multifunctional Soldier Materials - Soldier Augmentation ***Description:*** This effort researches novel multifunctional Soldier protection materials and associated processing science aimed at enabling critical Army applications in survivability via Soldier augmentation technologies. Research efforts include: multifunctional fibers, films, and coatings; adaptive and responsive materials for passive biomechanical assistance; materials for sensing body forces and kinematics; materials for high power and high speed actuation; actuator fibers and textiles; functionally graded materials; and color-changing materials. ***FY 2021 Plans:*** Will explore the development of new materials and structures, both passive and active that can be integrated with the human body to modify human biomechanics, and /or change color on demand; determine metamaterial structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	-	2.997

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer	-	0.368	-
Description: Funding transferred in accordance with Title 15 USC ?638			
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	8.104	12.248

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) AZ9 / *Soldier Protection Advanced Tech - Detectability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AZ9: *Soldier Protection Advanced Tech - Detectability*	-	0.000	4.500	3.391	-	3.391	5.472	5.498	5.559	5.559	0.000	29.979

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates and designs novel materials, technologies, techniques and applications increasing the capabilities of camouflage and concealment against known and emerging sensor threats. The results of this project enable effective deception capabilities, combinations of physical and electronic signature decoy components, and determination of analytical processes for modeling signature management technologies during multi-domain operations. These technologies will provide subsystems and concepts that shall decrease the probability of detection and targeting by peer and near-peer adversaries, enabling freedom of movement of semi-independent and dispersed formations and increased protection of high-valued assets. Components designed under this project will transition to Advanced Technology Development efforts in Soldier Lethality protection/survivability Projects to provide disruptive Camouflage, Concealment and Deception technologies to the Operational Army to support expeditionary maneuver in the Multi-Domain Battle Environment and retain windows of advantage.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project BB4 (Dismounted Soldier Survivability Materials), Project AZ5 (Soldier Protection Technology - Vulnerability), Project BE1 (Support Technology to Mission Command), PE 0603118A (Soldier Lethality Advanced Technology) / Project AZ8, (Soldier - Small Unit Detectability Adv Technology), and PE 0602712A (Countermine Systems) / Project H35 (Camouflage and Counter-Recon Tech).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Camouflage, Concealment and Decoys Technologies for Soldier and High-Value Assets	-	4.296	3.391
Description: This effort investigates and designs materials, processes, and concepts for innovative camouflage, concealment and deception technologies for Soldier and High-Value assets to defeat advanced current and emerging adversary Intelligence, Surveillance and Reconnaissance (ISR) threats including multispectral, hyperspectral and Light Detection and Ranging (LiDAR) sensors, and to reduce the probability of detection in multi-domain operations. Investigates analytical processes to model material and system performance and predict probability of detection in the multi-domain operational environment, assisting in closing the			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ9 / *Soldier Protection Advanced Tech - Detectability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
capability gap between current camouflage, concealment, and deception technologies and defeating enemy sensorial capabilities in future operating environments. ***FY 2020 Plans:*** Validate preliminary performance effectiveness of camouflage technologies under development; determine design metrics to discern performance of candidate camouflage system solutions in support of future hyperspectral and LiDAR sensor defeat; investigate analytical models for predicting performance; determine the effectiveness of candidate decoy systems in deceiving peer and near-peer adversaries; mature versatile optical film technology for standoff-based signature concealment in visual and near infrared spectral ranges to camouflage to conceal Soldiers and small ground assets; conduct experiments to assess dismounted Soldier vulnerability against enemy ground surveillance radar; investigate flexible Soldier worn materials to reduce Soldier radar cross section; explore active color changing materials for potential Soldier clothing and individual equipment; investigate near infrared, identification of friend versus foe capability for the individual Soldier. ***FY 2021 Plans:*** Will leverage performance effectiveness of camouflage materiel technologies to mature components of most promising solutions; determine design metrics that will be relevant for defeating known emerging sensor threats; leverage data showing vulnerability against ground surveillance radar for experimenting with flexible Soldier worn materials to reduce Soldier radar cross section; investigate technologies to alert Soldiers if detected by ground surveillance radar; design and mature components of active color changing materials for future integration into Soldier clothing and individual equipment; research alternative active and passive identification of friend versus foe capabilities for the individual Soldier to provide tailorable mission-dependent capability; validate performance effectiveness of new camouflage technologies against continuously emerging and changing threats based on previous results; evaluate camouflage system solutions in support of new/emerging hyperspectral and LiDAR sensor defeat; interrogate candidate deception solutions; continue to investigate color and optical property changing materials for high value asset concealment, utilizing varying environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort was realigned to PE 0602146A (Network C3I Technology) / AQ9 (Expeditionary Data to Decisions Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	0.204	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ9 / *Soldier Protection Advanced Tech - Detectability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	4.500	3.391

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BB4 / *Dismounted Soldier Survivability Materials*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB4: *Dismounted Soldier Survivability Materials*	-	0.000	4.946	3.093	-	3.093	3.863	3.955	4.013	4.013	0.000	23.883

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipment Technologies

A. Mission Description and Budget Item Justification

This Project investigates fibers, textiles, components, and materials focused on enhancing Soldier survivability from combat threats (flame and thermal, blast and ballistic, multispectral sensor, and laser threats) and environmental threats (e.g., cold, heat, wet, vector, antimicrobial, etc.) to increase operational effectiveness while decreasing the Soldier's physical and cognitive burden. The results from this Project will transition knowledge, materials, subcomponents and methods to Advanced Technology Development efforts in support of enhancing Soldier Lethality by providing protective material solutions focused on the aspects of dismounted movement and maneuver operations of the Army. This Project develops and applies validation methods that enable systematic studies of human systems integration principles and practices to protective equipment materials and designs to advance the understanding of trade-offs between protection, lethality, and mobility.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology - Vulnerability), Project BB4 (Dismounted Soldier Survivability Materials), and PE 0603118A Soldier Lethality Advanced Technology / Project BB3 (Dismounted Soldier Survivability Equip/Tech Integ).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Dismounted Soldier Survivability Materials	-	4.722	3.093
Description: This effort investigates materials, devices and methods that aid in the design and development of multifunctional materials for Soldier protective clothing and individual equipment. This effort conducts research to investigate and identify multi-functional material properties at the micron and sub-micron level to mitigate Soldiers susceptibility and vulnerability to operational threat, i.e., flame, thermal, environmental, and multispectral sensors. Efforts also investigate and develop devices and systems that enable extended dismounted mission duration by reducing the demand for water resupply and enabling Squad organic water filtration systems			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB4 / *Dismounted Soldier Survivability Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Develop and conduct experiments on novel textile architectures and weaves to provide protection against microwave frequency threats through reflection and scattering of directed energy; determine the efficacy of novel sensors that systematically measure heat flux during system and component flame resistance testing to quantify body region burn injuries; and explore materials and processes that enable individual Soldiers to desalinate contaminated water for hydration during emergency and extended semi-independent operations. ***FY 2021 Plans:*** Will conduct experiments on novel multi-component fiber architectures and fabric treatments to incorporate functionalities for improved durability over the life of the garment, providing more effective protection against operational threats for a longer period; design fibers and fabrics that can transmit power supporting integration of wearable electronics for situational awareness and decreased load; continue to investigate and validate materials and processes that enable individual Soldiers to desalinate contaminated water such that proper hydration levels can be maintained from any indigenous water source. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort decreased to support higher priority modernization areas of PE 0603118A (Soldier Lethality Advanced Technology) / BB3 (Dismounted Soldier Survivability Equip/Tech Integ).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.224	-
Accomplishments/Planned Programs Subtotals	-	4.946	3.093

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BB5 / *Physical Augmentation: Tech for Human Interactions*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB5: *Physical Augmentation: Tech for Human Interactions*	-	0.000	1.500	1.499	-	1.499	1.499	1.499	1.516	1.531	0.000	9.044

