

**TESTIMONY OF ALBERT J. SIMONE
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TO THE SUBCOMMITTEE ON DEFENSE
COMMITTEE ON APPROPRIATIONS
UNITED STATES HOUSE OF REPRESENTATIVES
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Mr. Chairman and members of the Subcommittee, on behalf of the Rochester Institute of Technology in Rochester, New York, I would like to first take this opportunity to thank you for the support that the Subcommittee has provided to RIT in the past three years. The Defense Appropriations bill has funded our remanufacturing research program with the Office of Naval Research (ONR) with appropriations of \$2,000,000, \$1,000,000 and \$2,000,000 in fiscal years 1997-1998, 1998-1999 and 1999-2000 respectively. These funds have enabled us to work with ONR on a feasibility study and engineering analysis of the SES 200B (Surface Effect Ship) to take advantage of the new SLICE hullform. This is a project that we believe will lead to significant strides in developing better approaches to the remanufacture of weapons and other systems.

RIT's National Center for Remanufacturing and Resource Recovery (NCR³) has developed processes and technologies that will convert a Surface Effect Ship (SES) to a ship with a SLICE hullform. The cost of that remanufacture will be \$7.5 million. A comparable new SLICE ship would cost the Navy \$18.5 million. If NCR³'s process is used to convert the 19 laid-up SES 100 ships, savings will total \$209 million. The remanufactured vessels would supplement new advanced SLICE-like vessels being proposed within the Navy to conduct communications, logistics, and other combat support activities in the near-shore littoral region. The Navy grant that NCR³ received for this project delivered a 116-to-1 return on the initial investment.

As a part of this project, the research team at NCR³ also developed a comprehensive database that identifies in detail each cost component of every system within the ship design. Since the Navy intends to use this ship as a platform for testing future advanced hull designs (as a part of ONR's advanced hull program), the RIT-developed database will be a critical resource to the Navy and ONR. In addition, the process, methodologies and technologies developed through this research program can be replicated for other systems throughout DoD.

Let me provide some additional background on remanufacturing, an emerging field that forms the context for the work of RIT and our National Center for Remanufacturing and Resource Recovery.

Budget constraints have become the epidemic of the late twentieth century, with both commercial and federal industrial centers being required to produce "more" using less money. The Department of Defense has certainly seen this trend particularly vividly, with equipment and machinery that can cost millions or even billions of dollars per item.

Constrained by an ever-shrinking budget and ever-increasing demands, the DoD has seen its fleet of planes, tanks and ships, weapon systems and related instrumentation as well as other high-technology equipment grow increasingly old and obsolete. The U.S. Department of Defense currently spends hundreds of billions of dollars in total ownership costs for new systems and equipment. Operation and maintenance expenses account for nearly 65 percent of that sum, and as the average age of equipment rises, those operation and maintenance costs also rise (\$109.3 billion estimated for fiscal year 2001).

Providing a solution to this seeming impasse is the National Center for Remanufacturing and Resource Recovery at the Rochester Institute of Technology (RIT). Expanding on the success of the SLICE project, NCR³ has begun work on the Modernization Through Remanufacturing and Conversion program (MTRAC), an organized approach for integrating remanufacturing into the full life cycle of a product or system.

Remanufacturing is certainly not a foreign term to the Department of Defense, which has undertaken several programs with similar types of methodologies and goals in recent history. The power of remanufacturing has been recognized by DoD branches as a solution to the issues facing them in terms of equipment life and procurement. Programs like SLEP, MTS, and initiatives like the Defense Technology Objectives have had considerable success within their respective areas of development. MTRAC seeks to expand and enhance these programs with the NCR³'s technical prowess in the areas of remanufacturing, reverse engineering, design for remanufacture, cleaning technologies, and other areas of technical expertise offered by RIT.

MTRAC will focus on usable templates and tools for cost-effective remanufacturing and upgrading in a multi-year, multi-phase technical program. It will make use of many specific instances of remanufacturing assessment studies, including the vast amount of data already compiled under the recently completed SLICE project.

