27 February 1974

SUMMARY REPORT
of
The ASAP Working Group
on
FOREIGN TECHNOLOGY

1. The ASAP Working Group on Foreign Technology was formed in March 1973 as a result of recommendations by an Ad Hoc Panel established by Dr. David, Director, Office of Science and Technology, Executive Office of the President, to provide suggestions for enhancing the Army's timely and efficient utilization of technology. The panel's recommendations included four suggestions for more effective utilization of the ASAP, one of which was to prepare an annual input of potential foreign hardware which could fulfill Army requirements.

2. Terms of Reference: The ASAP Working Group on Foreign Technology was established to review applicable areas of foreign technology with regard to Army requirements and to report annually on:

a. Those technical areas (by country) in which substantial improvement in state-of-the-arts vis-a-vis the US has taken place.

b. Existing or planned foreign developments which parallel or supplement proposed or existing Army efforts.

3. The Foreign Technology Working Group met four times with full meetings being held at the Pentagon on 25 April and 16 August, and rump sessions being held on 22 May at Huntsville, Alabama, and 12 October in Heidelberg, Germany, after regular meetings of the full ASAP. A brief summary of these four meetings is as follows:

a. 25 April - Working Group received briefings by OCRD, Foreign Science and Technology Center, and Missile Intelligence Agency regarding the monitoring of foreign technology by the R&D and intelligence communities. Presentations included organization and functions of these organizations and major areas of foreign technology of interest to the Army. A key question is how effectively the data/intelligence being collected is being utilized, i.e. is it getting to the technical people who can use it and are they in fact using it?

b. 22 May - At the regular meeting of the ASAP on 21-22 May 1973, the Working Group heard a summary of the evaluations being done on the CROTALE, RAPIER, and ROLAND low altitude, air defense missile systems and were given summaries of several other potential systems which might be candidates for purchase by the US for Army inventory. After the ASAP meeting, the Working Group members in attendance met to discuss specific areas on which they should concentrate within the broad Working

Group terms of reference. It was concluded that the most probable areas for the US to benefit from foreign technology and thus the areas for the group to concentrate on, are in:

(1) The purchase or manufacture of fully developed systems, or system elements, which are being considered for inventory by the Armies of the NATO nations.

(2) The initiation of interdependent development projects with foreign nations. (Interdependent development is cooperative R&D whereby the US and one or more other participants: Agree upon a materiel requirement; assign to one participant all development responsibility including funding; and other participants forego development and evaluate for possible adoption, the outcome of the unilateral development.) A complete report of this 22 May Huntsville meeting is attached as Inclosure 1.

c. 16 August - This meeting was geared to answer the question, "given an item of foreign hardware which matches a US Army requirement, what is the procedure for getting that item evaluated and accepted into the US inventory." At this meeting, the Working Group was briefed on current Army RDT&E procedures and also the lessons learned through US Army procurement and Americanization of the French RATAC ground surveillance radar.

d. 12 October - The Working Group met in Heidelberg, Germany, on the final day of an ASAP visit which included a review of FRG and United States activities in Germany, and the specific progress of Project Reforger. As a result of many informal discussions, the participation of several members of the Foreign Technology Committee in other activities, and specific briefings to the Group by Army members of the MAAG, Germany, the Group noted the following general areas where problems or potential mutual developments exist.

(1) The United States and the Federal Republic of Germany are currently involved in individual tank development programs: The XM-1 and the Leopard II. Apparently there is not an equal exchange of data on tank developments at this time. The United States has full knowledge of all German data on the Leopard, which is in a more advanced state of development than the XM-1. This is an obvious area for some mutual development, some common standardized elements, or at least more freely exchanged data.

(2) The Federal Republic of Germany is now experienced with bilateral or multilateral programs for development. Approximately 40 to 50% of their development money is spent on multilateral programs, and another 15% is spent on bilateral programs. The US might benefit by having the FRG outline the lessons learned, if they are willing.

(3) The United States is in an evaluation program of several ground-to-air missile systems which are near the end of normal development

within the NATO countries. These include ROLAND, CROTALE, and RAPIER. Since development of a ground-to-air system that fills the gap between the STINGER (or the Advanced CHAPARRAL) and SAM-D is not currently planned, it would appear that one of these weapon systems could potentially be a candidate for utilization of foreign technology.

(4) Other candidates might include:

(a) Some elements of electronic warfare.

(b) Non-nuclear warheads for LANCE (including guidance).

(c) Scatterable mines

(d) Computer support for fire control.

5. Conclusions: It would appear from the discussions of the requirements (and the status of development of some of the above systems) that the success of mutual programs, and the initiation thereof, will depend primarily on whether the United States really wants such programs, or is merely giving lip service to the idea due to current budgetary restrictions. A policy was expressed, (which appears to have emanated from the Office of the Assistant Secretary of Defense for International Affairs) that military systems should be 100% U.S. - made, and programs should be designed to protect U.S. technology and jobs. The dichotomy created by exploration of potential foreign systems and potential mutual requirements, and the adherence to such a policy, effectively blocks any real activity. Aside from the implied "100% USA" policy, there are other similar deterrents. These include:

a. Specific Army resistance to change in their requirements to adapt to an already developed weapon system. The Germans have shown substantial flexibility in accepting our concept of the STINGER, and the use of the TOW, even though their initial requirements did not exactly describe these systems.

b. Since foreign systems did not go through normal R&D channels within a Service, they frequently do not fulfill standardized concepts of reliability, environmental limits, etc., which may or may not be important, but which are demanded for all U.S. developments, and are difficult to compromise within our procurement procedures.