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project advances the understanding of human augmentation and interaction for enhanced operational performance with a focus on adaptation, training, human variability, metrics/methodologies for assessment, and task quantification. Research encompasses conducting applied research to develop metrics, measures, tools, and techniques to quantify and understand the relationships that enable maximum effectiveness of integrated Soldier-augmentation technologies. The resulting data are the basis for physical augmentation systems and equipment design standards, guidelines, and intelligent agent requirements to improve equipment operation and Soldier-system synergy. Application of this research will yield reduced workload, reduced Soldier training requirements, enhanced Soldier lethality/survivability, user acceptance, and allow Soldiers to achieve maximum performance. Major efforts explore novel techniques for Soldier assessment, characterization of individual variability effects on performance, development of evidence based design guidance for the application of augmentation technologies, exploration of the relationship of exoskeleton and physical assist device adaptation and baseline Soldier parameters such as gait, neuromuscular motor control and proprioception. This Project will also explore novel training paradigms for reduced Soldier-augmentation technology adaptation times to address current and future warrior performance issues. Individual efforts exploit wearable sensor technologies, translate surrogate task performance to operational outcomes, develop approaches to distinguish tasks and individual state and intent of movement, establish database of human movement variability to inform intelligent system design, and identify high impact applications of augmentation.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0602143A (Soldier Lethality Technology) / Project BC2 (Next Gen Mobility & Lethality Tech for Warfighters), Project BB9 (Human Performance Tech for Mobility & Lethality), Project BC6 (Human Perf - Tech for Warfighter Enhancement), and Project BB7 (Exoskeleton: Technology for Man-Machine Interface); and supports PE 0603118A (Soldier Lethality Advanced Technology) / Project BC1 (Human Performance AdvTech for Mobility & Lethality), Project BB6 (Physical Augmentation: Adv Tech for Field Demo), and Project BB8 (Soldier Centric Advanced Technology). Additionally, work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program within PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds), and the Veteran Administration's exoskeleton research area. This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance and with our international partners through The Technical Cooperation Program / Human Resources and Performance Group / Panel JP1 (TTCP HUM JP1).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB5 / *Physical Augmentation: Tech for Human Interactions*

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Training Adaptation and Movement Science ***Description:*** This effort investigates the science behind movement for physical augmentation to maximize mobility capacity and training adaptation to decrease learning curve with physical augmentation systems (e.g. physical assist devices, exoskeletons). This work will enable the Army to make informed decisions on the ultimate effectiveness of human augmentation technologies before significant resources are expended. ***FY 2020 Plans:*** Conduct experiments to understand how Soldiers adapt to using physical augmentation/exoskeleton type devices; investigate factors that predict slow vs fast adaptation to design training interventions so physical augmentation systems are utilized optimally for the greatest performance benefit; investigate bio-signals that predict change in human movement to develop design criteria for augmentation systems that are capable of anticipating changes in movement states (e.g. walk to sprint) and adjusting in real time. ***FY 2021 Plans:*** Will mature design criteria and develop training interventions to optimize physical augmentation systems for the greatest performance benefit; validate design criteria for smart controls of augmentation systems that are capable of anticipating changes in movement states (e.g. walk to sprint) and adjusting in real time based on previously categorized Soldier movement characteristics; conduct experiments that manipulate control parameters of augmentation systems to determine optimal control settings for various tasks and individuals. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.432	1.499
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.068	-
Accomplishments/Planned Programs Subtotals	-	1.500	1.499

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB5 / *Physical Augmentation: Tech for Human Interactions*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BB7 / *Exoskeleton: Technology for Man-Machine Interface*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB7: *Exoskeleton: Technology for Man-Machine Interface*	-	0.000	1.600	1.599	-	1.599	1.631	0.000	0.000	0.000	0.000	4.830

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602716A Human Factors Engineering Technology
* Project H70 Human Fact Eng Sys Dev

A. Mission Description and Budget Item Justification

This Project conducts applied research on metrics, measures, tools, and techniques to understand the relationships which enable maximum effectiveness of integrated Soldier-augmentation technologies. The resulting data are the basis for physical augmentation systems and equipment design standards, guidelines, and intelligent agent requirements to improve equipment operation and Soldier-system synergy. Application of this research will yield reduced workload, reduced Soldier training requirements, enhanced Soldier lethality/survivability, user acceptance, and allows the Soldier and systems to jointly achieve maximum performance. Major efforts explore novel techniques for Soldier assessment, characterization of individual variability effects on performance, and development of evidence based design guidance for the application of augmentation technologies to address current and future warrior performance issues. Individual efforts exploit wearable sensor technologies, translate surrogate task performance to operational outcomes, develop approaches to distinguish tasks and individual state, establish database of human movement variability to inform intelligent system design, and identify high impact applications of augmentation.

Results of these efforts supports key Army needs and leverages the technical research of PEs 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology). Additionally, this work complements and supports the Medical Research and Development Command under PE 0602787A (Medical Technology), Army Training and Doctrine Command (TRADOC), Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Exoskeleton	-	1.527	1.599
Description: This effort will accelerate Soldier lifting and mobility capabilities through applied research on exoskeleton systems with improved safety and reduced training requirements.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB7 / *Exoskeleton: Technology for Man-Machine Interface*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Refine surrogate tasks and associated performance metrics for dismounted operations scenario and begin developing consolidated assessment approach; investigate relationships between human movement variability and performance outcomes for quasi-operational dismounted Soldier tasks; investigate trade-offs between physical task requirements and performance outcomes, and develop approaches to classify and discriminate between tasks to support optimization of intelligent system design and control parameters. ***FY 2021 Plans:*** Will conduct experiments with integrated operational scenario and performance metrics for assessment of dismounted Soldier performance; expand models of human movement variability and performance outcomes to inform development of adaptive system designs and control approaches. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.073	-
Accomplishments/Planned Programs Subtotals	-	1.600	1.599

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BB9 / *Human Performance Tech for Mobility & Lethality*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB9: *Human Performance Tech for Mobility & Lethality*	-	0.000	2.500	2.997	-	2.997	2.997	0.000	0.000	0.000	0.000	8.494

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates human performance based information portrayal system design parameters that integrate mobility & lethality considerations (such as cognitive workload, target discrimination and engagement, and fatigue) into training/education tools, mission command platforms, and technologies that help Soldiers more rapidly and efficiently acquire complex skills and make decisions quickly from training through mission planning and execution.

Work in this Project directly supports integration of design guidance for multiple PE/Projects including PE 0603118A (Soldier Lethality Advanced Technology) / Project BD7 (Soldier Sys Interfaces/ Integration-Sensor Adv Tech), Project AY9 (Body Armor & Integrated Headborne Advanced Tech), and Project BC9 (Adv Soldier Sensors/ Displays AdvTech for Dismounts).

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Systems Interfaces & Cognitive Processes. Work in this Project supports key Army needs and leverages the technical research efforts at the Simulation and Training Technology Center to support synthetic training environments.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense's Close Combat Lethality Task Force.

All FY 2020 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Interaction for Situational Understanding	-	2.386	2.997

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB9 / *Human Performance Tech for Mobility & Lethality*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates, designs, and develops design guidance for information portrayal systems and sub-systems in augmented/virtual reality that enable Soldiers to make better, faster decisions for close combat operations at the small unit level. This effort also conducts experiments to populate performance models that have application across materiel and non-materiel solutions. ***FY 2020 Plans:*** Investigate impact of multimodal cuing (e.g. audio, visual, haptic) in augmented and virtual reality on decision making with navigation and target engagement in simulated operational environments; measure Soldiers response time, cognitive burden, behavioral, physiological and neurophysiological responses to inform what and how information should be portrayed to a Soldier in order for it to be meaningful and actionable. ***FY 2021 Plans:*** Will investigate the impact of virtual reality and augmented reality design parameters (e.g. graphical level of detail, uncertainty, degraded network conditions, focal depth) on decision-making, situational awareness, and navigation; continue to investigate Soldiers? response time, cognitive burden, and behavioral measures of performance to inform what and how information should be portrayed to a Soldier in order for it to be meaningful and actionable. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support increased testing of human situational understanding.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.114	-
Accomplishments/Planned Programs Subtotals	-	2.500	2.997

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB9 / *Human Performance Tech for Mobility & Lethality*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC2: *Next Gen Mobility & Lethality Tech for Warfighters*	-	0.000	5.678	7.514	-	7.514	7.820	2.594	2.623	2.649	0.000	28.878

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates the means to monitor, assess and predict Soldier and squad shoot and move performance to provide design guidance for individual and mission specific equipment (e.g. individual protection, small arms, load carriage, etc.). Research conducted focuses on translating mission tasks to measures of human performance. These measures of human performance will inform predictive algorithms and human based modeling and simulation that enable Soldier performance trade space analysis for acquisition, training, and operations. These data and algorithms will allow us to determine the impact of new capabilities on Soldier and Squad performance and effectiveness.This Project supports the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) joint Science and Technology program supported by the Office of the Secretary of Defense Close Combat Lethality Task Force.

