RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)										
DATE February 1999										
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1					R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z					
COST *(In Millions)*	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	Cost to Complete	Total Cost
Total Program Element (PE) Cost	214.600	228.415	216.778	210.332	214.436	237.414	242.391	247.490	Continuing	Continuing
URI/P103	196.601	209.201	206.778	200.332	204.436	227.414	232.391	237.490	Continuing	Continuing
DEPSCoR/P104	17.999	19.214	10.000	10.000	10.000	10.000	10.000	10.000	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 our 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, in conjunction with the other project within this program element, competitively supports programs at universities nationwide in three interrelated categories:

- Research. The main thrust of the URI is 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 addition, the URI 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

- Education. The URI promotes graduate education in science and engineering for U.S. citizens through the National Defense Science and Engineering Graduate Fellowship Program. Through FY 1998, the URI also supported the Augmentation Awards for Science and Engineering Research Training (AASERT) program, which awarded research traineeships for graduate students and also supported laboratory experiences for undergraduate students on defense research projects.

- Infrastructure. URI support for the development of research infrastructure responsive to defense needs includes three programs. 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 third program is the Defense Experimental Program to Stimulate Competitive Research in project P104.

(U) P 104, Defense Experimental Program to Stimulate Competitive Research (DEPSCoR). The DEPSCoR further helps to build national infrastructure for research and education in defense-critical fields 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY1998 Accomplishments:

(U) Programmatic accomplishments:

- Research. A MURI competition conducted by the Services resulted in 17 new starts in high-priority areas of multi-Service interest related to four Strategic Research Objectives identified in the DoD's corporate Basic Research Plan: nanoscience, biomimetics, compact power sources, and mobile wireless communications. 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. ($ 117.660 Million)

- Education. Under the National Defense Science and Engineering Graduate Fellowship program, 96 new graduate fellowships were competitively awarded for study leading to advanced degrees in science and engineering fields of importance to national defense. The FY 1998 competition for the AASERT program led to the award of research traineeships for more than 125 graduate students and support for the involvement of more than 50 undergraduate students in defense research. ($ 29.003 Million)

- Infrastructure. More than 230 new awards were made under the FY 1998 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 1998 competition under the DEPSCoR program resulted in 72 new awards. ($67.937 Million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

(U) Selected technical accomplishments:

- Researchers at the Georgia Institute of Technology, Northwestern University, and University of Minnesota at Minneapolis used a new method to demonstrate the feasibility of using ultrasonic guided waves to detect the initiation of flaws and other potential failure sites in annular structures, such as those in helicopter rotor hubs. The method includes a theoretical model for the propagation of ultrasonic waves of multiple frequencies traveling at different velocities through a complex structure, and a transfer function to interpret the effects of cracks or other flaws on the acoustic waveform when a structure is subjected to such waves. The new method has multiple advantages over existing x-ray, destructive-testing, and pulse-echo methods for detecting cracks in annular structures: it is less expensive and faster than any of the them; it does not require removing and replacing suspected parts, as do x-ray and destructive-testing methods; and it probes the entire path through the structure, unlike the pulse-echo methods that rely on reflection of transmitted pulses from cracks or other flaws. The use of the new method will increase understanding of deterioration mechanisms in materials and structures, and should enable development of technologies for detecting and predicting microcracks and fractures in real-time. These advances underpin early detection of structural flaws to prevent catastrophic failures in ships, aircraft, and other defense systems (e.g., due to metal fatigue and wearout in rotating machineries, such as high-cycle fatigue in jet aircraft).

- Scientists at Tufts University, Pennsylvania State University, and Columbia developed a biomimetic "nose" to detect volatile organic chemical compounds at vapor-phase concentrations of tens of parts per billion, more than ten times as sensitive as previous man-made "noses" and approaching the sensitivity of canine noses. It also has dramatically improved signal-to-noise ratios of man-made devices. The "nose" is biologically inspired in that it mimics olfactory systems of dogs and other vertebrates in two new and important ways. First, it detects the organic compounds using ensembles of different receptors distributed randomly on a surface, mimicking the olfactory epithelium in an animal's nose. The receptors are polymer microspheres impregnated with various fluorophors that fluoresce in the presence of different, specific compounds. A fiber-optic bundle images the detecting surface on a charged-coupled device; the spatial pattern of the fluorescence and its temporal duration vary with the compound being detected, due to the different spatial distribution and temporal response of the receptors for that compound. The second way in which this "nose" mimics animal olfactory functions is in the data processing for detecting, classifying, and quantifying the compounds; it uses computational neural networks that "learn" the spatial and temporal pattern of the response for each chemical using algorithms that are based on those that animal brains use to process olfactory data. The new "nose" can detect single compounds or mixtures of various compounds. It is a major advance in detection and identification of minute traces of biochemical compounds and has great potential for application in unexploded ordnance detection, chemical and biological warfare defense, and other areas important to protecting warfighters on land and sea.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