c. Users who were involved in the creation of initial requirements are reluctant to accept evaluation tests of weapon systems which show deviations and therefore, even if a foreign weapon system is purchased, the requirements are not removed from the books. This leads to confusion and unnecessary parallel development efforts.

d. Requirements development in the United States is substantially more parochial than in other countries, and we appear to be slow to inform our NATO allies about new requirements as they evolve. There is no clear mechanism to review a concept like a potential anti-ship warhead and guidance system for LANCE. This is a valid German requirement, since they must operate with the Baltic at the North, and can very well use anti-ship weapons that are land-based. Finding a sponsor within DOD for such a system, even though it might mean a larger production base, with the economies attendant to such a base, is extremely difficult.

e. There appears to be no way to develop, within DOD elements, an effective advocate for a foreign system that involves no "home" requirements development or no industrial or service element with an "invented here" attitude.

6. Recommendations: As a result of our current discussions and our previous reviews of on-going programs, we have the following recommendations to offer the Army concerning utilization of foreign technology:

a. The requirements and R&D personnel of the Army should jointly participate with requirements developers in foreign countries in specific tactical areas to determine whether a mutual agreement can be reached concerning specific requirements for any new weapon system concepts that have a potential for mutual use. This exchange of requirements should be developed into a formalized process for identifying specific programs in which foreign technology is to be used. An opportunity exists now with the Federal Republic of Germany to develop concepts and common requirements in (1) the electronic warfare area; (2) scatterable mine systems; and (3) the use of tactical warheads on LANCE.

b. Once a mutual program has been isolated, either for joint development or for U.S. production of a foreign system, the program manager selected should be endowed with sufficient authority by the Army Chief of Staff to accept the requirements as fulfilled by the weapon system rather than the requirements currently on the books. The program manager will need unique channels to the highest level of Army management, since the program will not have the normal advocates which a U.S. development would have.

c. It is possible that foreign weapon systems could be used as test candidates in competitive "shoot outs" in order to evaluate the U.S. counterpart or the requirements to which it has been designed. If such a weapon system test proved the foreign competitor to be clearly superior then requirements, timing, funding, and plans would have to be modified to purchase it. This seems an unlikely result in the real world and therefore it is suggested that any such a test candidate should be purchased with no assurance that follow on production

was a possibility. This may prevent some weapon systems from being made available for U.S. testing, and, until we decide "officially" that we will use foreign weapon systems, we must accept this fact.

d. Before any success can be achieved, it must be made clear that the policy of Congress, the Department of Defense, and the Army is to utilize foreign technology when it can be demonstrated to save the U.S. money, or development time, or to enhance our capability to integrate U.S. military operations with a foreign ally. It appears to the Foreign Technology Working Group that such a policy must be developed before any further major efforts are initiated to use foreign technology as represented by development or production weapon systems.

ARMY SCIENTIFIC ADVISORY PANEL
TASK FORCE ON FOREIGN SYSTEMS

SUBJECT: REPORT ON HUNSTVILLE MEETING AND FURTHER PLANS

During the May meeting of the ASAP in Huntsville, a few of the members of the Task Force on Foreign Systems heard a summary of evaluations which are being done on the CROTALE, the RAPIER, and the ROLAND. We also were given summaries of several other potential systems that might be candidates for purchase by the United States for Army inventory.

After this presentation, the Foreign Systems Task Force members held a short meeting in order to discuss the possible extent of our future work, and to make suggestions on how to best plan our next meeting. As a result of the group recommendations and some additional information from the Army, the following conclusions appear valid:

1. There is an obvious problem in making any developed systems fit Army requirements, since these requirements have been developed without any strong effort to compromise for weapon economy, state-of-the-art, or specific time constraints. Thus, one major problem which our Task Force might address is the method whereby the Army can reach necessary compromises among the available developed systems (or elements of systems), the obvious limitations on our R&D budgets, and the firm statement of requirements already in the Army system.

2. It is obvious that opportunities for foreign nation cooperation with the United States exist across the spectrum from pure research, to operational development, through the purchase or manufacture of fully developed foreign systems. The entire spectrum is beyond the capability of any reasonable task force to offer intelligent suggestions within a reasonable period of time.

3. In view of conclusion 2 above, it appears that the following framework should be used to plan our future activities.

a. There are many areas for profitable mutual programs with NATO nations as a group, or as individuals, in the field of fundamental research, and the United States Army should continue to seek areas where mutual programs would be beneficial. It does not appear that there are major problems or opportunities in this field that are not now susceptible to solution by normal Army organizations. Therefore, the Foreign Technology Task Force should not seek areas for more detailed contributions in this field.

b. With respect to the creation of development programs starting from attempts to standardize European and United States major requirements, and including full mutual development leading to a weapon system, recent

Encl 1

history has proven that such programs are extremely difficult and fraught with duplication, political perturbations, and expensive coordination. It therefore appears that we should not seek programs of this sort, and should resist them if offered. The Task Force has little, if any, contribution to make in this area.

c. Since R&D budgets will be limited for the foreseeable future, it appears that the most probable areas for the United States to benefit from foreign technology are:

(1) The purchase or manufacture of fully developed systems, or system elements, which are being considered for inventory by the Armies of the NATO nations.

(2) The initiation of interdependent development projects with foreign nations.