Work in this Project supports key Army needs and leverages the technical research of several PE/Projects to include PE 0602143A (Soldier Lethality Technology) / Project BB9 (Human Performance Technology for Mobility & Lethality), and Project BC6 (Human Perf - Tech for Warfighter Enhancement). This Project supports multiple Projects within PE 0603118A (Soldier Lethality Advanced Technology) including Project BB8 (Soldier Centric Advanced Technology), Project BC1 (Human Performance AdvTech for Mobility & Lethality), Project AY9 (Body Armor & Integrated Headborne Advanced Tech), Project AY5 (Soldier Squad Small Arms Armaments Advanced Technology), Project BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech), and Project BB6 (Physical Augmentation: Adv Tech for Field Demo).

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense Close Combat Lethality Task Force.

Work in this Project is performed by the United States Army Futures Command (AFC).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Interaction for Mobility & Lethality ***Description:*** This effort investigates and develops human performance based design guidance for protection and weapon systems and sub systems to improve the mobility and lethality of individuals and small units. The applied research translates traditional means for measuring and understanding human performance to the means to conduct assessment for Warfighter and small unit readiness and/or new capabilities. ***FY 2020 Plans:*** Investigate physical and cognitive tolerances and fatigue on task performance with head borne systems with varying weight distribution properties (e.g. moment of inertia, center of gravity, etc.) to inform protective equipment designs; conduct experiments to populate movement & maneuver performance models that integrate with Nett Warrior and other programmed situational awareness systems; investigate, validate, and mature wearable sensor components that are surrogates for tactical tasks of shoot and move in order to provide the means for Soldier and Squad assessment for both training and test & evaluation purposes. ***FY 2021 Plans:*** Will identify, validate, and mature components of innovative wearable sensors and algorithms for monitoring and assessment of situational awareness, cognitive state, and decision-making during critical Soldier tasks to provide the means for Soldier and Squad assessment for both training and test & evaluation purposes; identify predictive measures for Soldier shoot, move, communicate, navigate, and decide tasks during conditions of physical and cognitive stress in future operating scenarios; determine quantitative data and algorithms to populate commander decision aids, a predictive squad performance model, and the Synthetic Training Environment (STE). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602143A (Soldier Lethality Technology) / BC3 (Soldier Decision Making & Comms Performance Tech).	-	5.421	7.514
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.257	-
Accomplishments/Planned Programs Subtotals	-	5.678	7.514

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BC3 / *Soldier Decision Making & Comms Performance Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC3: *Soldier Decision Making & Comms Performance Tech*	-	0.000	10.759	4.408	-	4.408	4.517	4.627	4.712	4.762	0.000	33.785

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602716A Human Factors Engineering Technology
* Project H70 Human Fact Eng Sys Dev
PE 0602308A Advanced Concepts and Simulation
* Project C90 Advanced Distributed Simulation

A. Mission Description and Budget Item Justification

This Project conducts applied research to create analytical and empirical capabilities to characterize, model, and forecast human behavior related to cyber electromagnetic events through experimentation and field data collection. The result is increased mission effectiveness that enables strong mission command, intelligence operations, and cyber defenses, which lead to high information sharing, situational awareness, and collaboration. Major efforts focus on applied research to understand the conduct of effective cyber electromagnetic operations in that knowledge is required to create and effectively deploy cyber work systems that optimize human-machine interactions and account for operator and adversary behavior to achieve maximum effects. This Project also investigates technologies to quantify, predict, and enhance Squad-level shared Soldiers' situational awareness (SA) and understanding (SU) across volatile, uncertain, complex, and ambitious operating environments leading to demonstrated increases in mission effectiveness. The result of this effort will be systems that use real-time opportunistic measures of Soldier SA to adapt autonomous assets (routes, surveillance targets, etc.) based on dynamic needs of the Soldier/Squad due to changing mission environment. In addition, this Project will develop novel technologies and approaches to represent uncertain and dynamically changing information in a manner that is effective and quickly understood with reduced Soldier/Squad burden and minimal training requirements.

Results of these efforts are provided to Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Program Managers, Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier Performance in Sociotechnical Environments	-	10.270	2.960
Description: This research provides human cyber operations assessment and advanced human decision-support capabilities to deploy cyber work systems that optimize human-machine interactions and account for operator and adversary behavior. Without			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC3 / *Soldier Decision Making & Comms Performance Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
these capabilities, future cyber work systems will be too complex and burdensome for operator use and training resulting in critical bottlenecks as operators have to ?catch-up? with the speed of cyber activity. This research also supports technologies for Squad-level SA assessment (information visualization) that provide command-level decision support with communication and intervention capabilities. Research focuses on algorithms for the quantification and visualization of collective uncertainty at the squad level for mission command decision making. This effort also supports the monitoring and assessing of Soldier tactical readiness and effectiveness through technologies and approaches for opportunistic human sensing. ***FY 2020 Plans:*** Complete work on the mission monitoring and team workflow modeling capabilities effort; develop knowledge engineering (ontologies) and inferencing techniques to enable intelligent systems to draw conclusions about the state of the world and make recommendations for decision making; develop and document knowledge products capturing best-practices for the Cyber Mission Force in response to previously developed cyber-attacks and scenario events; initiate a decision-support technology research effort; create a decision aid to enable individuals and teams to respond more effectively to the cognitive challenges of networked operations and cyber domain by optimizing human-machine interactions; develop initial prototype development by integrating workflow and mission monitoring prototype with data sources; and apply tools in a representative mission environment. ***FY 2021 Plans:*** Will develop and document knowledge products capturing best-practices and frameworks for the creation and exploitation of a physiological time-series database to enable Soldier performance prediction; conduct experiments with advanced machine learning algorithms on physiological time-series data to quantify situational awareness and predict performance of the dismounted Soldier/Squad. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to support the Algorithms for Sensing Soldier in Mission Context and within this Project and PE 0602143A (Soldier Lethality Technology) / BC7 (Training Technology (Other than STE)).			
Title: Algorithms for Sensing Soldier in Mission Context ***Description:*** This effort investigates enhanced decision making under conditions of uncertain, complex, time sensitive, and dynamically changing information to optimize human-artificial intelligence (AI) shared situational understanding. Enhances operational performance of individuals and teams of Soldiers through novel visualization technologies that represent complex time-sensitive information in uncertain dynamic environments. ***FY 2021 Plans:***	-	-	1.448

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC3 / *Soldier Decision Making & Comms Performance Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop techniques for customized and intuitive visualizations to translate disparate and uncertain sources of complex, dynamic information into actionable knowledge for improved mission critical decision making. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned from the Soldier Performance in Sociotechnical Environments effort in this Project to enable the capability to enhance Soldier decision making by presenting critical data to the right Soldier at the right moment in the mission.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.489	-
Accomplishments/Planned Programs Subtotals	-	10.759	4.408

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BC6 / *Human Perf - Tech for Warfighter Enhancement*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC6: *Human Perf - Tech for Warfighter Enhancement*	-	0.000	2.676	3.023	-	3.023	3.392	1.418	1.376	1.390	0.000	13.275

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates and develops mechanisms for safely and effectively optimizing and enhancing Warfighter ability to shoot, move, communicate, and decide. These mechanisms have the potential to exploit the Soldier and Squad as the capability platform beyond materiel solutions provided to the individual and small unit. This project also conducts experiments to populate human performance models that enable tradespace analysis for portions of doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) analysis. This Project supports the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) joint Science and Technology program supported by the Office of the Secretary of Defense Close Combat Lethality Task Force.

This Project is also fully coordinated and complementary with the following Projects within PE 0602143A (Soldier Lethality Technology) / Projects BC2 (Next Gen Mobility & Lethality Tech for Warfighters), BB9 (Human Performance Tech for Mobility & Lethality), and BE3 (Joint Service Combat Feeding Technology). It directly supports the following projects within PE 0603118A (Soldier Lethality Advanced Technology) / Projects BC1 (Human Performance AdvTech for Mobility & Lethality), BB8 (Soldier Centric Advanced Technology), BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech)), and BE2 (Joint Service Combat Feeding Advanced Technology). It also has potential to inform material solutions within PE 0603118A (Soldier Lethality Advanced Technology) for the Soldier/Small unit.