- A team at the University of Illinois and the University of Texas at Austin made three significant advances in the area of predicting radar scattering from complex surfaces. First, they extended the new Fast Multipole method to numerically solve equations of electromagnetic wave propagation and compute in a day the scattering of 3-gigaherz radar from the Northrup/McDonnell-Douglas YF-23 (using a computer-assisted design file for the plane); this is a major advance over earlier methods, when solving a complex problem like this one, with two million unknowns, would have taken months and been plagued with errors. Second, they found a quicker way to compute scattering from nearly planar surfaces, which includes important cases such as optical gratings, scattering from very corrugated surfaces with high spatial frequencies (such as vegetation and other ground clutter), and microstrips on ground planes; for this class of scatterers, the researchers discovered a clever way to represent the problem using an integral that can be evaluated by an even faster algorithm than the standard Fast Multipole method. Third, the team devised a new Plane-Wave/Time-Domain (PWTD) algorithm that can quickly compute scattering involving wider frequency ranges, such as scattering of wideband radars. The PWTD calculation in the time and space domains can handle those problems, complementing the Fast Multipole method's Fourier transforms into the frequency domain that cannot do so. Like the Fast Multipole method, the PWTD method uses surface integrals that have major advantages over earlier methods that use volume integrals; it is faster and does not introduce the grid induced dispersion and numerical artifacts produced by the other methods. The team has extensive contacts with industry and government offices that will use the greater power and fidelity of the new methods to design low-observable platforms and target recognition systems for the DoD.

- Researchers at Carnegie Mellon University developed a process to make nanocrystalline phases of iron-cobalt (FeCo) and demonstrated that the materials have excellent soft magnetic properties that persist at higher temperatures needed for military platform applications. Soft magnetic materials are used in alternating-current devices, such as rotors of electric generators, because they can be easily magnetized and demagnetized in the presence of oscillating, applied magnetic fields and have correspondingly lower power losses due to hysteresis effects in those oscillating fields. The military services need soft magnetic materials as they move toward air, land, and sea platforms with more electric systems to replace fluid-cooling and hydraulic systems that require a great deal of maintenance and are a major cause of breakdowns. The new iron-cobalt materials are nanocrystalline, so they have soft magnetic properties that are superior to those of a single crystal or amorphous material; most importantly low power losses. The new materials exhibit those superior properties at higher temperatures than previous nanocrystalline soft magnets; they do so up to a Curie temperature of 970 degrees Celsius, 200 degrees higher than the Curie temperature for previous materials and high enough for applications in aircraft engines operating at 600 degrees Celsius with the needed safety margin. They also exhibit the properties at much higher magnetic fields, up to 2.1 Tesla, than earlier nanocrystalline magnetic materials; with the higher fields, generators made from the materials have higher efficiency. Thus, the new materials have good potential for application in electric systems to help increase efficiency and reduce weight, cost, and need for maintenance in aircraft engines and other subsystems for military platforms. The university researchers' collaborations with industry and national and DoD laboratories will promote transition of the research findings to potential applications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

- Scientists at Clemson University, North Carolina State University, and the University of Michigan developed unique measuring and modeling capabilities and used them to begin to understand the physical mechanisms affecting quasi-optical power generation by arrays of discrete solid-state sources at frequencies of 10-100 Gigaherz. Vacuum tubes traditionally have been used to get the multiwatt powers at higher frequencies that are required for missile seekers and military communications applications, but there is interest in using solid-state devices because they are cheaper, smaller, and more reliable. The problem is that a single solid-state source produces only 0.1-0.2 watts at the higher frequencies of interest. Using networks with transmission lines to combine outputs of single sources in a brute force way works for 10 sources, but begins to drop off in efficiency for greater numbers of sources due to the complexity of the combining networks. Attempts to get the higher powers by quasi-optically combining the electromagnetic outputs of arrays of 36-100 sources, rather than using metal connections, have yielded total power much lower than the sum of the powers of the single devices. To try to understand the problem with these quasi-optical methods, the researchers developed the first instrument that measures the electromagnetic field amplitude and phase in three dimensions near these solid-state arrays with minimal disturbance of the field. They also developed a unique model to simulate the electromagnetic field inside and outside the array, as well as temperature and nonlinear device effects inside the solid-state material. What they found, which is entirely new and unexpected, is that fields emitted by some sources within an array can be out of phase with those emitted by other sources, causing destructive interference in the electromagnetic field; essentially, power emitted by the former sources is being dissipated by the latter sources due to the phase mismatch. The understanding that the researchers are gaining of the fundamental physics should enable the control and elimination of the interference effects, which will improve output powers of high-frequency, solid-state arrays by factors of ten or more to the multiwatt levels needed for military applications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

