THE IMPACT OF TECHNICAL DATA TRANSFER PROBLEMS DURING A TRANSITION OF WEAPONS SYSTEM PRODUCTION BETWEEN NATIONS

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In the early 1980s the U.S. Army sought to replace its aging fleet of M102 105mm-towed howitzers with the British M119 under a Non-Developmental Item (NDI) acquisition strategy. This paper addresses the problems experienced, their possible causes and effects, and provides a list of lessons learned. Finally, recommendations are made to help future program managers mitigate or avoid the problems experienced by the M119 program.

Although the M119 program has been hailed as a very successful NDI acquisition, there were problems encountered by the program office along the way. The most significant of these was the transition of production from the original manufacturer, Royal Ordnance, to the U.S. arsenals at Rock Island, Illinois and Watervliet, New York. The major cause of this transition problem was the transfer of the Technical Data Package (TDP).

The TDP provided by Royal Ordnance was not, and never would be, found acceptable under U.S. standards. Additionally, the Program Office was restricted in its ability to mitigate some of the potential risks associated with TDP transfer. All in all, the TDP transfer problem cost the program an incredible amount of time and money.

All of the data presented here (with the exception of Reese and Fowler, which are periodical articles) were drawn from American sources. Neither Royal Ordnance nor the government of the United Kingdom provided input to this work. Representatives from Royal Ordnance were contacted via facsimile but did not respond. One source did agree to discuss issues contained in this

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work based on a grant of anonymity. The author was also provided multiple examples, from multiple sources, of General Officer "meddling" and pressure in the M119 acquisition process.

From Whence It Came

In late 1983, the U.S. Army initiated a program to redesign the structure, roles, and missions of its light infantry divisions (LIDs). Within this redesign of the LID, the decision was made to procure "a longer range, more lethal artillery weapon" (Army Magazine, 1986, pg. 365). Importantly, the Army Chief of Staff (CSA) "also established an extreme sense of urgency for fielding the light division" (U.S. Army ARDEC, 1987, pg. 1). The program direction that devolved from this CSA guidance was to search for a howitzer that the Army could "field immediately" (U.S. Army ARDEC, 1987, pg. 1). In terms of the M119 program, "immediately" was translated into a "must have" fielding date in selection criteria that would fall within fiscal year 1987 (U.S. Army ARDEC, 1987, pg. 3).

In January 1984, Army headquarters tasked the Army Materiel Command (AMC) to search the inventory of U.S. and NATO 105mm howitzers and develop a list of those capable of meeting the LID requirements for light infantry (HQ, U.S. Army AMCCOM, 1985, pg. 1). Over the course of the next five months AMC evaluated 20 weapons and eliminated all but four. It was from these four that the British Light Gun, the L119, was determined to be the "best candidate for the LID" (U.S. Army AMCCOM, 1985, pg. 2). The ARDEC briefed these results to the CSA in May 1984, recommending the L119.

The Chief's decision was to lease a sufficient number of L119 howitzers for testing, and to develop new 105mm rounds for increased range and lethality (HQ, U.S. Army AMCCOM, 1985, pg. 2). After this initial testing was successfully completed, the weapon was type-classified in December 1985. Production contracts were prepared and a licensing agreement between the U.S. and Royal Ordnance was negotiated the following year (Armament and Chemical Acquisition and Logistics Agency, 1994, pg. 1).

The licensing agreement was made necessary by the Army's decision to purchase only a portion of the weapons desired from Royal Ordnance, with the remainder being produced domestically. It authorized American production of the L119 and established royalty payment procedures.

The decision to produce the M119

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domestically was based on two factors. The first, maintainability, stressed concerns about the availability of spare parts and the lack of control over an offshore source. Second and conceivably more important, there were nationalistic considerations; specifically, the maintenance of the mobilization base. Each had an impact on the decision (U.S. Army AMCCOM, 1987). Based on these and other factors, the Government opted to perform production at Watervliet Arsenal, which would manufacture the cannon assembly, and Rock Island Arsenal, which would produce the trail assemblies. The two pieces would be assembled, and the howitzer completed, at Rock Island. These two arsenals, then, had to prepare their facilities for the gradual transition of production from Royal Ordnance.

The license agreement cost 1,150,000 pounds sterling for 145 complete howitzers, 20 carriage assemblies, 15 trail assemblies, additional parts and equipment from the U.K., and the royalty fees and TDP required for subsequent U.S. production (U.S. Army AMCCOM, 1987, pg. 1). The production contracts were signed in July 1987, with Royal Ordnance operating off what was considered to be a warm production base. Royal Ordnance delivered the first production guns to the U.S. for Production Verification Tests in early 1988. Production began in America in fiscal year 1988, with the first howitzers coming off the line in October 1990 (Reece, 1991, pg. 718).