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance. Work in this Project complements and is fully coordinated with research at the US Army Combat Capabilities Development Command Army Research Laboratory (ARL).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense Close Combat Lethality Task Force.

Work in this Project is performed by the United States Army Futures Command (AFC).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC6 / *Human Perf - Tech for Warfighter Enhancement*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Performance Technology for Warfighter Enhancement ***Description:*** This effort investigates mechanisms for exploiting human physiology to develop safe and effective interventions that create smarter, faster, more lethal Close Combat Warfighters. This work will result in a Soldier's ability to shoot, move, communicate, and decide faster than an adversary. Findings from these experiments will leverage existing systems and platforms to get the greatest human performance return in training and operations. ***FY 2020 Plans:*** Conduct neurostimulation experiments to determine efficacy for tactically relevant improvements in skill acquisition and Warfighting tasks; conduct experiments with a benchtop gut microbiome model to identify ration components that use the gut/brain connection to enhance and inform leap ahead gains in Soldier performance. ***FY 2021 Plans:*** Will conduct experiments to investigate the trade space for whom, when, and how neurostimulation is effective for improving tactically relevant skill acquisition and performance; compare and validate available neurostimulation systems for administration and efficacy for performance enhancement; validate the individualized Soldier benchtop gut microbiome model to determine inter and intra personnel variations for enabling higher precision recommendations for nutritional interventions that enhance Soldier performance via the gut/brain connection. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.554	3.023
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.122	-
Accomplishments/Planned Programs Subtotals	-	2.676	3.023

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC6 / *Human Perf - Tech for Warfighter Enhancement*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BC7 / *Training Technology (Other than STE)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC7: *Training Technology (Other than STE)*	-	0.000	0.000	14.155	-	14.155	14.421	14.690	14.830	14.782	0.000	72.878

Note

In Fiscal Year 2021 (FY21) this Project is realigned from:
Program Element 0602143A Soldier Lethality Technology
* Project BC3 Soldier Decision Making & Comms Performance Tech
* Project BE8 Synthetic Training Environment (STE) Technology
* Project BE9 STE Advanced Technology

A. Mission Description and Budget Item Justification

This Project investigates novel medical training simulations that address all levels of care through improvements in haptic feedback and automated performance assessments in support of Army medical Individual Critical Task Lists (ICTLs). This Project designs and develops early proof-of concept training systems to support non-traditional medical areas, such as dental training simulations. This Project conducts research in immersive virtual, mixed, and augmented reality environments that stimulate human senses (e.g. sight, sound, and touch) and also conducts experiments to understand how users interface with the technology in order to improve the realism of simulation environments and therefore create enhanced immersion and more effective training systems. Research is also conducted to support the modernization of the current Live Training Environment (LTE) to allow fair fight engagements across all training environments and training devices.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC) and at the Institute for Creative Technologies (ICT) University Affiliated Research Center (UARC) at the University of Southern California.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Medical Training Technology	-	-	3.695
Description: Included in this effort will be the development of new medical training simulations to train medical personnel across all levels of care. Improvements in haptic capabilities will ensure hyper bio-fidelity for all levels of care. Automated measures of student performance will support Army medical Individual Critical Task Lists (ICTLs). Research areas will also include more realistic tissue properties supporting part-task trainers and modular patient simulator systems. Initial exploration of Army ICTLs will result in early proof-of-concept development of proof-of concept training systems to support non-traditional medical areas, such as dental training simulations.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop haptics capabilities supporting augmented, mixed, and virtual reality by extending sense of hyper bio-fidelity and integrating emerging research into automated objective performance measures supporting Individual Critical Task Lists (ICTLs); develop proof-of-concept training systems to close capability gaps between current simulation technologies and ICTL requirements; validate usability studies and training effectiveness evaluations to gauge value of initial proof-of-concept development efforts; investigate updates to military medical training protocols (e.g., new emphasis on prolonged field care); develop research plans to include proof-of-concept development, usability studies, technology, and training effectiveness evaluations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to PE 0603118A (Soldier Lethality Advanced Technology) / BE9 (STE Advanced Technology) to support development of immersive visualization technologies for training.			
Title: Warfighting M/S Concepts and Design (ICT) ***Description:*** This Project designs and develops photorealistic synthetic environments, multi-sensory interfaces, artificially intelligent agents, and human performance assessment technologies to create virtual, augmented, and mixed reality simulation environments for training. This Project uses advanced modeling, simulation, and leadership development techniques to leverage the emerging immersive technologies of industry and the research and development community to advance the Army's capabilities. ***FY 2021 Plans:*** Will conduct research on immersive, virtual, mixed, and augmented reality environments that incorporate senses such as sight, sound, and touch; will develop tools, techniques and technologies to understand how users interface with technology to improve perceptions of immersion in simulated environments to create enhanced realism and more effective training systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to support PE 0602143A (Soldier Lethality Technology) / BE8 (STE Technology) to accelerate live training technology.	-	-	1.270
Title: Cyberspace Electromagnetic Activities (CEMA) Effects Modeling and Simulation ***Description:*** This effort investigates and develops capabilities to more accurately model and simulate Cyberspace Electromagnetic Activities (CEMA) necessary to support training events for Corps and below. ***FY 2021 Plans:***	-	-	1.460

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will mature cloud-based network simulation components to support collective Army cyber training events; determine standard data representations to tag information on simulated networks sufficient for training Information Warfare techniques relevant to the conduct of Multi-Domain Operations (MDO); investigate collective training measurement methods for CEMA training assessments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding was partially realigned from PE 0602143A (Soldier Lethality Technology) / BC3 (Soldier Decision Making & Comms Performance Tech).			
Title: Innovative Synthetic Training Technology ***Description:*** This effort investigates and designs methods of applying Artificial Intelligence (AI) into the STE to simulate a fully immersive environment in large urban settings with a population of adaptable, noncombatant virtual human agents for increasing the realism and complexity of training scenarios. In addition, it develops tools, techniques and technologies for improving the immersion of human senses within simulation environments with the goal of creating enhanced realism within the simulated environment. ***FY 2021 Plans:*** Will investigate neural networks and reinforcement learning techniques to simulate a ?fabric of Life? or fully immersive environment in a large urban setting with the population of adaptable, noncombatant virtual human agents to increase the realism and complexity of training scenarios; design and develop photorealistic synthetic environments, multi-sensory interfaces, artificially intelligent agents, and human performance assessment technologies to create virtual, augmented, and mixed reality simulation environments for training; investigate and design techniques and methods for integrating different sensory cues into virtual environments that result in enhanced training and leader development; and validate the design of virtual humans that embody natural language, gesture, gaze, and language understanding to simulate conversational speech within virtual humans. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602143A (Soldier Lethality Technology) / BE8 (Synthetic Training Environment Technology).	-	-	5.509
Title: STE Live Training ***Description:*** This effort investigates technology to enhance the fidelity of live training systems and investigates future live training capabilities for conducting force-on-force, combined arms exercises to enhance readiness at Army home stations and Combat Training Centers. ***FY 2021 Plans:*** Will investigate eBullet capability to simulate tactical engagements with realism equivalent (or near) to Infantry weapon systems; investigate capability to simulate combat vehicle ballistic fly-out of munitions to a precise point of impact on target and accurately	-	-	2.221

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
adjudicate weapon effects based on lethality/vulnerability models; investigate capability to simulate friendly and enemy combat vehicle vulnerability/lethality for battle damage assessment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	-	-	14.155

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BD1 / *Adv Soldier Sensors/Displays Tech for Dismounts*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BD1: *Adv Soldier Sensors/ Displays Tech for Dismounts*	-	0.000	4.967	11.467	-	11.467	12.059	16.118	16.298	16.300	0.000	77.209

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602709A Night Vision Technology
* Project H95 Night Vision And Electro-Optic Technology
PE 0602712A Countermine Systems
* Project H24 Countermine Tech

