Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Air Force											Date: May 2017	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	24.094	26.492	33.635	0.000	33.635	36.737	37.824	36.510	37.338	Continuing	Continuing
635323: *Directed Energy Bioeffects Parameters*	-	2.375	4.909	5.388	0.000	5.388	5.290	5.193	5.320	6.650	Continuing	Continuing
635324: *Human Dynamics and Terrain Demonstration*	-	6.274	6.759	5.432	0.000	5.432	5.449	5.930	6.046	7.500	Continuing	Continuing
635325: *Mission Effective Performance*	-	10.444	10.141	6.626	0.000	6.626	6.846	6.982	7.122	7.265	Continuing	Continuing
635327: *Warfighter Interfaces*	-	5.001	4.683	16.189	0.000	16.189	19.152	19.719	18.022	15.923	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to enhance Airman performance and effectiveness in the aerospace force. State-of-the-science advances are made in warfighter training, warfighter system interfaces, directed energy bioeffects, deployment and sustainment of warfighters in extreme environments, and understanding and shaping adversarial behavior. The Directed Energy Bioeffects Parameters project develops, demonstrates, and transitions technologies to predict, evaluate, and mitigate the effects of directed energy on personnel and mission performance, and exploits the offensive capabilities of directed energy systems. The Human Dynamics and Terrain Demonstration project develops, demonstrates, and transitions human-centric technologies to address processing, exploitation, and dissemination of intelligence, surveillance, and reconnaissance (ISR) capability needs. The Mission Effective Performance project develops, demonstrates, and transitions advanced training, simulation, mission rehearsal, and other performance-aiding methods and technologies to enhance warfighter readiness. The Warfighter Interfaces project develops, demonstrates, and transitions technologies to revolutionize the way airmen synergistically use Air Force systems, including autonomous machines and adaptive teams of airmen and machines. Efforts in this program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 3, Advanced Technology Development because this budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Air Force					Date: May 2017
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	25.448	26.492	22.811	0.000	22.811
Current President's Budget	24.094	26.492	33.635	0.000	33.635
Total Adjustments	-1.354	0.000	10.824	0.000	10.824
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-0.688	0.000			
• SBIR/STTR Transfer	-0.666	0.000			
• Other Adjustments	0.000	0.000	10.824	0.000	10.824

Change Summary Explanation

Increase in FY 2018 due to increased emphasis on autonomy and human-machine teaming.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*	Project (Number/Name) 635323 / *Directed Energy Bioeffects Parameters*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635323: *Directed Energy Bioeffects Parameters*	-	2.375	4.909	5.388	0.000	5.388	5.290	5.193	5.320	6.650	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops, demonstrates, and transitions technologies to predict, evaluate, and mitigate the effects of directed energy on personnel and mission performance, and exploits the offensive capabilities of directed energy systems. This project also develops the human components of the guidelines for testing, deployment, and protection from high power microwave and high energy laser systems and uses this information to enhance the effectiveness of these weapon systems in air, space, and cyber operations. The optical radiation bioeffects thrust develops and demonstrates technologies that counter optical threats, while exploiting optical systems for directed energy weapons applications. The radio frequency (RF) radiation bioeffects thrust develops and demonstrates technologies to assess RF bioeffects and collateral hazards from high power RF directed energy systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Optical Radiation Bioeffects	1.558	3.550	4.324

Description: Develop and demonstrate optical protective technologies for aircrew and ground personnel to provide protection against directed energy threats. Develop modeling capabilities to assess collateral hazards from high power directed energy laser systems.

FY 2016 Accomplishments:

Completed initial demonstration of physiological/behavioral response model in engagement-level simulation within distributed simulation and Air Force modeling and simulation architecture for overall weapons evaluations. Completed initial demonstration of human vulnerability model built within a DoD standardized format and continued additional component development, integrating vision effects along with probability of eye and skin injury. Completed effort to design probabilistic risk assessment tools for lasers. Extended laser eye protection (LEP) evaluations to perform night visor aircrew acceptance testing, including laboratory testing, and ground and flight assessments.

FY 2017 Plans:

Further integration of physiological/behavioral response models into engagement-level simulation capabilities for directed energy weapon threats and concepts. Validate and demonstrate modeling and simulation tools which transition engagement-level simulations to mission and campaign models to evaluate the utility and impact of directed energy systems. Develop human systems integration modeling tools for laser eye protection devices. Evaluate new technologies for laser eye protection.