Interdependent development is cooperative R&D whereby the US and one or more other participants: Agree upon a materiel requirement; assign to one participant all development responsibility including funding, and other participants forego development; evaluate for possible adoption the outcome of the development. Interdependent development may correspond to exploratory, advanced, engineering, or operational systems development and may culminate in a decision to accept foreign developed materiel as meeting US requirements.

d. Where the US is purchasing fully developed systems, strong deterrents should be developed to prevent the Army organizations involved from making major changes in such systems under the guise of unfulfilled requirements, details, standardization, and/or improved performance. These deterrents should apply whether the system is purchased directly or manufactured within the US.

Willis M. Hawkins

Chairman

Please File

Terms of Reference
ASAP Ad Hoc Group on Foreign Systems

1. General Comments.

a. The technologies of numerous US allies have developed to a point where they now have comparable expertise with the US in many fields and may even surpass the US in certain areas. This fact, and the increasingly prohibitive costs of materiel development, argue strongly for a continuing monitorship of foreign technology to insure against duplication of effort.

b. In 1972, an Ad Hoc Panel was established by direction of the Office of Science and Technology, Executive Office of the President, to provide suggestions for enhancing the Army's timely and efficient utilization of technology. Panel recommendations included four suggestions for more effective utilization of the Army Scientific Advisory Panel (ASAP) including preparation of an annual input of potential foreign hardware which could fulfill Army requirements.

2. Terms of Reference. In view of the above, an ASAP Working Group is established to review applicable areas of foreign technology with regard to Army requirements and to report annually on -

a. Those technical areas (by country) in which substantial improvement in state-of-the-arts vis-a-vis the US has taken place.

b. Existing or planned foreign developments which parallel or supplement proposed or existing Army efforts.

3. Procedual Guidance:

a. In preparation of this input it is suggested that the following organizations be among those consulted by the Working Group: International

Attachment #1

Division, OCRD (DARD-PPI); International Development Branch, AMC HQ (AMCRD-PI); Foreign Science and Technology Center (FSTC); Army MAAGs and/or DAOs in selected high technology.

b. This ad hoc group will operate on a continuing basis. Members will serve for a period of one year.

c. The ad hoc group will report findings in the month of December in order to be of greatest value to R&D programming decisions.

HISTORICAL SUMMARY OF US ARMY UTILIZATION OF FOREIGN HARDWARE

PURPOSE: This paper has been prepared at the request of the Army Scientific Advisory Panel Working Group on Foreign Technology to provide background material on the utilization of foreign hardware and developments by the US Army. The intent of the research effort was to answer the following questions:

1. What foreign hardware has been adopted by the US Army and why was it adopted?

2. How did the Army learn about this hardware?

3. What were the mechanics of procuring, testing, and adopting the hardware?

4. Were identifiable advocates responsible in large part for the decision to adopt the hardware and the implementation?

5. How widely was the equipment used after it was adopted?

SOURCES/REMARKS: No previous efforts to write such a paper were uncovered. It was therefore necessary to gather research on an item by item basis, and to do this the following sources (among others) were used: Office of the Chief of Military History, AMC Historical Offices (HQ and Commodity Commands), FSTC, TAG library, DDC, OCRD files. We know that other sources exist and that the list of foreign hardware here included is not complete. This paper should, however, provide a good sampling of the subject. Of the five questions for which answers were sought, historical records provide relatively good data for questions 1, 2 and 5. The answers to questions 3 and particularly 4 tend to fade with time and to be omitted from summaries of a historical nature. While checking of additional sources would probably add a few items to our list of foreign hardware, it is doubtful whether additional data could be uncovered to answer questions 3 and 4 without a time consuming search of bulky retired files on a hardware item basis. This is not presently practical. As a further note it should be understood that while some of the hardware items listed cross service lines, our basic attempt has been to keep this paper restricted to those items of foreign hardware adopted by the US Army.

DISCUSSION:

1. World War I and Period from 1919-1939: Because of US unpreparedness for entry into World War I the AEF was dependent on France and Britain for nearly all military equipment except rifles and small arms ammunition. In the period immediately after the war, the Army examined its needs in a number

of areas and established its requirements. Because of its World War I experience with allied hardware, its acquired knowledge of German weapons, and the fact that the US had little experience in the R&D of modern weapons of war (1918 vintage), many of the developments in the period 1919-1939 were patterned after foreign hardware. While it is not explicitly stated, it appears that during at least the first part of this period (1919 to about 1935) a number of our items were reverse engineered from foreign hardware. The following areas may be of interest:

a. Artillery

(1) Adoption of French Artillery Design: Two months after US entry into World War I, the Army, at the recommendation of the Ordnance Department, made the decision to adopt French artillery design in order to speed procurement and took steps to obtain from the French Government, production drawings for the 75mm gun, the 105mm and 155mm howitzers, and ammunition for these weapons. When the French drawings arrived 6 months later, they contained numerous errors and were not immediately adaptable to American production processes. Other problems included Congressional insistence on competitive bidding, interservice competiton for facilities (with Navy having 1st priority), a government policy of letting companies with foreign orders complete them prior to starting US development, and the delay for industry tooling up. As a result, only 815 field guns were manufactured in the US during the period 1 April 1917 - 11 November 1918 with the remainder coming from our allies.