A. Mission Description and Budget Item Justification

This Project designs and develops low power, next generation modular sensor and display components for detection and identification of both threats and friendlies in all environments. Work in this Project supports the Army Science and Technology Soldier Lethality, Next Generation Combat Vehicle, and Future Vertical Lift modernization priorities as well as the Soldier Lethality Cross Functional Team (CFT) effort.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Soldier Sensors/Displays Technology for Dismounts	-	4.741	11.467
Description: This effort models, simulates, investigates, designs, and develops novel low power, modular electro-optic / infrared (EO/IR) and explosive hazard (EH) technologies, displays, augmented reality approaches and aided/automatic target detection and recognition algorithms that enable improved Soldier maneuver and lethality through greater information fidelity and automated algorithms to increase Soldier probability of recognition/identification and tracking of all threats. This effort is coordinated with PE 0603118A (Soldier Lethality Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603463A (Network C3I Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), and PE 0602145A (Next Generation Combat Vehicle Technology).			
FY 2020 Plans: Develop methods to model and simulate EO/IR system performance for computer-aided prototyping design models and augmented reality applications; model emerging active and passive EO/IR technologies, applications, and threats (e.g. hostile fire			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD1 / *Adv Soldier Sensors/Displays Tech for Dismounts*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and unmanned aerial systems) to support sensor system designs and combinations; investigate target acquisition performance measures to address EO/IR signature countermeasures; and validate performance of novel augmented and mixed reality software in a variety of environments. ***FY 2021 Plans:*** Will validate computer-aided prototyping design models and augmented reality (AR) applications; develop synthetic image generation techniques to enable optimized designs of advanced electro-optic / infrared (EO/IR) sensors and algorithms; mature components of virtual prototyping capabilities to support validation of sensor performance against various threats; model performance of advanced low-light sensors in multiple, simulated battlefield conditions; investigate designs for backside illuminated silicon (BSI) complementary metal-oxide-semiconductor (CMOS) to validate approaches for improved quantum efficiency (QE) in near-IR for advanced low light level imaging; develop low power, high performance application specific integrated chips (ASIC) to reduce the size, weight, power, and cost of solid state low light level sensors; develop readout integrated circuits (ROICs) with pixel bins that provide high resolution, high definition imagery in darkest conditions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase in funding from PE 0603118A (Soldier Lethality Advanced Technology) / BC9 (Adv Soldier Sensors/Displays AdvTech for Dismounts) to support acceleration of advanced low light sensors.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.226	-
Accomplishments/Planned Programs Subtotals	-	4.967	11.467

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BD6 / *Soldier Sys Interfaces/Integration-Sensor Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BD6: *Soldier Sys Interfaces/ Integration- Sensor Tech*	-	0.000	1.124	1.119	-	1.119	0.920	0.966	0.796	0.804	0.000	5.729

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing & Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs, and validates advanced technologies and algorithms for enhancing dismounted Soldier deployed robotics and autonomous systems used to improve the Small Unit's situational awareness, survivability, and lethality. Technologies to be investigated may include: algorithms for dismounted robotic systems to enable autonomous navigation, automated object recognition, persistent surveillance, launch and recovery from vehicles, networked lethality, manned-unmanned teaming, and collaborative behaviors; and advanced user interfaces to optimize human-robotic interaction during dismounted operations. These advanced technologies will enable Squad and Platoon level autonomous reconnaissance using robotic systems to minimize the operator's dedicated control of the systems and reduce their cognitive burden, thus allowing Soldiers to be more lethal and survivable.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0603118A (Soldier Lethality Advanced Technology) / Project BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech) and Project BC9 (Adv Soldier Sensors/Displays AdvTech for Dismounts).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier System Interfaces & Integration (Sensor Technology)	-	1.073	1.119
Description: This effort will investigate, design, and validate advanced dismounted Soldier robotic and autonomous systems technologies to enable autonomous navigation, manned-unmanned teaming, and networked reconnaissance to improve Soldier lethality, situational awareness, and survivability during tactical operations.			
FY 2020 Plans: Investigate and develop algorithms for dismounted Small Unit level Small Unmanned Aerial Systems (SUAS) to enable autonomous operations; investigate and design soldier-robotic user interfaces to minimize soldier dedicated control of robotic assets; investigate and develop modular robotics architectures to allow for a common platform to conduct validation of algorithms			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD6 / *Soldier Sys Interfaces/Integration-Sensor Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and enable integration of third party software and hardware components; and validate emerging technologies in controlled laboratory and simulated environments to assess functionality, reduce risk, and improve system design. ***FY 2021 Plans:*** Will investigate, design, and develop autonomous navigation algorithms, such as obstacle avoidance algorithms for fast flights and operations during night, to enhance the movement and maneuver of dismounted Small Unmanned Aerial Systems (UAS); investigate, design, and develop autonomous search and sensing algorithms to enable resource constrained Small UAS to perceive, detect, identify, and recognize objects in the environment; investigate, design, and develop mission and path planning algorithms and associated user interfaces for autonomous Small UAS; investigate, design, and develop algorithms to enable precision landing, recharging, and launch capabilities for Small UAS to enable extended operations; validate functionality of algorithms on open architecture Small UAS platforms in laboratory and simulated environment to reduce risk and improve system design. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.051	-
Accomplishments/Planned Programs Subtotals	-	1.124	1.119

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BD8 / *Soldier & Sm Unit Tactical Energy Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BD8: *Soldier & Sm Unit Tactical Energy Tech*	-	0.000	9.145	9.043	-	9.043	9.154	11.424	11.574	11.691	0.000	62.031

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices
* Project H11 Tactical and Component Power Technology
* Project H94 Elec & electronic Dev

A. Mission Description and Budget Item Justification

This Project conducts applied research and development on materials and component level power and energy technologies in the areas of energy storage, power generation, alternative energy, and intelligent power distribution and thermal management designs that support Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Soldier power needs to include next generation squad weapons and advanced optical devices and sensors. Enables future Soldier lethality and mobility for longer mission durations at lighter weights to provide enhanced lethality and tactical overmatch of adversaries, and to reduce the burden on the Soldier.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tactical Power for Soldier Lethality	-	3.692	3.695
Description: This effort investigates, designs, and develops innovative materials and component level power generation and energy storage technologies that support next generation weapons, sensors, radios, and human augmentation devices enabling Soldiers and Small Units to maximize probability of target hits, improve collective situational awareness, ensure multiple communication streams, and assist with tactical tasks in order to decrease Soldier load and power burden, and increase power capabilities by providing more energy to prolong mission run-time.			
FY 2020 Plans: Conduct lab-based experiments on advanced cathode materials and pairings to assess its ability to increase the runtime of Soldier borne devices in small, lightweight, flexible form factors; optimize Silicon Anode materials for both primary and rechargeable configurations to enable greater energy densities from 300-500 WH/Kg for Soldier and Small Units that require more Power & Energy, with longer runtimes, in distributed operations, with limited resupply; investigate and develop small, power generation			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD8 / *Soldier & Sm Unit Tactical Energy Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
devices that are powered by logistically available fuels to enable integrated Soldier borne/operated sensors and radios for critical applications; assess small, electromechanical components with greater efficiency and power density to support Soldier and Squad level battery recharging; investigate recoil, thermal and acoustic energy harvesting technologies that scavenge unused signatures from the Next Gen Squad Weapon to provide power for fire control technologies. ***FY 2021 Plans:*** Will develop Si-Anode based buttstock batteries (BSBs) for the Next Gen Squad Weapon that minimize weight and maximize energy; conduct component level Technology Readiness Level 5 verification and validation of these high capacity batteries in a laboratory environment; investigate advanced energy storage and power generation materials and components specifically targeted at increasing runtimes of digital Soldier devices; investigate energy storage, weight distribution, power distribution, and safety for the next generation squad weapons power/data rail and native battery; investigate advanced cathode materials and pairings to determine increase on the runtime of Soldier borne devices in small, lightweight, flexible form factors; mature components of small, power generation devices powered by logistically available fuels to enable integrated Soldier borne/operated sensors and radios for critical applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Materials & Component Technologies for Energy Independence ***Description:*** The effort develops technologies to substantially reduce the number of batteries required to accomplish dismounted Soldier/Squad mission objectives by developing more efficient power and thermal management for small systems and harvesting energy and alternative energy technologies thereby significantly reducing Soldier-borne load and logistics requirements for Soldier/Squad power and energy. ***FY 2020 Plans:*** Develop aqueous electrolytes and other high voltage electrolytes/additives for conformal, flexible, safe, abuse tolerant lithium ion and lithium metal batteries; research and develop a multifuel-fired power generator with high fuel efficiency and reduced noise signatures, emphasizing logistics fueled heat source, thermal selective emitter and photovoltaic cell; develop and design inductors and other power components using novel materials; explore technologies to harvest electrical power by converting and storing energy via kinetic, elastocaloric thermal materials and catalytic synthesis of fuel-like chemicals from indigenous resources; develop more efficient catalysts for carbon dioxide electroreduction to useful energy carriers; and develop higher efficiency plasmonic catalysts to catalyze the breakdown of fuels to produce usable energy. ***FY 2021 Plans:*** Will investigate optimized coupling between multifuel-fired heat sources and thermophotovoltaic converters for portable multifuel-fired power generators; research and develop multiplexed micro reactors and investigate at different scales for wearable or	-	5.037	5.348

