RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 2000	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1				R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z					
COST *(In Millions)*	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	Cost to Complete	Total Cost
Total Program Element (PE) Cost	220.431	224.016	253.627	217.549	225.520	230.221	235.023	Continuing	Continuing
URI/P103	201.224	199.853	253.627	217.549	225.520	230.221	235.023	Continuing	Continuing
DEPSCoR/P104	19.207	24.163						Continuing	Continuing

(U) A. Mission Description and Budget Item Justification

(U) BRIEF DESCRIPTION OF ELEMENT:

(U) P103, University Research Initiative (URI). The URI has three primary objectives: (1) to support basic research in a wide range of scientific and engineering disciplines pertinent to maintaining the U.S. military technology superiority; (2) to contribute to the education of scientists and engineers in disciplines critical to defense needs; and (3) to help build and maintain the infrastructure needed to improve the quality of defense research performed at universities. Paralleling these objectives, this project competitively supports programs at universities nationwide in three interrelated categories:

- Research. The main thrust of the URI is the multidisciplinary research program of the University Research Initiative (MURI). MURI efforts involve teams of researchers investigating high-priority topics that intersect more than one traditional technical discipline; for many complex problems, this multidisciplinary approach serves to accelerate research progress and expedite transition of results to application. In FY 2001, two additional thrusts are university research for the National Nanotechnology Initiative and for critical military infrastructure protection. The URI also supports the Presidential Early Career Awards for Scientists and Engineers (PECASE), single-investigator research efforts performed by outstanding scientists and engineers early in their independent research careers.

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- Education. The URI promotes graduate education in science and engineering for U.S. citizens through the National Defense Science and Engineering Graduate Fellowship Program.

- Infrastructure. URI support for the development of research infrastructure responsive to defense needs includes two programs in the FY 2001 budget request. The Defense University Research Instrumentation Program (DURIP) allows researchers to purchase more costly items of research equipment than typically can be acquired under single-investigator awards. The URI Support Program (URISP) broadens the base of academic institutions participating in defense research by involving institutions that historically have not received much defense funding. The programs within this project P103 accomplish their infrastructure-building objectives in conjunction with the Defense Experimental Program to Stimulate Competitive Research that is in project P104 of this program element through FY 2000.

(U) P 104, Defense Experimental Program to Stimulate Competitive Research (DEPSCoR). The DEPSCoR helps to build infrastructure for research and education by involving institutions of higher education in states that historically have not received much Federal research funding. It is executed in coordination with state committees formed for the National Science Foundation's Experimental Program to Stimulate Competitive Research. Beginning in FY 2001, the DEPSCoR is moved from project 104 within this URI program element into a new program element (PE 0601114D8Z).

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(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY1999 Accomplishments:

(U) Programmatic accomplishments:

- Research. The FY 1999 MURI competition conducted by the Services resulted in 19 new awards in the following, high-priority areas of multi-Service interest: semiconductor physics; nanolithography; novel optical and infrared materials; biosensors for detection of chemical and biological agents; quantum information physics; propulsion, vacuum microwave electronics; radiation hardening; ionospheric characterization; and computational design of materials. Fundamental advances in these areas will enable the development of new technologies applicable to a broad range of future military systems. The multidisciplinary nature of these areas, and their multi-Service relevance, make them ideally suited for inclusion under the multidisciplinary element of the URI. In addition to the new MURI efforts, multidisciplinary and PECASE programs begun in prior years continued, with new competitive awards for PECASE programs. ($137.212 Million)

- Education. Under the National Defense Science and Engineering Graduate Fellowship program, 122 new graduate fellowships were competitively awarded for study leading to advanced degrees in science and engineering fields of importance to national defense. ($15.961 Million)

- Infrastructure. More than 230 new awards were made under the FY 1999 DURIP competition, enabling the purchase of research instrumentation needed to sustain universities' capabilities to perform cutting-edge defense research. Under the URI Support Program, efforts initiated in prior years continued in areas such as electronic and magnetic materials, image analysis, micromanufacturing, and neurodynamics. The FY 1999 competition under the DEPSCoR program resulted in 67 new awards. ($67.258 Million)

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(U) Selected technical accomplishments:

- Researchers at Purdue University and the University of Southern California, in collaboration with Marconi Integrated Systems, Incorporated, made dramatic improvements in algorithms used to extract information about terrain and urban features from large sets of imagery data in multiple spectral regions. The new techniques that the researchers developed for constructing and managing imagery data enabled them to make full use of the information in hundreds of spectral bands from multiple sensors spanning the infrared to ultraviolet portions of the electromagnetic spectrum; previously available methods exploited only a small number of bands. The researchers also achieved five-fold improvements in registration accuracy, enabling features derived from information in multiple spectral bands to be determined with an accuracy of 1-2m (0.5-1 pixel), compared with previous results of 5-10m (2-4 pixels) for this type of imagery. New methods were developed and demonstrated for automatically extracting urban features such as buildings and, for the first time, road grids, from multiple image sources; this resulted in improved detection rates of the features with much reduced false alarm rates. The researchers derived three-dimensional information by combining the data obtained from the new techniques with terrain elevation data acquired by photogrammetric means, and they created a virtual-reality environment for viewing, analyzing, and verifying the three-dimensional information. This research accomplishment is a significant step in the development of algorithms and tools for generating terrain and urban data that are needed to support military requirements for accurate, consistent, and timely battlefield visualization.

- Researchers from the University of Southern California, University of California at Berkeley, California Institute of Technology, State University of New York at Buffalo, North Carolina State University, and University of Washington developed a new theory that predicts how molecules come together and assemble themselves into structures. The theory is the first to take into account the three-dimensional shape of molecules and the dipole moments that result from the spatial distribution of electrons and nuclei (previous theories treated the dipoles as point charges), as well as the external forces and molecular dynamics that affect molecular self-assembly. Applying the new theory to polymers, the researchers were able to explain anomalies, unique nanoscale topologies, that had been observed in certain polymerization reactions. They also were able to predict that polymers with higher electro-optical coefficients would result if the self-assembled molecules were more spherical in shape. In this way, they designed and made polymers with twice the electro-optical coefficients of previous polymers; photonic devices made from the polymers require less applied voltage to stimulate the same change in refractive index, making it possible to modulate high frequency (up to 100 Gigaherz) signals with drive voltages of less than one volt. This can improve the efficiency of radio frequency links by a factor of more than one hundred. The new polymers can be used in photonic applications such as high speed communications or advanced radar technology using direct radio frequency modulation. The ability to control the self-assembly in a broad range of materials, not just polymers, has a broad range of defense applications in areas that depend on nanoscale structures, such as molecular-scale electronic circuits, ultra-high density memories for data storage, and complex miniaturized machines.

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- Computer scientists at the Carnegie Mellon University and University of Pittsburgh developed the first comprehensive system of intelligent software "agents," which can automate time-consuming tasks that otherwise would require human resources to gather information and make decisions or act on it. The agents are programs that have a certain amount of internal expertise (e.g., knowing how to carry out certain actions or how to get information from certain sources), that operate autonomously to decide when to carry out various tasks or communicate with other agents, that clone themselves when needed and move from one system to another, and that carry out standing orders or report back to a human user when there is something to report. The researchers' analysis and modeling generated the algorithms, protocols, and languages needed to produce the first system architecture that addresses all aspects of the problem: how agents interact with human users; how they interact with information resources; and how they communicate with each other and the network as a whole, to decide how to optimally apportion among themselves the elements of a complex task. The advantages of this comprehensive approach are that it yields systems that are easy for non-experts to learn to use quickly and that are easily built up in an incremental way, while the system is being used, to larger-scale systems for increasingly complex problems. Prototypes of the system have been used in several applications, including: (1) automating support for technicians at Warner-Robbins Air Force Base, reducing delays in aircraft maintenance due to paper exchanges of information with engineers and logisticians; and (2) tracking of real and simulated forces, including both personnel and equipment, for command and communications aspects of wargames using the Modular Semiautomated Forces simulated battlefield. The long-term value to the military is in getting humans out of the loop for complex but routine tasks that can be performed as well by software agents.