(2) Westervelt Board (Caliber Board): One month after the Armistice, the Army Chief of Staff appointed a board of 7 officers, headed by BG William I. Westervelt, to convene in France at the earliest practicable time "to make a study of the armament, calibers, and types of materiel, kinds and proportion of ammunition, and methods of transport of the artillery to be assigned to a Field Army." This board was to map out a comprehensive development program. During the period from 12 January 1919-5 May 1919 when it submitted its report to the Chief of Staff, it consulted with French, Italian, and British artillery experts, examined allied and enemy materiel, inspected plants and consulted American commanders in the AEF and the Chiefs of Ordnance, Coast Artillery, Field Artillery, and Chemical Warfare. The report, approved by the Chief of Staff on 23 May 1919, showed that every piece of artillery, artillery support equipment, and artillery ammunition in the Army inventory needed improvement. The heart of the report was the section on "Types of Artillery Recommended: Ideal and Practical." For each class of artillery, the board described the characteristics of an "ideal" weapon and then advised what should be used as a practical one. The importance of this board can be seen in the fact that for the next 15 years, apart from small arms projects, most of the developments at which the Army Ordnance Department aimed were those outlined in the Westervelt Board report, and as late as 1939 and 1940 officers still cited the board as the incontrovertible authority on armament. Its importance to this paper is in the influence that evaluation of foreign hardware played on its recommendations.

(3) 75mm: The Westervelt Board recommended that while work should proceed on the "ideal 75mm weapon," as a practical (interim) measure the Army should use 50% 75mm guns, Model 1916, and 50% French 75mm guns. In 1926 the Army superseded the French 75mm gun with the US developed 75mm gun, Model 1923E. The 75mm pack howitzer, M1, was developed by the US and standardized in 1927. While the French 75mm gun probably had some effect on this development, it appears that the Vickers-Maxim 2.95 inch mountain gun affected its design more. Before World War I, the Army had spent a good deal of effort designing a mountain gun better than this English weapon. This project was dropped during World War I, but was revived based on recommendations of the Westervelt Board, and eventually culminated in the 75mm pack howitzer.

(4) Manufacturing process for 3" gun: Watertown Arsenal engineers improved the French developed process of autofrettage or radial expansion thereby producing a superior forging for the 3 inch gun quickly and economically. This process was extended to the manufacture of other guns.

(5) 105mm Howitzer: Based upon Westervelt Board recommendation, experienced FA and Ordnance officers drew up specifications and in 1920, four carriages and howitzers were built for test. These models were unsatisfactory. While the Ordnance Department worked upon improved American models, the Field Artillery (FA) tested some of the German 105s captured in World War I and rechambered to take American ammunition. The FA's enthusiasm was such that the FA Board recommended adoption of the German 105mm howitzer for service use. The Chief of Ordnance protested due to shortage of proper ammunition, the cost of putting 300 German Howitzers into condition and the lack of uniformity in those on hand from which to prepare drawings for quantity production. The General Staff therefore decided to put the German howitzer in storage and have one battery of four new American models manufactured for service test. The US model that was adopted in 1934 was the M2. This was improved and modified and evolved into the 105mm howitzer, M2A1, in 1939.

(6) 240mm howitzer: The Westervelt Board recommended an 8" gun and a 240mm howitxer. In order to assemble ballistic data, two years of firing tests of the French Schneider 240mm howitzer, M1918, and the American model M1918M1 were held at Aberdeen Proving Ground and Fort Bragg. Development of both items was halted in 1924 because of budget cuts and not resumed until 1939.

b. 37mm Anti-tank Gun: The Army learned about the German 37mm AT gun in 1935 reports from the US military observer in Berlin. The German gun was purchased from Rheinmetall (which was offering the gun to foreign countries for test and quantity purchase) and tested with a US experimental 37mm gun, a French 25mm gun, and a German 47mm gun. As a result of the tests and the "proven superiority of 37mm anti-tank weapons," the Chief of Infantry recommended that the specifications of the new medium tank then under consideration include armament of the US 37mm AT gun being developed by the Ordnance. The design that was ultimately accepted closely resembled the Rheinmetall weapon.

c. Bazooka Rocket: In 1939 the Swiss Company, Mohaupt, claimed to have developed a new explosive of greater explosive force than TNT and a fuze that doubled the effect of the explosive. This explosive was demonstrated for the British and Americans. While both countries were impressed with the explosive, the high asking price ($25K in advance of negotiations) halted negotiations with both countries. In 1940 Henri Mohaupt himself came to Washington under the aegis of the American agent of Edgar Brandt, the French munitions maker, with a model of a rifle grenade of his explosive. The US Army made an agreement with Mohaupt for the test firing of 200 rifle grenades at Aberdeen Proving Ground. As a result of that test, the US Army and Navy recommended purchasing rights to employ the Mohaupt principle in any form to which it might become adaptable. Only then did it come to light that Mohaupt did not have a new explosive, but was using the Munroe hollow charge principle protected by a 1911 British patent. As a result the US Army was able to conclude a contract with Mohaupt at a much lower price than the Swiss had first demanded. An adaptation of Mohaupt's design later formed the basis of the bazooka rocket.