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD8 / *Soldier & Sm Unit Tactical Energy Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
portable multifuel-fired power generator heat sources; develop flexible and safe aqueous/gel batteries and validate use in diversified application platforms for follow-on robustness studies; investigate the solvation, transport, liquid structure, and interface/interphase of multivalent cation electrolytes; further extend the new halide-graphite intercalation chemistry to multivalent cations; investigate devices based on a series of new materials and chemistries in both aqueous, non-aqueous, and hybrid systems; investigate reversible Martensitic phase transformations in solid-state cooling materials such as nickel-titanium alloys and new architectures, and conduct experiments with advanced characterization techniques to enable future high-performance and silent operation for applications related to directed energy, pulse power, and Soldier wearable cooling; fund research on blue whirl combustion technology for harvesting energy from a broad range of liquid fuels at a much higher efficiency than currently possible; determine new catalytic materials and pyrolysis reactor process in one-step to produce useful chemicals/fuels as energy scavenger for compact energy power sources for robotic autonomous systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.416	-
Accomplishments/Planned Programs Subtotals	-	9.145	9.043

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BE1 / *Support Technology to Mission Command*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE1: *Support Technology to Mission Command*	-	0.000	0.726	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.726

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project XW5 Small Unit Expeditionary Maneuver Technology

In FY21 this Project is being realigned to:
PE 0602146A Network C3I Technology
* Project AQ9 Expeditionary Data to Decisions Technology

A. Mission Description and Budget Item Justification

This Project investigates and designs technologies that support Soldier/Small Unit survivability, mobility, and combat effectiveness during mission command operations at operational and tactical levels in lethal and contested environments, enabling decentralized and dispersed operations in the future operating environment. This Project designs innovative mission command node platforms with enhanced mobility and agility, increased protection and survivability against electro-magnetic interference (EMI) and other threats, and rapid movement and emplacement, resulting in increased lethality and coordination of dispersed formations during operations and supporting resilient formations in multi-domain operations. Component technologies designed under this Project will transition to Advanced Technology Development efforts in the Soldier Lethality Modernization priority in support of decentralized and dispersed mission command operations in future operating environments and expeditionary maneuver in the Multi-Domain Operations Environment.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), and the following Projects within PE 0602143A (Soldier Lethality Technology): Project BB4 (Dismounted Soldier Survivability Materials), Project BD8 (Soldier & Sm Unit Tactical Energy Tech), Project AZ9 (Soldier Protection Advanced Tech - Detectability), PE 0603118A Soldier Lethality Advanced Technology / Project AZ8 (Soldier - Small Unit Detectability Adv Technology) and PE 0602712A (Countermine Systems) / Project H35 Camouflage and Counter-Recon Tech).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Small Unit Expeditionary Mission Command Research	-	0.693	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE1 / *Support Technology to Mission Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates and designs components of agile, modular, non-traditional Command Post platforms designed to enable the mission command network, supporting decentralized and distributed mission command operations in the future operating environment. Investigates material node platforms and other component concepts supporting rapid emplacement and displacement with enhanced survivability, mobility, signature management protection, and secured/non-degraded communication capabilities. Investigates and conducts experiments to validate component performance in a multi-domain battle operations. The large-footprint and logistics-intensive nature of current mission command systems compromise Soldier Lethality and mission effectiveness and do not provide the enhanced mobility and protection necessary to effectively execute mission command operations in the extremely expeditionary, multi-domain environment of the future. This research effort will enable tactical leaders to make timely decisions, integrate more seamlessly into the battlefield through a decrease in size, signature, and logistics burden, and will increase both maneuverability and survivability by enabling the development of agile Command Posts that support Multi-Domain Operations. ***FY 2020 Plans:*** Investigate tactical Command Post design and component concepts to identify individual component metrics that support mission command effectiveness based upon critical operational partner needs such as rapid emplacement, displacement and survivability in the future operating environment; conduct experiments on Command Post components for EMI protection and secure communications to validate component performance to allow defeat of adversary efforts to disrupt mission command operations, as well as to open and retain windows of advantage in the multi-domain environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** The funding in this effort was realigned to PE 0602146A (Network C3I Technology) / AQ9 (Expeditionary Data to Decisions Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.033	-
Accomplishments/Planned Programs Subtotals	-	0.726	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE1 / *Support Technology to Mission Command*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BE3 / *Joint Service Combat Feeding Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE3: *Joint Service Combat Feeding Technology*	-	0.000	3.996	4.109	-	4.109	4.073	4.764	4.817	4.817	0.000	26.576

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H99 Joint Service Combat Feeding Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops nutrient compositions and stabilization techniques to maximize the Warfighter's physical and cognitive performance on the battlefield, investigates technologies to enhance detection and identification capabilities of chemical and biological threats in foods, and develops innovative ration and field feeding technologies to reduce resupply requirements for the multi-domain battlefield. The Army serves as the Executive Agent for this Department of Defense (DoD) program, with oversight and coordination provided by the DoD Combat Feeding Research and Engineering Board.

Work in this PE is related to and fully coordinated with PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) to develop technologies and concepts; Army Additive Manufacturing Community of Practice to enable customization, increase readiness, and improve sustainment due to fabrication of end-use items at point of need; Office of the Assistant Secretary of Defense (OASD) Applied Research for Army Priorities (ARAP) to transition and develop materiel solutions in the synthetic biology and microbiome technical areas; Defense Health Agency (DHA) Joint Program Committee-5, which seeks to develop effective nutritional countermeasures against stressors and to maximize health, performance, and well-being; and Office of Navy Research (ONR) PE 0601153N Defense Research Sciences Biosciences program to evaluate nutritional countermeasures to physiological environmental extremes.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Joint Service Combat Feeding Technology	-	3.815	4.109
Description: This effort investigates, designs, and develops nutrient compositions and stabilization techniques to maximize the Warfighter's physical and cognitive performance on the battlefield. The effort investigates technologies to enhance detection and identification capabilities of chemical and biological threats in foods and develops innovative ration and field feeding technologies to reduce resupply requirements. Work in this area results in increased performance, less food-borne illness, and overall increased readiness of the Warfighter.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE3 / *Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Identify and test nutritional interventions that prevent performance decrements associated with known degraded immune function and consequential weight loss in extreme environments; identify and test novel prophylactic nutrition to mitigate or prevent cause of illness in deployed troops globally such as gastrointestinal dysbiosis that affects operational readiness; investigate and design nutrient stabilization techniques to retain or improve quality of products when stored/utilized in environmental extremes and multi-domain battlefields to ensure that nutrients required for optimal performance are both retained and are bioavailable at the point of consumption; transition weight reduction concepts for Close Combat Assault Ration formulations for advanced technology demonstration; investigate chemical agent permeability in ration packaging in support of Chemical Biological Radiological Nuclear and Energy (CBRNE) threats; transition novel energy ration components to advanced development; develop and model food formulations that retain desired sensory and organoleptic (appearance, odor, flavor, texture) characteristics after processing, storage and distribution to enable the customization of nutrients tailored to each individual warfighter?s need based on real time health status and operational scenario for rapid recovery and/or mission preparation. ***FY 2021 Plans:*** Will continue investigation of nutritional factors affecting immune function and muscle recovery, and perform ex-vivo experimentation to identify gut microbiome effects on immune, gastrointestinal, and neurological health for preventing performance decrements in deployed troops; validate lipid oxidation analysis techniques to improve monitoring ability in ration components and ensure optimized nutrition; identify effects of high fat intake on physical performance to ensure optimal nutrient profiles in weight reduced rations; investigate microbial response to vacuum microwave drying and antimicrobials effects on Salmonella to maintain food safety; mature component technologies for reagent-less biosensors to decrease logistical burdens in multi-domain operations; continue investigation of food product production with additive manufacturing; and design and develop ration packaging system to improve cost and efficiency. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.181	-
Accomplishments/Planned Programs Subtotals	-	3.996	4.109