FY 2018 Plans:

Support low-power ground testing as part of Self-Protect High Energy Laser Demonstrator (SHiELD) Advanced Technology Demonstration (ATD). The SHiELD ATD will be supported in order to assess concepts of operation risks from laser exposures

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635323 / *Directed Energy Bioeffects Parameters*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
and in order to ensure test safety. Activities will include the integration of simulation capabilities as well as validation of predictive laser bioeffects models. Develop probabilistic risk assessment tools to evaluate hazards and effectiveness of developing laser weapons. Continue mission assessment of campaign mission with simulations involving directed energy threat and concept assessment. Complete assessment of threshold level damage effects on physiological/behavioral responses using in-house models. Complete assessment of block 3 laser eye protection capability with prediction metrics for next spiral in acquisition.			
Title: Radio Frequency Bioeffects ***Description:*** Develop and demonstrate technologies to assess RF bioeffects and collateral hazards from high power RF directed energy systems. ***FY 2016 Accomplishments:*** Developed fast (near real-time) anatomy and physiology-based computational tool for RF-induced thermal response. Completed prototype high peak power effects model integration into software suite and began verification and validation studies. Increased efficiency of human posing and morphing for electromagnetic analysis. ***FY 2017 Plans:*** Continue verification and validation studies for high peak power effects model in support of next-generation counter-electronics weapons. Develop and validate a model of effects of low gigahertz radiation. Inform development of fire control technology for millimeter wave and high power microwave technologies based on safety and effectiveness. ***FY 2018 Plans:*** Complete validation of a high average power bio-heat dosimetry model. Continue verification and validation of thermal effects models for high average power systems. Initiate fast thermal gradient effects model, and validation of dosimetry model. Continue development of fire control algorithms for millimeter wave technology, and initiate development of system training software in preparation for distributed simulation events.	0.817	1.359	1.064
Accomplishments/Planned Programs Subtotals	2.375	4.909	5.388

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635323 / *Directed Energy Bioeffects Parameters*

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*	Project (Number/Name) 635324 / *Human Dynamics and Terrain Demonstration*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635324: *Human Dynamics and Terrain Demonstration*	-	6.274	6.759	5.432	0.000	5.432	5.449	5.930	6.046	7.500	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops, demonstrates, and transitions technologies to identify human threats within the air, space, and cyber domains. These technologies will enhance Air Force capabilities in ISR, layered sensing, autonomous and adaptive decision-making systems, decision aids for computer network attack/defense/support, ISR force development and training, cross-cultural communication, human-centric exploitation of measurement and signatures intelligence, and advanced molecular diagnostic methodologies to assess airman performance.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Human Analyst Augmentation	4.319	4.215	3.717
Description: Develop and demonstrate human-centered design processes and operational tools that optimize ISR information exploitation and analysis.			
FY 2016 Accomplishments: Demonstrated initial analytical work environments and toolsets to advance performance for ISR work roles in contested environments that span the processing, exploitation, and dissemination process from time-dominated tactical work situations to content-dominated operational and strategic reach back operations.			
FY 2017 Plans: Develop analytical work environment concepts to support advanced multi-intelligence analysis. Demonstrate airmen-centered tools for future distributed ground processing concepts. Assess efficacy of new concepts, methodologies, and tools.			
FY 2018 Plans: Develop human-machine collaboration and automation technologies to improve work efficiency and product quality of ISR analysts. Preparing for transition speech-to-text technologies to the Air Force Distributed Common Ground Station architecture.			
Title: Human Trust and Interaction	1.206	2.044	1.715
Description: Develop and demonstrate machine translation and speech-to-text tools to support the span of Air Force mission areas including ISR and cyber operations.			
FY 2016 Accomplishments: Demonstrated and tested advanced multimedia machine translation and automatic speech recognition tools.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635324 / *Human Dynamics and Terrain Demonstration*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigate advanced multimedia translation and automatic speech recognition tool applications in military environments for mission focus areas and domains. ***FY 2018 Plans:*** Improve automatic speech recognition and machine translation results by incorporating context, including techniques for actively learning unknown words, and providing multilingual search capabilities to increase the task throughput of human operators performing intelligence, surveillance, and reconnaissance.			
Title: Human Signatures ***Description:*** Develop automated and assisted methods to exploit human threat biosignatures to defeat terrorist activities and hidden person-borne threats. Provide improved models of virtual humans to deliver mission-ready training for ISR analysts and create more immersive, realistic experiences in joint and coalition exercises. ***FY 2016 Accomplishments:*** Investigated integration of normative anthropometric-based human signatures algorithms into sensor system processors. ***FY 2017 Plans:*** Integrate human detection algorithm to provide operators with real-time counts of gender and age differentiation into operationally relevant sensor applications. ***FY 2018 Plans:*** No current plans as funding has been reallocated in FY18 to support AFRL Autonomy Initiative.	0.749	0.500	0.000
Accomplishments/Planned Programs Subtotals	6.274	6.759	5.432