2. Wartime Cooperation, 1940-1945: The wartime period was unique in that many legal restrictions on exchange of technical and R&D information were dissolved in the interests of allied victory. The Tizard Mission to the US in September 1940 included British and Canadian representatives of the Army, Navy, and Air Force and was a precursor of a series of special missions to America, Britain, and Canada. Initially, the US got more help in basic research than it gave, but this condition was reversed later in the war and the US scientific contributions came to be of great importance. The first move of the US Army in joining efforts with the British on both procurement and R&D was the creation of a Special Observer Group in London in May 1941. This group gave the US Army access to British "establishments" including military installations and manufacturing plants. The existence of this group and similar groups in the US made close collaboration on development and standardization of equipment possible. The collaboration also included free exchange of manufacturing techniques and processes. Equipment that was adopted by the US Army under this wartime collaboration included:

a. Canal Defense Light: This searchlight mounted in a specially designed General Grant tank turret was designed to aid night crossings. British research developed the CDL unaided. Delivery of the complete drawings to the Office, Chief of Ordnance, enabled the US Army to build 500 of these special turrets in 18 months, whereas at least two years of preliminary work would have been needed otherwise.

b. Field Artillery Range Finder: The M1916 field artillery range finder of World War I was still in use in 1942 when samples of one-meter range finders being produced in Canada for the British Army were procured for test by the fire control laboratory at Frankford Arsenal and by the Field Artillery Board and the Infantry Board. One of these British instruments was lighter, less bulky, and more accurate than any other range finder yet tested. Furthermore, it was more easily manufactured, cost

less, and used less strategic material. It was therefore standardized in December 1942 as the M7 for field artillery use, and, with modifications, as the M9 for infantry use. At the same time the M1916 was classified as limited standard and development of all other experimental one-meter rangefinders was cancelled.

c. High Explosives: In 1940 there were at hand, several explosives of higher shattering effect; or brisance, than TNT. One of the most important of these was cyclotrimethylene-trinitramine which the US called cyclonite and the British called RDX. Because RDX was far too sensitive to be used in the pure state in a shell, it was necessary to mix it with oil, wax, or other explosives to form usable compositions. The British had managed to desensitize RDX by mixing it with 9% beeswax to form Composition A, for press-loading into shells; with 39.5% TNT and 1% beeswax to form Composition B, chiefly for bomb loading; and with 11.7% plasticizing oil to form Composition C, for demolition work. These formulae were given to the US by the Tizard Mission in 1940.

d. Minefield Clearing Devices: At the outset of World War II the US had no equipment specifically for clearing minefields. In 1940 the Corps of Engineers received information concerning a French mechanical mine exploder which consisted of a tank propelling three sets of roller disks, two mounted on the front and one on the rear. From the French design, the Army developed a like item, the T1, which was tested at Aberdeen in 1942. The T1 showed that it could detonate mines, but fell far short of possessing the other characteristics desired in a mine exploder - indestructability, maneuverability, and simplicity of design. However, since the principle appeared sound and no better ideas were available, development of exploders of the French type continued. Another type of device was the Scorpion designed by the British in North Africa. The Scorpion used steel chains attached to a revolving roller to beat the ground in front of the tank. On the basis of drawings sent to the US by the British in the summer of 1942, the US Lamson Corporation began manufacture of an American model, the T3. In December 1942, before the T3 was completed, General Barnes, the Chief of Ordance, visited the Eighth Army Tank School in North Africa and witnessed a demonstration of the Scorpion. General Barnes was impressed and recommended the US manufacture of at least 50 T3's for immediate shipment overseas. Thirty were pushed to completion and shipped in the spring of 1943. The T3's did not prove to be satisfactory.

e. Sighting and Control System for 37mm anti-aircraft gun: In 1940 the existing sighting and control system for the 37mm gun was scrapped in favor of a British development, the Kerrison predictor and "oil gears." These "oil gears" were electrohydraulic power control units mounted on the carriage and linked by an electrical data transmission system to the mechanical director. The separate, off-carriage Kerrison predictor computed the firing data as it tracked the target. This British remote control system, originally designed for use with the 40mm Bofors gun, was so undeniably superior to the American system that the Ordnance Technical Committee recommended adopting the British type for all new 37mm carriages. So equipped, the carriage was designated the M3A1.

f. 40mm Bofors anti-aircraft gun: The US Army evaluated the Swedish Bofors 40mm and attempted to purchase it in 1937 and 1938 without success due to misunderstandings with the Bofors company. The British strongly advocated adoption of the Bofors at the beginning of the War. While the carriage differed little from the 37mm carriage, the gun was considered by many experts to be superior to the 37mm. The Bofors fired a heavier projectile at a higher muzzle velocity with a slightly faster cyclic rate of fire to a greater range. In the fall of 1940 the Navy and the Army acquired models. With close collaboration between the Army, Navy and the British, the US was able to hasten negotiations for manufacturing rights and drawings. Construction of two pilot models started even before contracts with the Bofors Company were formalized. The Army officially adopted the air cooled Bofors as the 40mm automatic anti-aircraft gun M1 in April 1941 with the explicit statement that as quantity manufacture was achieved, the 40mm was to supersede the 37mm gun. That moment came in the summer of 1943, a delay that had been prolonged by the necessity of transposing the metric measurements of the foreign drawings to US Ordnance standards. Americanization of the Bofors included substitution of an American fuze in the ammunition, and modifications to the mount and carriage.

g. 404 type Hispano-Suiza Gun: In 1937, Army Ordnance designers began work on a .90 caliber (about 22.8mm) gun for aircraft. This project was eventually cancelled because of the urgent need of the Army Air Corps and the existence of the 404 Type Hispano-Suiza Gun, the essential features of which would neet the requirement. This 20mm gun was described in a report from Paris. The US Army purchased the gun and 2000 rounds of ammunition. While waiting for the shipment to arrive, Aberdeen tested a Danish Madsen 23mm, a 20mm Rheinmetall, a 20mm Swiss Oerlikon, and a 20mm French Hispano Suiza of earlier design, the last two guns borrowed from the Navy. The new Type 404 gun was tested for several months and concluded to be superior to all of the others tested. In the Spring of 1939, the Army bought 33 additional type 404 guns from the French and began negotiations to secure US manufacturing rights. In May 1940, the 404 was approved for standardization as the 20mm automatic gun M1. Watervliet Arsenal prepared drawings for contractors because the French drawings not only would be delayed in arrival but also would be in metric measurements. Though in the interest of saving time, the 20mm automatic cannon was purchased, a number of modifications were introduced to make it fully satisfactory for air combat. These included changes in recoil mechanisms, firing mechanisms, and loading devices to provide seven models of the 20mm for different types of aircraft. A total of 134,633 20mm guns were produced.