- Scientists at the University of California at San Diego developed novel metallic-intermetallic, laminated composites as model materials for armor design and for possible use in tanks and other systems. The materials are lightweight (less than 4 grams/cm3), easily processed in a laboratory with a mechanical press and inductive heating, inexpensive (created from commercially available foils), and have been demonstrated to stop 7.62-millimeter, small-arms rounds at velocities as high as 870 meters/second. The researchers successfully fabricated materials using several metal combinations, including titanium-aluminum, nickel-aluminum, and stainless steel-aluminum. They also produced advanced composite materials with a thick ceramic phase between intermetallic layers, with ceramic-particulate reinforced layers, and with corrugated interfaces between layers. Each of these advanced materials exhibits unique advantages in ballistic performance, such as the tendency for corrugated, metallic-intermetallic composites to induce rotation in penetrators (thereby dramatically decreasing the depth of penetration into the composite). The scientists are using a unique Eulerian, finite-element, computer model to characterize and predict the deformation and fracture of these materials. The computational work currently is focused on optimizing the number and thicknesses of the laminate layers and the geometries of the interfaces; the goal is to understand the fundamental mechanisms that govern the material's response to a penetrating projectile. The expected benefits to the DoD are armor materials that are lighter, easier and less expensive to fabricate, and have better ballistic performance than conventional armor designs.

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(U) FY 2000 Plans:

- Research. A FY 2000 MURI competition is being conducted for new awards in basic research underpinning high-priority areas such as data fusion in microsensor arrays; adaptive learning technology; decision making with information uncertainty; mobile, augmented battlespace visualization; real-time, fault-tolerant communication network protocols; solitonic information processing; quantum communications and quantum memory; artificial intelligence for training systems; adaptive and mobile networks for dynamic environments; phonon enhancement for electronic devices; programmed surface chemical assembly; ultra-cold atom optics; and prime reliant coatings. Multidisciplinary and PECASE programs begun in prior years are continuing, with new competitive awards under the PECASE program. ($138.542 Million)

- Education. A FY 2000 competition is being conducted to award approximately 120 graduate fellowships under the National Defense Science and Engineering Graduate Fellowship Program. ($15.407 Million)

- Infrastructure. FY 2000 competitions are being conducted for new awards under the DURIP and DEPSCoR programs. Efforts begun in prior years under the URI Support Program will continue. ($70.067 Million)

(U) FY2001 Plans:

- Research. Topics for the FY 2001 MURI competition will be selected in high-priority basic research areas such as those related to: cognitive performance and training; networks of multiple sensors; compact power sources; smart materials and structures; and intelligent systems for autonomous operations. An initiative will begin to support research in nanoelectronic device physics, nanostructured materials, and nano-biodevices, as part of the National Nanotechnology Initiative. Another initiative will support research in areas related to the protection of critical military infrastructures, such as power grids and command, control, communications, and computer systems. Multidisciplinary and PECASE programs begun in prior years will continue, with new competitive awards under the PECASE program. ($176.474 Million)

- Education. A FY 2001 competition will be conducted to award approximately 190 graduate fellowships under the National Defense Science and Engineering Graduate Fellowship Program. ($25.032 Million)

- Infrastructure. A FY 2001 competition will be conducted for new awards under the DURIP program. Efforts begun in prior years under the URI Support Program will be completed. ($52.121 Million)

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(U) ACQUISITION STRATEGY: Not Applicable

(U) B. Program Change Summary	FY1999	FY2000	FY2001	Total Cost
Previous President's Budget	228.415	216.778	210.332	Continuing
Appropriated Value		231.378		Continuing
Adjustments to Appropriated Value				
a. Congressionally Directed undistributed reduction	(7.984)			
b. Rescission/Below-threshold Reprogramming, Inflation Adjustment		(1.619)		
c. Other (SBIR)		(5.743)	43.295	Continuing
Current President's Budget	220.431	224.016	253.627	Continuing

Change Summary Explanation:

(U) Funding: FY 1999 adjustment reflects Congressional undistributed reductions. FY 2000 adjustments reflect inflation savings and the government-wide rescission. Program budget adjustments in FY 2001 include basic research initiatives related to the National Nanotechnology Initiative and critical military infrastructure protection, as well as the transfer of the Defense Experimental Program to Stimulate Competitive Research from this program element to the new PE 0601114D8Z.

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

(U) C. Other Program Funding Summary Cost Not applicable.

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(U) **D. Schedule Profile** Not applicable.