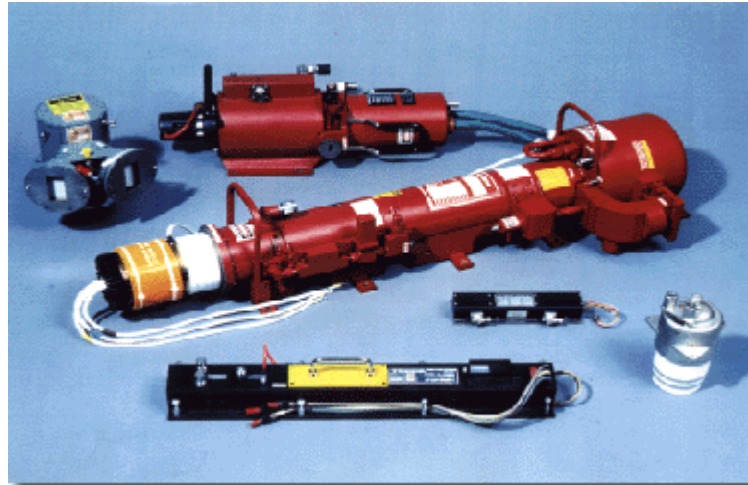


TWT

Flexible Manufacture of Microwave Vacuum Devices

All service branches have applications for high power microwave devices. Historically, these devices have been tubes, such as the Traveling Wave Tube (TWT). Since there are few uses for the TWT outside of the military sector, the commercial industry has not been the driving force for cost and performance of these devices. Currently, the military purchases approximately 2/3 of the total tubes sold. There is continuing work to develop higher power Radio Frequency (RF) semiconductors, but for the frequency and power required, the TWT is the device of choice for applications from 1 to 100 GHz. TWTs are used in over 200 existing weapon systems and supporting these systems alone would require TWTs through the year 2030.



The Army and Navy jointly funded the TWT project with a significant amount of industry cost share. Among the programs expected to benefit from the TWT effort are the Navy Cooperative Engagement Capability (CEC), Air Force MFEWCM, Army Patriot Advanced Capability (PAC-3), and Tri-service Global Broadcast System (GBS). The objective of the project was to improve the manufacturing efficiency through the concept of flexible manufacture. Flexible manufacture is the use of one or a small number of manufacturing lines to produce a large variety of products, in this case a variety of different TWTs.

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APPROACH

In phase I of the project, a manufacturing improvement program involving several manufacturers was established. Each participant in the program would work in a different part of the frequency spectrum, but would share their work through frequent "tech talks." The participants would focus on manufacturing improvements which would reduce the cost of tube manufacture. Improvements centered on the concept of flexible manufacture and included manufacturing automation, new assembly techniques and test automation. The results were then presented to the participants and interested parties.

ACCOMPLISHMENTS /PAYOFF

During Phase II, each of the following three manufacturers worked on improvements focusing on different frequencies and technologies.

Northrop Grumman, working on C Band devices, focused on the reduction of touch labor and direct material. Each part of the tube was evaluated for low cost implementation and streamlined manufacturing methods. Standardized methods were worked out for piece/part processing and assembly fixturing. Additionally, automated test methods were developed. The existing C Band tube was used as a baseline for new process work and detailed cost comparisons were maintained. A cost reduction of over 40% was realized for the C Band tube and, because of flexible manufacture, much of these savings are applicable to other tubes.

Teledyne focused on the industry-wide issues in helix, barrel and support rod fabrication for Ka Band devices. The initial study showed that application and measurement of support rod loss patterns are the critical issues in a high yield, low cost manufacturing environment. Several techniques for loss pattern deposition were evaluated, while the key problem of reducing the reject rate was addressed using improved measurement equipment.

CPI Inc. developed manufacturing improvements for a coupled cavity millimeter wave tube. Their tasks included improved process layout, redesigned RF window, modified assembly methods for the RF circuit



assembly, redesigned magnet assembly, collector and gun assemblies and a new automated test station. New process documentation was developed as part of the flexible manufacture. The documentation was picture-oriented to reduce assembly errors and enhance manufacture of different tubes on the same manufacturing line. This particular tube is to be used in the PAC-3 missile and 100% payback is expected on the 50th unit.

The TWT project team, under the leadership of the American Competitiveness Institute (ACI), recently the 2000 Defense Manufacturing Technology Achievement Award for work on the Flexible Manufacture of Microwave Vacuum Devices Project. This honor is presented each year by Deputy Under Secretary of Defense for Science & Technology, Dr. Delores M. Etter, and the Joint Defense Manufacturing Technology Panel. The award is made for a specific innovative manufacturing technology achievement that has had a significant impact on one or more of the following: rapid transition of defense-essential or defense-unique technologies, affordability, cycle time, readiness, quality and/or decoupling cost from volume.