h. The Bailey Bridge: In late 1941, the US Army Corps of Engineers had a multiplicity of bridges most of which were heavy, bulky, difficult to transport, and slow to erect. In addition, the increasing weight of tanks was making it necessary to reinforce the bridges and shorten the spans. The British, by contrast, had been working toward the provision of all-purpose bridging and by the summer of 1941 were ready to begin production of the Bailey Bridge. In the summer of 1940, MAJ Frank Besson returned from England with working drawings of the Bailey. The

Engineer Board asked the firm of Sverdrup and Parcel to use the drawings, but to make the bridge conform to the practices of American rolling mills. Three weeks after Pearl Harbor, the Engineer Board wrote G-4 asking permission to spend $50K to buy one Bailey Bridge for testing. The Bailey Bridge was finally evaluated in comparative tests with the US H-10 and H-20 bridges. As a result of these tests and enthusiasm of US engineers in the European Theater of Operations, the Bailey was adopted by the US Army as a replacement for the H-20 in all theaters. In 1944, the US bought 850 Bailey Bridges (from US contractors), a quantity sufficient to meet overseas demands. While the Bailey Bridge and the treadway bridge were the workhorses of World War II, differing opinions on the worth of the Bailey among factions of the Engineer Board and other US commanders kept the Bailey from becoming a US Army all-purpose bridge.

3. Post World War II: With the end of World War II the basically free exchange of technical information, processes, patents, etc., during wartime came to a close. Gradually, the R&D exchange between the US and other technologically advanced countries, particularly those of Western Europe, assumed a more businesslike nature, finally evolving into the somewhat competitive (although still cooperative) system we have today. In the 1957-1959 time frame a number of bilateral agreements were negotiated with most of our technologically advanced allies for the interchange of patent rights and technical information for defense purposes. At about this same time the US DOD began to negotiate bilateral R&D data exchange agreements and investigate areas of cooperative R&D. While the attempted joint development programs (e.g., MBT-70) were basically unsuccessful, it can be stated that the US remained abreast of state-of-the-arts in hardware development abroad. In the early part of the post World War II period, the US had a clear superiority in defense technology among the allied nations and the flow of technology was basically one way. US assistance aimed at rebuilding the European economy and production base helped to develop a sophisticated R&D machine which rapidly became competitive in certain disciplines with the US. The US, while recognizing this European expertise and taking advantage of foreign innovations in US development program, has not made wide use of foreign end items. Some of the reasons given for this are that acceptance of foreign hardware would compromise the US requirement, erode US technology, and result in an unfavorable balance of payments. In addition, the purchase of a foreign technical data package would require extensive technical data conversion from the metric to the English system. While these objections to acceptance of foreign hardware remain, the rapidly increasing cost of military weapon systems is forcing all of us to look at cheaper methods of providing new weapons. It remains to be seen what new areas of cooperative development the US may enter into with its allies to insure continued defense hardware development at acceptable costs. Some of the more important items of foreign hardware of interest to the US Army in the post World War II period were:

a. SS-10/SS-11/ENTAC: This weapon system originated in Germany late in World War II as an air-to-air single wing, roll stabilized missile designated the X-4. Problems in developing solid fuel rocket motors at that time and the close of the war ended the German effort. After the war, the French Air Force picked up the effort. The French Army recognized the potentialities of the X-4 as a ground launched, antitank missile and developed it into the SS-10. In early 1952, the US Army purchased a quantity of SS-10s for test, but concluded that it was not reliable enough for Army use. Based upon Army and Marine Corps requirements, and military characteristics as established by the Army Field Forces (predecessor to CONARC and now FORSCOM), the Army during the period 1950-1954, investigated and conducted R&D in the field of various antitank guided missile systems. These investigations/feasibility studies indicated the soundness and attainability of an antitank guided missile using manually controlled line-of-sight trajectory, subsonic speed, simple wire guidance system, oscillatory control surfaces, and simple solid propellant booster-sustainer rocket. In May 1956, the US entered into an agreement with France (in which the US contributed 1/3 of the total cost of $5M) for the development of the SS-11 antitank guided missile. By this agreement, the US acquired technical data on the French SS-11 development, but no license rights. In 1958, because of international complications and a possible Berlin crisis, Army/Marine requirements for an antitank guided weapon, the failure of the US DART antitank guided missile program, and the French improvements to the SS-10 (which was again tested by the US in the 1954-1958 period), the SS-10 was approved for US Army use as an interim system to provide limited operational capability for selected Army units. Formal standardization action took place in April 1959. In March 1959, CONARC submitted revised guidelines in the form of military characteristics for use as a yardstick in evaluation of other available antitank guided missile systems. Consideration was given to the SS-11 and ENAC (related French developments), COBRA (German), VIGILANTE (British), and MOSQUITO (Swiss). In conjunction with the US purchase of SS-10 missiles from France in 1959 and 1960 the US purchased some SS-11s for test and evaulation. As a result of Army and Marine tests of the SS-11 and ENTAC, and reviews at USA Ordnance Missile Command, Chief of Ordnance, Chief of R&D, DCSLOG, and Military Requirements Review Committee levels, ENTAC Requirements Review Committee levels, ENTAC was type classified Standard A for infantry use on 13 April 1961 and the SS-11 was standardized as limited production type (LP) for helicopter armament on 12 May 1961. The US government subsequently purchased a license for US production of ENTAC and SS-11 from France. While the US provided $2.7M of a total of $6.9M for French SS-12 development (follow-on to SS-11), the US terminated its support in 1962 and did not purchase SS-12s.