At its conclusion, MTRAC will provide generic templates based on these examples that can be universally applied to ships, aircraft, tanks, trucks, and a variety of other vehicles, platforms, and equipment to determine candidacy for remanufacturing. MTRAC will seek to provide a product that meets or exceeds new product standards, including updated technological modifications as necessary at a lower cost than the purchase of a new product.

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In 1997 Defense Secretary William S. Cohen presented the *Report of the Quadrennial Defense Review*, in which he identified deficiencies in U.S. military readiness and outlined a strategic reform plan for the 21st century. As a result, U.S. defense procurement costs rose to \$60.3 billion in the FY2001 budget, a one-third increase over the \$44.8 billion allotted in FY1998. In the *1999 Annual Defense Report*, Defense Secretary Cohen continued to discuss the reasons for soaring procurement and maintenance costs:

The Department faces a number of challenges in keeping its equipment ready for the next mission. Aging systems, spot spare parts shortages, and high OPTEMPO are placing increased pressure on the materiel readiness of the force. Of particular concern are negative readiness trends in mission capable rates for aircraft. Lack of experience among maintainers has caused improvements in mission capable rates to lag. Ground equipment condition is somewhat better, but the long-term capability to sustain this equipment is increasingly difficult because of the effects of equipment wear, excessive age, and the rising cost of spare parts. These factors increase maintenance costs, the total number of spare parts required, and the number of personnel needed to perform the maintenance... The Department released over \$1.8 billion in Kosovo emergency supplemental funding to meet the most urgent requirements.

In a recent article, "The Year of Declining Readiness," written by Tom Philpott for the January 1999 almanac issue of *Sea Power*, several facts were presented that again emphasized the lack of resources and overworked weapon systems:

Navy funds to upgrade weapon systems and equipment have fallen more than 50% since 1990; the maintenance backlog at Navy bases and facilities is estimated at \$2.5 billion and will surpass \$4 billion in three years. Five years ago about 42 percent of the Navy's ships were underway at any time. Today that figure is close to 55%.

Vice Adm. Conrad C. Lautenbacher Jr., deputy chief of naval operations for resources, warfare requirements and assessment, asserts in the same article, "Lean budgets are impacting equipment upgrades as well. We're down to 40 percent of what we used to do [in equipment modifications]. That's been a heavy loss to us ... We're effectively aging our equipment faster than we have done in previous years."

As the United States continues to be a leader in global peace, it is apparent that our future forces are going to be using older equipment for longer periods of time. A balance must be realized between declining budgets and the need to revitalize our aging equipment in order to provide advanced technology insertions into the frontline weapon systems. Unlike most firms in the private sector, branches of the DoD manufacture, consume and maintain many of their own systems. Rapid advances in technology and ever-shortening system life cycles demand quick response times for conversion and/or upgrades of existing systems. One of the answers to modernizing our defense resources while working with a shrinking funding source is through a practice that the commercial sector has embraced for forty years called **remanufacturing**. Remanufacturing is a highly effective strategy of restoring used, durable products to a "like-new" condition while enabling technology upgrades at substantial savings to the end user.

Major original equipment manufacturers (OEMs) such as Caterpillar, Detroit Diesel, Eastman Kodak, Xerox and Cummings have internalized the philosophy of remanufacturing in order to reap the economic advantages that bolster their profits. The rising cost of energy, the demand for nonrenewable resources, and the dwindling

availability of landfill space are placing a premium on industrial processes. Remanufacturing retains approximately 85% of the labor, energy and manufacturing operations that comprise the value added in the original production process. The result is a product that is as good as the original and can be sold to consumers at 50% to 70% of the price of a comparable new product.

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Since many systems employed by the DoD are costly to manufacture and maintain, strategies to reduce these costs have the potential to conserve significant financial resources. Remanufacturing is a powerful approach to sustaining and advancing technological systems. It is often conducted through a series of steps including disassembly, cleaning, inspection, refurbishment, technology upgrade, assembly and testing to original or enhanced specifications. Often, remanufactured systems are upgraded with the advanced features of today's equipment.