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE3 / *Joint Service Combat Feeding Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE6: *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	-	0.000	2.745	6.317	-	6.317	3.021	3.153	3.555	3.591	0.000	22.382

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project H84 Materials

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and assesses a variety of bio-based materials through the application of biotechnology advances to develop material capabilities that respond and adapt to a wide range of external stimuli and biological processes for protection, situational awareness, and sustainment. Innovative materials will be sought that are capable of sensing and responding, as well as adapting response, to a broad spectrum of environmental variables. Research will develop materials that are able to self-monitor, self-heal, and self-sustain. Research will explore new biology-based methods for controlled synthesis and assembly to create materials with precise chemistries, microstructures, properties, and responsive functionalities through controlled molecular placement, spatial architectures, and interfacial structures. These materials have potential to enable more survivable, situationally aware, lighter weight Soldier systems and electronics. Research conducted focuses on unique and/or novel material properties, developing models, materials characterization techniques, non-destructive testing methods and advanced fabrication/processing methodologies.

Work in this PE complements PE 0601102A (Defense Research Sciences) / Project AA3 (Single Investigator Basic Research), Project AA3 (Single Investigator Basic Research), Project AA7 (Mechanics and Ballistics), and Project AA5 (Biotechnology and Systems Biology) and informs PE 0603118A (Soldier Lethality Advanced Technology) / BB3 (Dismounted Soldier Survivability Equip/Tech Integ).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Bio-enabled Materials and Processes	-	2.621	2.984
Description: This effort conducts applied research through the application of biotechnology advances to develop materials with capabilities to respond and adapt to a wide range of external stimuli and biological processes. Investment in bio-enabled materials research allows for the design of materials that are capable of sensing and responding, as well as adapting to a broad spectrum of environmental variables with the ability to self-monitor, self-heal, and self-sustain. Investments in this area could lead to future			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
applications in Soldier performance, situational awareness, protection and sustainment. Research from this effort has potential to transition to multiple end items and applications. ***FY 2020 Plans:*** Investigate the integration of rapidly selected peptide reagents for applications in improved sensors for human performance and situational awareness; investigate a more information-driven peptide reagent design process drawn from previous studies; and design and synthesize biological materials, including a focus on diatoms for improved logistics, increased robustness and new capabilities in gradient / hierarchical materials with nanoscale resolution of features to control optical, structural and reactive performance for potential application in adaptive coatings for vehicles. ***FY 2021 Plans:*** Will investigate chemically and structurally diverse biological building blocks (peptide-based) for advanced sensing applications, protection, and interface/assembly of hierarchical materials; investigate advanced coatings and materials assembly utilizing bio-derived and bio-composite materials for advanced sensing and protection (e.g. situational awareness, counter-biocorrosion, and biological inhibitors) and electro-magnetic applications such as antennas, lenses, and optically triggered skins/coatings; identify targets and design strategy for accelerated degradation of high value assets (electronic components, protective coatings), logistics reduction (e.g., accelerated repair and reclamation of rare-earth elements), and next generation anti-tamper technologies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to further investigate novel molecular biology.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.124	-
Title: Scalable and On-Demand Production of Novel Molecules ***Description:*** This effort conducts applied research through the investigation of new methods to produce novel biological molecules. Typical customized molecule production is extremely expensive and difficult to achieve. Investment in synthetic biomanufacturing techniques will further the applicability and widespread use of novel molecules to further Warfighter performance.	-	-	3.333

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2021 Plans: Will investigate computational and experimental tools facilitating the use of molecular biology to produce novel molecules of interest. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to maximize gains from unanticipated acceleration in this technology area.			
Accomplishments/Planned Programs Subtotals	-	2.745	6.317

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BE8 / *Synthetic Training Environment (STE) Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE8: *Synthetic Training Environment (STE) Technology*	-	0.000	15.438	14.133	-	14.133	16.207	15.787	15.963	15.964	0.000	93.492

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602308A Advanced Concepts and Simulation
* Project C90 Advanced Distributed Simulation
* Project D02 Modeling and Simulation For Training And Design
PE 0602716A Human Factors Engineering Technology
* Project H70 Human Factors Eng Sys Dev

A. Mission Description and Budget Item Justification

This Project designs and develops technologies supporting the Army's Synthetic Training Environment (STE). The Synthetic Training Environment (STE) is the next generation holistic collective training capability that will train units where they will fight, with whom they will fight with, and in complex operational environments to include dense urban and sub-terrain; within the entire range of combined arms maneuver tasks in support of Multi- Domain Operations. STE Information Systems (STE-IS) delivers the Common Synthetic Environment consisting of Global Terrain/One World Terrain (OWT), Training Simulation Software (TSS), and Training Management Tools (TMT). The STE will be available where training occurs (home station, combat training centers, armories, institutions, shipboard, deployed) and will include Air and Ground Reconfigurable Virtual Collective Trainers (RVCTs), a Soldier/Squad Virtual Training (S/SVT), and a live training capability. The STE will be cloud-enabled, compatible with the Army Enterprise Network, and service-based through the Common Operating Environment, including Live and Constructive. The STE will provide the realistic repetitions necessary to fight 25 bloodless battles before the first battle; a Secretary of Defense priority.

This effort is coordinated with work done in PE 0603118A (Soldier Lethality Advanced Technology) / Project BE9 (Synthetic Training Environment (STE) Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy and supports the STE Cross Functional Team efforts.

Work in this Project is performed by the United States Army Futures Command (AFC) and at the Institute for Creative Technologies (ICT) University Affiliated Research Center (UARC) at the University of Southern California

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Innovative Synthetic Training Technology	-	7.845	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates and designs methods of applying Artificial Intelligence (AI) into the STE to simulate a fully immersive environment in large urban settings with a population of adaptable, noncombatant virtual human agents for increasing the realism and complexity of training scenarios. In addition, develops tools, techniques and technologies for improving the immersion of human senses within simulation environments with the goal of creating enhanced realism within the simulated environment. ***FY 2020 Plans:*** Investigate artificially intelligent individuals and groups of virtual humans as role-players to support increased scenario complexity and social interactions with trainees and reduce the need for costly live role-players and simulation support teams; develop artificially intelligent virtual humans with adaptable human behaviors driven by their own beliefs, desires, and intentions; apply methods for natural language understanding allowing for social dialogue with the virtual humans. Expand and apply knowledge in cognitive architectures, social simulations, and virtual human research areas to provide design, development, and improvement of new technology products focused on the accurate and immersive inclusion of the human dimension in virtual and mixed reality context. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to PE 0602143 (Soldier Lethality Technology) / BC7 (Training Technology (Other than STE)).			
Title: STE One World Terrain ***Description:*** This effort investigates and designs tools and methods to improve the speed and fidelity of a terrain capability that provides a representation of the globe, fully accessible through the Army network and usable by all simulation trainers; develops complex representations (including megacities and subterranean) of the operational environment and the Multi-Domain battlefield in synthetic training environments. ***FY 2020 Plans:*** Research alternative data sources for applicability to modeling & simulation (M&S), with emphasis on providing accurate representation (geometry) and visuals (quality at ground level); investigate alternative data sources to improve availability of rich data for next-generation terrain representation; research data fusion techniques by exploiting data sources and processed data to demonstrate a behavior pattern of disparate data over the same geographic area, initiating the need for automated processes to combine and de-conflict different data into a single, consistent dataset for end-use applications; and develop tools and procedures for merging data sources into a single, consistent dataset. ***FY 2021 Plans:*** Will develop a whole world terrain at low to medium resolution using available data; evaluate alternative data sources to fill gaps; develop tools to rapidly process source data into a single representation that serves all application needs; develop and investigate	-	1.934	5.832