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*	Project (Number/Name) 635325 / *Mission Effective Performance*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635325: *Mission Effective Performance*	-	10.444	10.141	6.626	0.000	6.626	6.846	6.982	7.122	7.265	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops, demonstrates, and transitions advanced training, simulation, mission rehearsal, and other performance-aiding methods and technologies to enhance warfighter readiness. This project also develops advanced methods and technologies to enable interactive live, virtual, and constructive (LVC) environments for performance-aiding methods and technologies. Focus areas include integrated high-fidelity weapon systems training technologies for air, space, and cyber; tailored immersive simulation environments for airmen at the tactical and operational levels; and incorporation of performance assessment and feedback tools. These methods and technologies facilitate the development of mission-essential competencies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Continuous Learning	10.444	10.141	6.626
Description: Develop and demonstrate secure, persistent, and standardized LVC training enterprise. Utilize modeling capabilities for technology demonstration efforts focused on developing software-based tools for training that would replace human instructors. This enables more efficient mission execution training in an LVC environment.			
FY 2016 Accomplishments: Completed operational trials of integrated LVC operations training and assessment methods in large force exercise. Demonstrated shareable content and metrics in joint and coalition mission training contexts. Began development of reusable models for improving adversary realism in distributed mission operations (DMO) and LVC environments. Demonstrated deployable LVC training in integrated manned and unmanned aircraft and ground operations exercise. Began development of scenario and metrics specifications and standards for deployable LVC operations.			
FY 2017 Plans: Begin definition of standards for sharable scenario content, data, models, and metrics across a range of military operations. Transition fast jet learning management system into routine operational training and to an alternate research domain. Begin development of methods to create adaptive learning environments across multiple missions contexts. Define studies to evaluate efficiencies to be derived from the creation and use of more sharable scenario content models and metrics in LVC testbeds.			
FY 2018 Plans: Continue standards definition for sharable scenario content, data, models, and metrics across a range of military operations. Demonstrate learning management system in a series of LVC testbeds. Continue development of methods to create adaptive			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635325 / *Mission Effective Performance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
learning environments across multiple missions contexts. Execute evaluation studies on sharable scenario content models and metrics in LVC testbeds.			
Accomplishments/Planned Programs Subtotals	10.444	10.141	6.626