Remanufacturing serves a strategic goal of satisfying technology needs at critical moments while reducing lead times for procuring new systems. It also does not require the same resources needed for the manufacture of new systems, so remanufacturing operations can be done much closer to the system's point of use. Unlike recycling, where only the material value of a product is recovered, remanufacturing captures the material value as well as the labor and capital investment of value-added operations that took place in the original production.

In order for a product to be remanufactured in the best possible manner, it needs to be designed for remanufacture from the start. A number of design strategies have been developed to facilitate remanufacturing. They include: avoidance of permanent fastenings such as welding or crimping, making designs modular so that assembly/disassembly times are minimized and standardizing fasteners to reduce assembly/disassembly and material handling complexity.

The nature of military procurement, the high cost of military equipment, and the problem associated with maintaining an inventory of unique spare parts have made remanufacturing an attractive and important part of the DoD's efforts to preserve the technical superiority of the military services.

Remanufacturing can be thought of as a single stage in the life cycle of a system or piece of equipment, as depicted in Figure 1. Its operations can be made more efficient through the use of support technologies and methodologies. For example, reverse engineering techniques can be used to generate original equipment design specifications and tolerances when this information is unavailable at the remanufacturing stage. The use of intelligent production scheduling and part inventory management techniques can significantly improve the cost effectiveness of remanufacturing systems. Design capture can be utilized to collect information from equipment at the end-of-life and feed back improvements to the design process. Life cycle costing methodologies can support

intelligent design selection by uncovering cost information up to and including system end-of-life.

The Phalanx Remanufacture Program at the Crane Division of the Naval Surface Warfare Center in Crane, Indiana provides an excellent example of how remanufacturing can contribute to greater affordability and enhanced performance of naval systems. Crane Division faced high costs in procuring equipment kits required for the conversion or overhaul of the Close-In Weapon Systems (CIWS) to an upgraded configuration. All components required for target system upgrade were purchased as newly manufactured items at high cost and with long procurement lead times. The Louisville Site-NSWC initiated the Phalanx

Remanufacture program to reduce costs and lead times. The program involves depot level overhaul of Phalanx weapon systems, in combination with required upgrades, using remanufactured components from the original configuration. More than \$150,000 in savings per overhaul or upgraded system was achieved by the remanufacture program with no diminution in system readiness. (Source: Dept. of the Navy, Best Manufacturing Practices Data Base, Feb. 4, 1998, <http://www.bmpcoe.org>.)

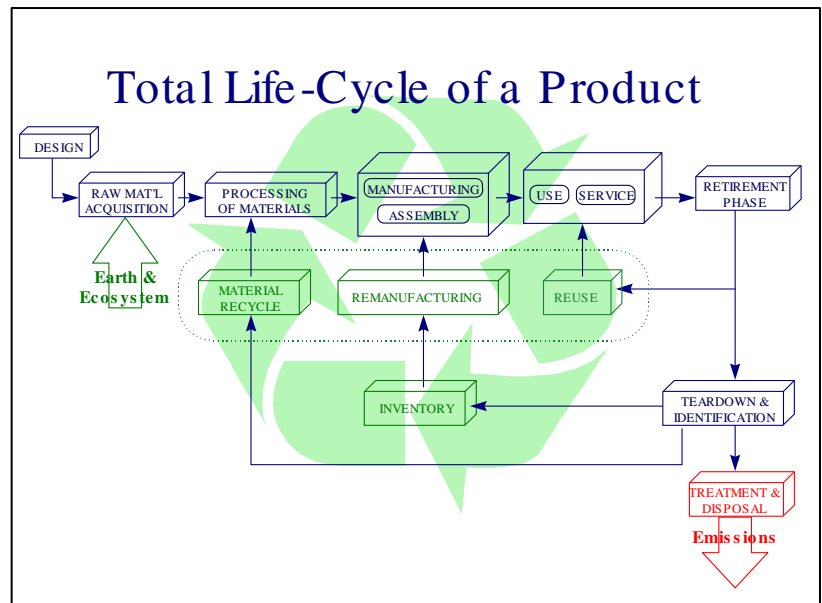


Figure 1: Life Cycle of Systems/Equipment

Significant examples of DoD remanufacturing efforts include:

- **Navy– Phalanx Close-in-Weapon System:** The remanufacturing of these complex systems involving depot level overhaul and upgrades reaped savings of \$150,000 per system, with no diminution in system readiness.
- **Air Force – 71 B-52H Bombers:** This aging platform has been through several service life extensions from its original introduction in the 1950's.
- **Army – 1,700 two-and-a-half ton Trucks:** AM General remanufactured older trucks into like-new condition for the Army Reserves.
- **Marines – High-Mobility Multipurpose Wheeled Vehicle (HMMWV):** In fiscal year 1999, \$69 million was allocated to the Light Tactical Vehicle Remanufacture program designed to replace its aging Humvee fleet with the HMMWVA2 upgrade version.

It is clear that the DoD provides an excellent environment for remanufacturing. In fact, many objectives requiring specialized technology, which remanufacturing can provide, are already in place.

Over the last several years, the DoD has been making a concerted effort to establish more cost-effective methods for the production of military platforms. Included in these efforts are two DoD objectives that identify remanufacturing as a key element to the critical area of military readiness. The first initiative, the Sustainment/Readiness Working Group (SRWG), was established by the Joint Defense ManTech Panel (JDMTP) to identify the necessity for guidelines and business policy practices designed specifically for manufacturing issues related to DoD weapon systems. The SRWG has identified repair and remanufacturing technologies as a primary focus for the DoD as a means to minimize costs for modernization, upgrades, and retrofits of existing weapon systems.

A second initiative, the Affordable Sustainment of Aging Aircraft Systems, was identified in 1997 as a Defense Technology Objective (DTO MP.07.06) and was specifically targeted to develop affordable repair and remanufacturing technologies as a solution to the increasing age of military aircraft and the increasing costs of purchasing new aircraft. This objective identifies remanufacturing as a key method for supporting life extension of aging aircraft systems, reducing life-cycle costs, enhancing operational readiness, and advancing lean concept deployment in repair.

The establishment of these initiatives is a clear indication of the DoD's commitment to the development of remanufacturing processes and procedures to enable the manufacture of high-quality systems at significantly reduced costs.

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In order to successfully address the continuing need for the development and implementation of cost-effective upgrade and conversion techniques, the National Center for Remanufacturing and Resource Recovery (NCR³) began the development of the Modernization Through Remanufacturing and Conversion (MTRAC) program. MTRAC is a multi-year, multi-phased approach to developing a centralized program for the advancement of remanufacturing technology. NCR³ will develop tools and processes to aid in the design for remanufacture, remanufacturability assessments, cost estimation for upgrades and conversions, and advanced technology insertions.

Using the information collected and technology developed from its current project with ONR, NCR³ has begun work on Phase I of the MTRAC program, compiling a comprehensive database. This database identifies, in detail, life-cycle cost of each component of every system within the ship's design. The information will be an invaluable resource to the Navy and ONR, particularly in the testing of future hull designs. RIT is requesting continued funding in the amount of \$4 million for the implementation of the next stage of the MTRAC program.

Typically, remanufacturing is only considered once a system is approaching the end of its useful life. Remanufacturing can yield significant economic and performance returns, however, if it is integrated into the design process. Design for Remanufacture, a focus of MTRAC's Phase II, will ensure that the product will stay on par with technology

advancement. This will result in reduction in maintenance and support cost while reducing investment in new systems up to 20%.

MTRAC is designed to completely overhaul the way that the DoD looks at their current conversion program and will utilize NCR³ as the centralized clearinghouse for all remanufacturing technology issues for the DoD. This program will be applied across all DoD entities to perform advanced research and development of remanufacturing for the DoD.

The development and implementation of MTRAC for the DoD will greatly enhance the life span, capability, technology and combat readiness of our nation's aging weapons platforms.

The MTRAC program consists of several phases. Phase I focuses on preliminary development of tools and identification of pilot remanufacturing projects. The database, tools, and projects will continue to be refined and used to advance research in the main focus areas of remanufacturing for Phase II. Phase III will use the information and additional experience gained in Phases I and II to develop metrics, tools and processes for the Design for Remanufacture, build economic cost models for remanufacturing, and begin a DoD-wide technology transfer effort. The proposed Phases for the MTRAC initiative are outlined below:

Phase I (Technology Development)

The objectives for Phase I:

- Begin development of tools, processes and guidelines for remanufacturing.
- Build a comprehensive database of remanufacturing case studies.
- Review and assess current programs designed for life cycle extension. Identify gaps or inconsistencies with remanufacturing principles.