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
a processes for generating fully attributed hi-resolution terrain insets such as underground geometry, key civilian infrastructure components, complex road networks, hydrological features, and complex structures. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to further experiments testing the data gathering and integration necessary to build the One World Terrain.			
Title: STE Training Management Tool ***Description:*** This effort investigates Adaptive Training (AT) methods to facilitate authoring, distribution, management, and evaluation of tailored instruction for both individuals and teams; and evaluates the impact of training and educational tools / methods on comprehension, reasoning, learning, performance, retention, and transfer of knowledge and acquired skills to assess Training Effectiveness (TE) in Synthetic Training Environments. ***FY 2020 Plans:*** Validate a base authoring concept for adaptive training; expand concepts for authoring tools, team modeling, team instruction, and Army team domains to support the development of team (unit level) tutoring systems; mature training strategies for autonomous software systems; and develop tools to rapidly author scenario variants to customize training. Develop models and tools for automated measurement of critical training outcomes for selected individual and collective tasks; and explore and identify new sensors for measuring effectiveness in collective training events. ***FY 2021 Plans:*** Will design and develop natural language artificial intelligence (AI) processing techniques for small team verbal communications during task execution; develop proof of principle for automating team performance assessments and for actionable automated after action review (AAR) feedback to teams, leaders, and instructors; develop a robust intelligent team adaptive training capability to maximize training outcomes at point of need; develop AI methods grounded in learning science to support self-optimizing systems that produce skill retention and transfer into the operational environment; conduct experiments to validate team performance measures; assess the effectiveness of different machine learning approaches to facilitate automated authoring of scenario based training for individuals and teams; develop models for assessing competencies of individuals and teams using a combination of live, virtual, and constructive training events in militarily relevant domains; investigate the use of physiological measures as a means of improving automated adaptation of training and for assessing training outcomes, predicting training transfer, and providing real-time feedback to instructors and students during the execution of individual and collective training. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	4.958	5.291
Title: STE Training Simulation Software	-	-	3.010

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort designs and develops technologies that support Multi-Domain Operations modeling and maturing of simulation configuration and scalability components for collective training. In addition, designs and develops technologies that allow the synthesis of robust military behaviors that enable the scaling of Synthetic Training Environment (STE) collective training configurations and delivery to the Point of Need through the exploitation of emerging computing and networking technologies that optimize computing architectures for integrating components (models, behaviors, data, etc.) of the Training Simulation Software (TSS). ***FY 2021 Plans:*** Will investigate autonomous, artificially intelligent agents that adapt to changing battlefield conditions, friendly forces, non-combatants, and enemy threats in a military relevant virtual training environment; investigate multi-resolution modeling applications such as Live, Virtual, and Constructive (LVC) experimentation utilizing AI enabled attributes; and design and develop cutting-edge M&S methods to enable the reuse and development of new Army and Department of Defense (DoD) STE-ready models for Multi-Domain Operations in support of System of Systems (SoS) analysis, experimentation, technology tradeoffs, capability assessments, concept development, and training. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increased from PE 0602145A (Next Generation Combat Vehicle Technology) / BF6 (Crew Augmentation and Optimization Tech) to support AI based development efforts for intelligent character behaviors.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.701	-
Accomplishments/Planned Programs Subtotals	-	15.438	14.133

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BP9 / *Soldier Lethality Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BP9: *Soldier Lethality Technologies (CA)*	-	0.000	30.626	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.626

Note

Congressional Interest Item funding provided for Soldier Lethality Technologies.

A. Mission Description and Budget Item Justification

This project is for congressional increases that support applied research in support of Soldier Lethality, where the Soldier and Squad are treated as an integrated combat platform. The fundamental challenge is to overcome an erosion in close combat overmatch relative to the pacing threats identified in the National Defense Strategy. This program increase leverages science, technology, and human potential to achieve the overmatch necessary to maneuver, isolate, and defeat our adversaries in any environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Medical simulation and training	-	3.626
FY 2020 Plans: Medical simulation and training		
Congressional Add: Active and passive camouflage concealment and deception	-	3.000
FY 2020 Plans: Active and passive camouflage concealment and deception		
Congressional Add: Human systems integration	-	10.000
FY 2020 Plans: Human systems integration		
Congressional Add: Expeditionary mobile base camp technology	-	2.000
FY 2020 Plans: Expeditionary mobile base camp technology		
Congressional Add: SOCOM communications capability	-	2.500
FY 2020 Plans: SOCOM communications capability		
Congressional Add: Soldier Lethality Technologies Program Increase	-	5.000
FY 2020 Plans: Soldier Lethality Technologies Program Increase		
Congressional Add: Harnessing Emerging Soldier Lethality Technology Research	-	4.500
FY 2020 Plans: Harnessing Emerging Soldier Lethality Technology Research		
Congressional Adds Subtotals	-	30.626

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BP9 / *Soldier Lethality Technologies (CA)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BR9 / *Personnel & Airdrop Safety Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
BR9: *Personnel & Airdrop Safety Technology*	-	0.000	4.098	3.725	-	3.725	3.519	3.951	3.615	3.615	0.000	22.523

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project XW5 Small Unit Expeditionary Maneuver Technology

A. Mission Description and Budget Item Justification

This Project funds the research and investigation of component technologies to enhance cargo and personnel airdrop capabilities for global precision delivery, rapid deployment, and insertion for force projection into hostile regions. Areas of emphasis include parachute technologies, parachutist injury reduction, precision offset aerial delivery, soft landing technologies, and airdrop simulation. Technologies support the Soldier Lethality Army Modernization Priority. New operational concepts call for increased precision of personnel and cargo in austere environments in which small units are dispersed and logistical supply is limited. The Army requires enhanced payload extraction and other increased capabilities to support the airdrop requirement for current and future vehicles exceeding aircraft payload weight capacity. TheU.S. Army Airborne Board (Chaired by the XVIII Airborne Corps Commanding General) identified increased payload capabilities as a critical requirement to support the mission readiness profile for the Global Response Force (GRF), and will support Joint Forcible Entry requirements while maximizing the capacity of a C-17 aircraft.

Work in this Project supports key Army needs and complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project BD6 (Soldier Sys Interfaces/ Integration- Sensor Tech), and PE 0603118A (Soldier Lethality Advanced Technology) / Project BE5 (Personnel & Airdrop Safety Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Personnel & Airdrop Safety Technology	-	3.912	3.725
Description: This effort investigates technologies that enhance payload extraction, which will allow current vehicles to be dropped with more armor and support equipment, and reduce the design constraint on future vehicles that have airdrop as an operational requirement, increase parachute gliding capabilities, and mature delivery accuracy of cargo aerial delivery systems that support varying payload weights. Research in the area of novel parachute materials will provide increased capabilities for cargo and personnel aerial delivery systems. This effort will support an investigation of new Modeling and Simulation (M&S) tools in order to develop validation methods for airdrop concepts. This effort also investigates technologies that advance airborne personnel			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BR9 / *Personnel & Airdrop Safety Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
insertion safety requirements to modernize the Airborne Soldier and provide the ability to effectively execute the airborne mission through reducing safety risk and increasing capabilities. ***FY 2020 Plans:*** Explore multi-modal sensing methods and control techniques to study the efficacy of precision aerial delivery via a variety of decelerator systems deployed via conventional and non-traditional methods in GPS denied/degraded and anti-access / area denial (A2/AD) environments to address future operational challenges; investigate augmentation of personnel airdrop systems to enhance airborne jumper performance while expanding operational footprint opportunities; conduct experiments fundamental to understanding aerodynamic characteristics of airdrop systems; and develop advanced modeling techniques applicable to the full spectrum of the acquisition process to improve airdrop safety and reduce the cost of future development efforts. ***FY 2021 Plans:*** Will conduct research into sensing technologies that augment personnel or autonomous cargo airdrop systems, enabling accurate, reliable insertion and resupply missions across a broad scope of operational conditions and non-traditional airdrop environments; examine new parachute designs and avionics necessary to facilitate maximum mission effectiveness conducted across an array of technologies and modalities using analytical, numerical, and experimental methods. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.186	-
Accomplishments/Planned Programs Subtotals	-	4.098	3.725

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A