b. Multifuel Engines: The basic combustion process used in the multifuel engines was developed by D. Meurer of the MAN Company, a German concern. In this process the combustion chamber is in the shape of a cup, fuel is directed on the walls of the cup, and air is swirled in the combustion cup at high velocities. The combination of air swirl and controlled rate of fuel pick-up from the walls of the cup produces a

controlled rate of combustion. The basic German objective in this development was the reduction of noise in direct engines. However, this combustion process also allowed the use of a wide range of middle distillate fuels including gasoline. Continental acquired a license to use the process in its engine development program and in 1954 the US Army initiated some exploratory work with Continental on the MAN process. The feasibility of applying this process to American production vehicles was studied and in 1957 the Ordnance Tank-Automotive Command initiated development of the LDS-427 multifuel engine with Continental. US interest in multifuel engines was a direct result of the national fuel policy which indicated that diesel fuels might not be available for Army vehicles in case of major war. The LDS-427 (140HP) was developed as the power plant for the 2 1/2 ton cargo truck. After intensive testing the first procurement contract was awarded to Continental in 1961. As a result of the success of the LDS-427, in 1961 Continental proposed follow-on development of an increased displacement, 140HP, naturally aspirated engine, the LD-465, for the 2 1/2 ton truck and an increased displacement, 210HP, supercharged engine, the LDS-465, for the 5 ton truck. 90% of the parts for these two engines would be interchangeable. The Army accepted. The LD-465 engine development was successful and is currently used in the 2 1/2 ton cargo truck. The maintenance problems associated with the LDS-465 were never overcome and in 1969 a decision was made to phase out this engine, replacing it with a Cummins diesel engine in the 5 ton truck.

c. US Army Fixed Wing Aircraft: A significant portion of the Army's fixed wing aircraft have come from Canada, specifically de Havilland of Canada. These aircraft were originally developed for Canadian military, or at least government, use and were tested, accepted, and procured by the US Government either directly from de Havilland of Canada or through the Canadian Government.

L-20 Beaver: This is a single engine nonoplane developed by de Havilland Canada for bush pilot operations. The prototype flew in August 1947, ten months after design began. In February 1951, the USAF held a competitive evaluation of liaison aircraft at Wright-Patterson AFB. The Beaver won and shortly thereafter the Air Force placed a procurement order. The Army later joined the Air Force in procuring Beavers. For a decade, the L19 Bird Dog and the L20 Beaver have been the primary fixed wing observation aircraft in the Army inventory. The beaver is used by Canada and 53 other countries.

OTTER: This single engined, general utility transport, capable of carrying 9-11 passengers, was also developed by de Havilland Canada for bush pilot operations and flew for the first time in December 1951. It is used by the RCAF for Arctic search and rescue. Early in 1955, de Havilland Canada began production of 90 OTTERS for the US Army. The first six of these were delivered in March 1955. Designated the U-1A by the Army, this aircraft is used for forward area supply, transporting troops/paratroops, casualty evacuation, etc.

CV-2 CARIBOU: This twin engine transport was developed by de Havilland Canada with the assistance of the Canadian Department of Defense to combine the load carrying capacity of the DC-3 with the STOL capabilities of the Beaver and OTTER. Construction began in 1957 and the prototype flew in July 1958. In 1959 five CARIBOU were delivered to the US Army, through the Canadian Department of Defense, for testing. As a result of this evaluation, the CARIBOU was type classified in December 1960 and the Army contracted with de Havilland for 159 aircraft. To allow the CARIBOU purchase, The Secretary of Defense waived the restriction limiting US Army fixed aircraft to an emply weight of 5000 lbs. The 134 aircraft still in service in January 1967 were transferred to the Air Force under an interservice agreement.

C-8A Buffalo - In May 1962, the US Army invited 25 companies to submit proposals for a new STOL tactical transport aircraft as a follow-on to CARIBOU. de Havilland Canada won with an improved, developed version of the CARIBOU powered by two GE turboprop engines. Development costs for the Buffalo were shared equally by the US Army, Canadian Government, and de Havilland Canada. The Army began evaluation of delivered aircraft in April 1965. In January 1967 this aircraft was turned over to the Air Force along with the CARIBOU.