Phase II (Technology Advancement, Validation and Initial Implementation)

The objectives for Phase II:

- Expand the research and development of advanced remanufacturing principles: Design for Remanufacturing, Signature Analysis, Cleaning Technologies, Reverse Engineering.
- Continue expansion and development of remanufacturing case study database.
- Continue development of remanufacturing tools through case study approach.

Phase III (Implementation and Technology Transfer)

The objectives for Phase III:

- Perform DoD-wide technology transfer including: remanufacturing process assessments, remanufacturing training, workshops and seminars, direct assistance, and educational literature.
- Examine life cycle considerations with regard to remanufacturing.
- Build economic models and cost estimators for remanufacturing versus replacement.
- Develop guidelines, metrics, and tools for Design for Remanufacture.

Project Workload Distribution

Phase I – FY 00 & 01	
• Development & Analyses	60%
• Validation	20%
• Implementation & Technology Transfer	20%
Phase II – FY 02 & 03	
• Development and Analyses	30%
• Validation	30%
• Implementation & Technology Transfer	40%
Phase III – FY 04 & 05	
• Development & Analyses	10%
• Validation	15%
• Implementation & Technology Transfer	75%

The costs associated with these phases is outlined below:

Phase	FY00	FY01	FY02	FY03	FY04	FY05
Phase I: Technology Development	\$2m	\$4m				
Phase II: Technology Advancement, Validation & Initial Implementation			\$5m	\$5m		
Phase III: Implementation & Technology Transfer					\$6m	\$6m

The cost benefit of remanufacturing within the MTRAC program will have a direct impact on the DoD. As funds for new systems become more restricted, remanufacturing becomes a more economically feasible solution for system modernization. NCR³ proposes to develop comprehensive guidelines and tools necessary for consistent, cost-effective remanufacturing. As a result, the DoD will be able to modernize platforms at considerable cost savings compared to procuring newly built systems. Increasing the implementation of effective remanufacturing techniques into industry will produce better products and systems at lower overall costs. The more cost-competitive manufacturing becomes, the greater the cost savings to the DoD. Remanufacturers will be able to produce modernized platforms at lower cost.

The National Center for Remanufacturing and Resource Recovery (NCR³), the only center of its kind in the nation, has the unique capabilities and resources to conduct state-of-the-art research and development in remanufacturing for the DoD. The Center's activities in investigation and development of processes and tools for remanufacturing and life-cycle design are conducted by a combination of experienced faculty, full-time technical staff, graduate students, and student co-ops with expertise in Industrial and Manufacturing Engineering, Mechanical Engineering, Electrical Engineering, Packaging Science and Economics.

NCR³ is part of RIT's Center for Integrated Manufacturing Studies (CIMS) a state-of-the-art, 157,000 square-foot facility which was specifically designed to provide an infrastructure for technology transfer and applied research for the manufacturing sector. CIMS resources include 20 technical support labs in areas such as simulation, packaging, DFM/DFA, Computer Aided Design, Manufacturing and Engineering, and ergonomics. With extensive technology transfer areas and distance learning capabilities, CIMS can bring technology to anywhere in the United States.

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Mr. Chairman, we believe that our National Center for Remanufacturing's Modernization Through Remanufacturing and Conversion program can lead to significant cost savings and strengthen our country's military preparedness. The Office of Industrial Programs within the Office of Naval Research is very interested in the work that RIT is doing in the area of remanufacturing and we look forward to continuing our collaborative research program with them. In order to continue development and implementation of the MTRAC initiative, we are requesting an appropriation of \$4 million in the FY2001 budget.

Thank you again, Mr. Chairman, for providing us with the opportunity to submit this testimony to your Subcommittee. If you or the members of the Subcommittee have any questions, please do not hesitate to call us and we will be glad to provide additional information.