(U) FY1999 Plans:

- Research. Topics for new MURI starts were selected in high-priority research areas such as solid-state electronics (radiation hardening, vacuum electronics, and nanolithography), detection of chemical and biological agents (high selectivity and stochastic sensing mechanisms), computational neuroscience for learning and human/machine interactions, novel materials (tunable electronic polymers, adaptive infrared response materials, computational design), propulsion (pulsed detonation phenomena), ionospheric characterization (global specification and forecasting), and information processing (nonclassical representation and manipulation). The results of that MURI competition should be announced in early 1999. Multidisciplinary and PECASE programs begun in prior years are continuing, with new competitive awards under the PECASE program. ($137.183 Million)

- Education. A FY 1999 competition is being conducted to award approximately 200 graduate fellowships under the National Defense Science and Engineering Graduate Fellowship Program, as the separate AASERT program of graduate research traineeships is discontinued. ($23.412 Million)

- Infrastructure. The FY 1999 competition under the DURIP program resulted in 233 awards for research equipment needed to perform cutting-edge defense research. Sixty-seven new awards were made under the DEPSCoR program. Efforts begun in prior years under the URI Support Program will continue. ($67.820 Million)

(U) FY2000 Plans:

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z	

- Research. Topics for new MURI starts will be selected in high-priority research areas such as novel materials; devices and structures concepts; information science, including data fusion, distributed computing, quantum computing and quantum memory; biomolecular science and engineering; advanced, ultrawide-bandwidth communications; electronic/electro-optical devices; and compact power systems. Multidisciplinary and PECASE programs begun in prior years will continue, with new competitive awards under the PECASE program. ($133.486 Million)

- Education. A FY 2000 competition will be conducted to award approximately 200 graduate fellowships under the National Defense Science and Engineering Graduate Fellowship Program. ($23.117 Million)

- Infrastructure. FY 2000 competitions will be conducted for new awards under the DEPSCoR and DURIP programs. Efforts begun in prior years under the URI Support Program will continue. ($60.175 Million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

(U) FY2001 Plans:

- Research. Topics for new MURI starts will be selected in high-priority research areas such as fields underlying the understanding of harsh battlespace environments for military personnel and systems, life extension and life assurance for materials and structures, the physical and mathematical bases of information science, modeling and simulation, and education and training to improve human performance under extreme stress. Multidisciplinary and PECASE programs begun in prior years will continue, with new competitive awards under the PECASE program. ($130.094 Million)

- Education. A FY 2001 competition will be conducted to award approximately 200 graduate fellowships under the National Defense Science and Engineering Graduate Fellowship Program. ($21.449 Million)

- Infrastructure. FY 2001 competitions will be conducted for new awards under the DEPSCoR and DURIP programs. Efforts begun in prior years under the URI Support Program will be completed. ($58.789 Million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1	R-1 ITEM NOMENCLATURE UNIVERSITY RESEARCH INITIATIVE PE 0601103D8Z

(U) B. Program Change Summary

	FY1998	FY1999	FY2000	FY2001	Total Cost
Previous President's Budget	222.628	216.320	220.522	214.219	Continuing
Appropriated Value	230.788	229.420			Continuing
Adjustments to Appropriated Value					
a. Congressionally Directed undistributed reduction	(13.714)	(1.005)			
b. Rescission/Below-threshold Reprogramming, Inflation Adjustment	(2.474)		(3.744)	(3.887)	
c. Other					Continuing
Current President's Budget	214.600	228.415	216.778	210.332	Continuing

Change Summary Explanation:

(U) Funding: Funding changes due to inflation program adjustments.

(U) Schedule: Not Applicable

(U) Technical: Not Applicable

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

D. Acquisition Strategy: Not Applicable

(U) E. Schedule Profile Not Applicable