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603456F / *Human Effectiveness Advanced Technology Development*	Project (Number/Name) 635327 / *Warfighter Interfaces*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635327: *Warfighter Interfaces*	-	5.001	4.683	16.189	0.000	16.189	19.152	19.719	18.022	15.923	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops, demonstrates, and transitions technologies to revolutionize the way airmen optimize the capabilities of Air Force systems, including autonomous machines and adaptive teams of Airmen and machines. Improvements in the presentation of operational information to the community of users, from the system operator to the commander, must be developed in step with advancements in the acquisition, storage, and retrieval of information. This project provides the advances in understanding of human cognitive abilities, as well as the utilization of human interfaces, multisensory fusion, high-resolution image displays, and three-dimensional (3-D) audio to customize communications and enhance shared understanding across a diverse user community in air, space, and cyber for maximum situational awareness.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Applied Neuroscience	0.437	0.000	0.000
Description: Develop sense, assess, and augment technologies to facilitate efficient workflow in distributed operational environments. Develop empirically validated cyber operator-centered tools for distributed cyber operations integrated into a single user interface. ***FY 2016 Accomplishments:*** Verified and validated design recommendations for an integrated offensive and defensive cyber operator tool set. Finalized design of neurophysiological-based Airman performance sensor suite. Refreshed sensors, methodologies, and approaches to assess operator functional state relating to stress, cognition, trust, and airman-machine teaming. ***FY 2017 Plans:*** No FY17 plans due to reallocation of funds to support AFRL Autonomy Initiative and BATMAN III ***FY 2018 Plans:*** No FY18 plans due to reallocation of funds to support AFRL Autonomy Initiative and BATMAN III			
Title: Battlespace Acoustics	2.984	3.073	4.071
Description: Demonstrate ability to forecast acoustic profiles for any atmospheric/terrain condition. Demonstrate technologies to enhance the battlefield Airman's situational awareness through wearable interfaces. ***FY 2016 Accomplishments:*** Validated real-time 3-D acoustic models into mission planning tools. Evaluated high-fidelity 3-D acoustic models against real-world data obtained from airborne platform measurements in different weather and terrain environments. Conducted human panel			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635327 / *Warfighter Interfaces*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
validation studies of weather effects, landscape sounds, and geography used in developed acoustic models. Initiated applications of physiological sensors, usability engineering methodologies to prototype and test innovative solutions required for battlefield airmen and pararescue jumpers. ***FY 2017 Plans:*** Transition real-time 3-D acoustic models into mission planning tools. Transition high-fidelity 3-D acoustic models against real world data obtained from airborne platform measurements in different weather and terrain environments. Model and validate (through human listener studies) the impact of weather, landscape, and geography on acoustic propagation. Evaluate applications of physiological sensors and human performance assessment technologies for the battlefield airmen and pararescue jumpers. Refresh usability engineering methodologies to prototype and test innovative solutions required for battlefield airmen and pararescue jumpers. ***FY 2018 Plans:*** Transition real-time acoustic mission planning capability to enhance training and optimize mission effectiveness. Develop advanced interfaces for real-time interaction with acoustic models of listening environments to enhance warfighter situational awareness and effectiveness. Employ advanced usability engineering methodologies for rapid prototyping, testing and seamless integration of innovative technologies into tactical ensembles supporting Battlefield Airmen and Pararescue operations. Transition enhanced, man-wearable communication systems, mobile interfaces, and physiological sensors to enhance situation awareness, improve training, and support real-time battlespace monitoring for dismounted operators.			
Title: Human Role in Semiautonomous Systems ***Description:*** Develop and demonstrate an integrated human-centered interface to control multiple Remotely Piloted Aircraft (RPA) that have various levels of autonomy and that optimize net-centric information flow. Develop and demonstrate manned-unmanned interaction and team concepts for tactical environments. ***FY 2016 Accomplishments:*** Fostered advancements in the design, demonstration, and evaluation of novel airman interface designs that support decision-making and situation awareness while controlling multiple RPAs in a highly dynamic mission environment. Performed final evaluations of multi-transit control station interface technologies that will enable a single Airman to simultaneously control multiple, heterogeneous RPAs transiting through airspace by using high-fidelity simulations and flight tests. Delivered mature prototype of RPA transit operations workstation. Enhanced and evaluated initial designs of interfaces for a networked RPA collaborative environment to permit teams of pilot, sensor, and payload operators to collaborate for mission execution purposes, during various RPA mission phases in various threat environments. ***FY 2017 Plans:***	1.580	1.610	12.118

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603456F / *Human Effectiveness Advanced Technology Development*	**Project (Number/Name)** 635327 / *Warfighter Interfaces*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Enhance and evaluate refined interface designs for a networked collaborative environment to enable distributed teams of manned and unmanned systems to work synergistically to maximize mission effectiveness. Establish design patterns for optimal human-autonomy dialog tailored to the specific computational methods utilized by the underlying autonomy. Refine intelligent agents for decision support and plan monitoring, across a wide range of applications. ***FY 2018 Plans:*** Develop human-machine interface (controls, displays, and decision support) to enable effective manned-unmanned tactical flight operations. Develop and demonstrate control techniques to direct maneuvers and tactics at manageable pilot workload levels. Develop and demonstrate architectures and interfaces to enable manned-machine teaming for the tactical air environment. Develop external contingency management methods for flight operations. Demonstrate pilot-vehicle interface capabilities in high-fidelity virtual simulation to assess pilot performance and mission effectiveness.			
Accomplishments/Planned Programs Subtotals	5.001	4.683	16.189

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.