Impact of the Technical Data Package

A technical data package defines the system's design configuration and the production, engineering, and logistics support procedures required to ensure the system's adequate performance. The TDP consists of all applicable technical data, including drawings, quality assurance provisions, and packaging details (DSMC, 1991).

As part of its licensing agreement with the U.S., Royal Ordnance agreed to provide the Americans with a TDP that was "sufficient to manufacture in the U.S." (Armament and Chemical Acquisition and Logistics Agency, 1994, pg. 1) and which "consists of all the recorded 'know-how' required to manufacture, assemble and test...the L118/L119 gun" (Nathan, 1995, January 30). What Royal Ordnance actually provided was much less: an archival set of drawings, a set of manufacturing drawings (which showed in-progress drawings, some gage and inspection drawings), an illustrated parts catalog (similar to our -34P technical manuals), and a Final Inspection Record (Nathan, 1995, January 30). While all of these documents are valuable in and of themselves, they did not satisfy the U.S. Government's requirements for TDP content and accuracy of drawings.

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According to the original schedule, the technical data package was to be delivered in January of 1986. It was not

actually received, however, until August of that year, due to problems that Royal Ordnance experienced in collecting and assembling the required information (Nathan, 1994, pg. 18). Additionally, the TDP as delivered was "'archival', grossly inaccurate, and missing essential manufacturing data" (Armament and Chemical Acquisition and Logistics Agency, 1994, pg. 1).

The engineers at Rock Island and Watervliet recognized that this TDP was of little use to them and returned it to Royal Ordnance for rework. Royal Ordnance claimed in response that the Technical Data Package met the requirements, but agreed to fix it for an additional cost of $4.75 million. The Americans in the program office felt "in a bind" at this point: Royal Ordnance had failed to comply with the licensing agreement and should fix the Technical Data Package at no cost, yet there was severe pressure to get the howitzer into the system quickly. As a result, the program office opted to avoid lengthy litigation by paying Royal Ordnance to rework the TDP.

"Royal Ordnance had no idea what an Americanized Technical Data Package looked like"

This revised TDP still failed to meet requirements in August 1987 (Nathan, 1995, January 30). Again, the problems centered on the actual quantity and detail of information being provided. Schedule slippage, coupled with the delay engendered by Royal Ordnance in modifying the original TDP, prompted the project office to have this version fixed at ARDEC and at the arsenals in Rock Island and Watervliet. The cost of this domestic fix was $3.0 million (Armament and Chemical Acquisition and Logistics Agency, 1994, pg. 1). The end result was a TDP nearly $7.75 million over budget and more than three years' late.

These problems highlight the potential difficulty in dealing with sources other than those routinely involved in production for the U.S. Government. This is not to say that similar problems never occur with domestic manufacturers. Rather, the problems were significantly exacerbated by Royal Ordnance's inexperience with the American "way of doing business."

One of the critical requirements of an American technical data package is that it provides the information required by manufacturers to "produce to [the] TDP with stringent configuration management requirements" (Nathan, 1994, pg. 1). This requirement caused a significant portion of Royal Ordnance's TDP problems. The company produced the L119 in its own plant using a "fit at production" philosophy, so that the accuracy of drawings used on the production floor was less critical. However, Royal Ordnance had difficulty putting this process on paper. As one member of the project team stated, "Royal Ordnance had no idea what an Americanized Technical Data Package looked like" (Nathan, 1994, pg. 1).

Furthermore, the "British Technical Data Package also had a substantial amount of sole source or proprietary components, which is unacceptable in a U.S. Technical Data Package" (Nathan, 1994, pg. 2). The British procurement process does not require competition. As a result, their system

has no need for the TDP information which is typically used by Americans to facilitate competition among different commercial sources or, alternatively, to produce the component in a U.S. Government arsenal.

The real issue had little to do with the TDP itself, but rather with the difference in the production philosophies of the Americans and Royal Ordnance. Essentially, at Royal Ordnance each howitzer was built individually, with pieces machined to fit each weapon regardless of design drawings. These production floor changes were seldom, if ever, reflected in the technical drawings included by Royal Ordnance in the TDP it provided to the U.S. Essentially, the TDP failed to reveal the actual process followed in manufacturing the L119.

Given no requirement for changes to be tracked or reflected on drawings, configuration control of the L119 was also a problem. In fact, with no standard manufacturing process and no approved design, it seemed nearly impossible that two identical howitzers could roll off the production line.

Fixing the Problems

Based on the differing views of production and configuration management between the U.S. and Royal Ordnance, it isn't surprising that the TDP provided by Royal Ordnance would fall short of what U.S. manufacturers required to produce the M119.

The drawings provided by Royal Ordnance in August 1986 were really nothing more than a rough draft for what the U.S. government would consider a TDP. To achieve that level of accuracy and detail, Royal Ordnance had first to update the TDP they were using in line with the howitzers they were producing. This required that they revise virtually every drawing to reflect the waivers, deviations, and engineering changes already approved on the shop floor, then implement a configuration management and status accounting system to ensure that any subsequent revisions were recorded on the spot (Nathan, 1994, pg. 2). This process, undertaken by Royal Ordnance with extensive U.S. help, took well over a year. Once completed, the technical data products provided by the company's manufacturing element improved significantly, although they remained below U.S. standards.