d. 105mm Tank Gun M68: As a result of the tripartite (UK, Canada, US) Tank Armament Conference in England in November 1956, the US, in early 1957, initiated a program to procure and Americanize the UK X15E8 "20 pounder". This 105mm gun was designate the T254. Impetus for this move was concern about the Soviet armored threat, a warning by Bureau of the Budget regarding plans to limit funding of future tank developments, and a desire to be able to fire the UK 105mm spin stablized ammunition. Plans for the T254 were to increase the firepower of the M48 tank and also to mount it in an M48A2 turret on a chassis of the T95 series tank as a T95E5 medium gun tank. At the Fourth Tripartite Conference on armor in Quebec in October 1957, the UK, Canada, and the US agreed on the desirability of having a single main battle tank, the military characteristics of which could probably be met by a medium gun tank. The XM60 was designated to fill this role until an air transportable T95 series would be developed. One of the guns considered for the main armament of the new tank was the T254. To select the main armament for the XM60, the Army Chief of R&D arranged a "turkey shoot" at Aberdeen Proving Ground in 1958. Ballistic Research Laboratory was directed by the OCRD Chief of the Combat Materiel Division, Colonel Michael S. Davison, to develop a test program to generate performance data for a selection basis for an XM60 tank main gun. Responsibility for the test went to the Chief of Ordnance for a coordinated Ordnance - CONARC test. CONARC allowed the Chief of Ordnance to take full responsibility, participating only in observer status. In the subsequent testing by BRL during October-November 1958, the T254 was determined to be the best all around weapon (despite the fact that its armor penetration capability was only considered mediocre) and was ultimately selected for the XM60 as well as for some models of the M48. In 1960 the US and UK concluded a standardization agreement to insure interchangeability of the UK and US 105mm tank guns. In addition, the UK 105mm gun is used in the FRG

Leopard I, the Swedish Sχ Tank, and is also used by Japan, Israel, and several other countries.

e. RATAC (AN/TPS-58 Ground Surveillance Radar: The RATAC radar was developed by the French Central Laboratory for Telecommunications (LCT) under contract to the French and German Governments. Total rights to RATAC are vested in the Governments of France and FRG, and LCT (which is at least partially owned by the Government of France). In 1969, the US Army secured a RATAC for military potential tests at Fort Sill. In January 1970, the US Army in Vietnam (USARV) submitted an Expedited Non-Standard Urgent Request for Equipment (ENSURE), asking DA to provide 24 RATACs for use in Vietnam as replacements for the outdated AN/TPS-25. The US Army purchased these 24 RATACs from the French manufacturers through the US licensee, ITT Guilfillan. Concurrent with this ENSURE procurement, the Army negotiated a second program with ITT Guilfillan to modify the RATAC to meet US production standards and deliver 6 Americanized radars (designated the AN/TPS-58) for Army test and subsequent type classification as a replacement for the AN/TPS-25. The Army also negotiated a memorandum of understanding (MOU) with the Government of France (who also acted for FRG in this matter) delineating the terms of the US/France/FRG cooperation in this area and agreeing to pay a pro-rated share of the development cost. The 24 ENSURE RATACs were shelterized by ITT Guilfillan, shipped to USARV beginning in August 1971, and employed during the remainder of the US Army effort there. The six AN/TPS-58s will be delivered for test in January 1974. Total cost of the ENSURE RATAC effort was about $18.3M, about 50% more than the original estimate. Cost of the six Americanized versions will be about $12.6M, or about twice the original effort.

CONCLUSIONS:

1. A significant portion of the current US Army operational military hardware was originally patterned after foreign hardware (principally European) during the periods shortly after World War I and during World War II. This hardware then underwent numerous product improvements and resulted in the equipment we currently have in the inventory. The prime example of this was the development of a family of field artillery weapons.

2. From the historical accounts perused, it appears that the US Army, during the period between World Wars I and II, borrowed foreign technology quite freely without great concern for the ownership of the industrial proprietary rights. In the same token, it appears that little, if any, pressure was put on the US in their Americanization of foreign hardware effort by other countries.

3. The cooperation in R&D among allies (particularly the US, UK, and Canada) during World War II was ~~a~~ not typical of normal peacetime cooperation.

The relaxation of normal national policies in this situation allowed the relatively free flow of substantial information on developments, manufacturing process, etc.

5. In the period immediately after World War II, the US found itself the unchallenged technological leader in the world. The result was a largely one-way flow of technology which lasted for several years until continental Europe rebuilt its technology base and again made its influence felt.

6. The situation today is one of relative equality between the US, UK, FRG, and France in military technology. Each country has wide knowledge of the others' developmental efforts. This is due to the fact that each of the four countries has extensive ties with the other three (bilaterally and through NATO), and each country also has an ambitious foreign sales program and advertises its products widely. In this atmosphere of competition among allies, it is natural that proprietary rights should be jealously guarded.

7. Rising R&D costs and the desirability of eliminating duplicative development efforts and standardizing hardware among allies has prompted a good deal of allied effort in cooperative R&D - Joint development programs in which the US has participated have been basically unsuccessful to date. Interdependent development (unilateral development to meet joint requirements) is in an exploratory stage. Purchase of foreign hardware off-the-shelf has been done in a number of cases, but there have been numberous problems. There is considerable national resistance to the US purchase of foreign hardware based on the following arguments:

a. Compromise of US Requirement - Some deviation from US requirement is normally required in adopting a foreign piece of hardware. Key question is what requirements are essential. Associated with this is the high cost of "Americanization" of the foreign system to meet US world-wide requirements. Case in point is RATAC.

b. Erosion of Technology - Reliance on foreign technology could erode like US technological capability.

c. Less than Total Ownership by DA - Selling nation may attach restrictions on US use of equipment, e.g. US was restricted from passing RATAC information to Israel or RVN.

d. Conversion of Foreign Data Package to US Standards.

e. Balance of Payments - Congress has frequently looked askance at the purchase of foreign technology in lieu of US technology because of the effect on US jobs and balance of payments.

f. Security - A prime example of this problem is the situation with French CROTALE low altitude air defense missile which is being evaluated

for possible adoption by US Army. CROTALE has been sold to Libya. US is presently evaluating the effects of this sale on possible US deployment of the missile.

8. While considerable lip service has been paid to the concept of reducing R&D costs by making use of foreign technology, little of a substantive nature has yet been done.