The impact of these TDP problems was enormous, driving program cost $24 million above budget and delaying initial fielding by more than three years. The TDP itself cost nearly eight times the amount originally planned.

In the absence of a good TDP, the initial 1984 estimate for retooling Rock Island and Watervliet arsenals to produce the M119 was $8 million, based on historical data from production of the M102 howitzer. This history failed to provide an accurate projection of the requirements for the M119. In early 1985, the first revised estimate increased tooling costs to $10 million. Another refinement, which took place just prior to the receipt of the first Royal Ordnance TDP, raised the estimate to $13 million (Nathan, 1995 [January 30], pg. 1), or $4.75 million each for Watervliet and Rock Island in fiscal

year 1987, with roughly an additional $3.5 million for Rock Island alone in fiscal year 1988 (HQ, U.S. Army AMCCOM, 1987, pg. 3). However, the eventual receipt of the TDP, and the subsequent revisions made to it, resulted in a final estimate for tooling costs of $23.3 million.

Army and AMC staffs approved these funds, and production tooling began in March 1990 (Nathan, 1995, January 30). As a result of TDP problems, tooling costs for the arsenals were almost three times the original estimates.

However, because production tooling (and production itself) could not begin in the U.S. until a usable TDP was developed, the timeliness of American production was threatened. The transformation of the production lines at both arsenals depended on the ability of their engineers to estimate and forecast equipment and material requirements. This estimation process, usually based on some form of technical drawing, is critical to a rapid transition. Facing an ever increasing amount of pressure, "(T)he arsenals could not afford to wait for an Americanized Technical Data Package in order to start production" (Fahey, 1994, pg. 2). Instead, the process went ahead using data gathered through a concurrent engineering effort at Rock Island. In this process,

> (A) concurrent engineering team (Arsenal production, ARDEC engineers, production planners, quality control and product assurance and logistical people) [got] together to review and mark up drawings to make them suitable for U.S. arsenal approval (Fahey, 1994, pg. 2).

To expedite the overall effort, the concurrent engineering team at Rock Island forwarded the 'Americanized' versions of individual Royal Ordnance TDP drawings to the manufacturing floor as they were finished. This process, which was both time and manpower intensive, produced a TDP that was "not an optimal Technical Data Package, but was a Technical Data Package that the arsenals could produce to" (Fahey, 1994, pg. 2).

As of the summer of 1995, there is no competitive TDP available. Production is still being conducted from Ordnance Drawings produced at Rock Island Arsenal.

The problems with the M119 technical data package during transition of production to the U.S. provide an important source of information for future program managers.

1. Technical data transference is critical if production transition is to be effective. Virtually every problem associated with the domestic production of the M119 stems from the inaccuracies and problems with the Technical Data Package. No significant problems were experienced with the actual physical reconfiguration of the arsenals to do the production. Once the required information was available, the arsenals functioned as they were supposed to. In this case, Royal Ordnance was not necessarily unwilling to provide accurate

technical data. In fact, due to the structure and process by which they had been producing the L119 for the U.K. Army, they were unable to provide an American quality TDP.

2. Foreign suppliers may or may not understand our acquisition practices. Clearly, Royal Ordnance did not. Issues which are peculiar to U.S. acquisition process in general, and to TDPs in particular, such as proprietary or sole source information restrictions, the level and degrees of accuracy for technical drawings, and rigidness of configuration control can introduce serious problems into the acquisition cycle if not handled properly.

3. Buying in a 'rush' is dangerous. With the selection of an existing system, the Army hoped to procure a weapon system in less time than that required for a full development. The use of a Non-Developmental Item (NDI) strategy is not at odds with using a methodical and structured approach. However, in addition to the time savings offered by NDI, in this case senior Army officials outside the acquisition chain tried to gain additional time by rushing the procurement cycle. As a result, proper investigation and confirmation procedures were not used to assure Royal Ordnance's capability to perform to contract. The pressure to get the howitzer into U.S. production forced the program office into an untenable position in terms of contract clause enforcement. In this case, the buyer 'needed to buy' more than the seller 'needed to sell.' As a result, the program office had difficulty forcing Royal Ordnance to live up to the agreements of the contract; it was faster to concede and pay the extra money than it was to fight it out.

4. Trying to fix something after the fact is hard to do. Once the contract was awarded to Royal Ordnance, it became extremely difficult to 'force' them to change and do things our way. This was the case with the discrepancy over the original Royal Ordnance-delivered TDP with regard to its compliance with the license agreement. Royal Ordnance claimed compliance, and it would have been extremely costly in terms of time and money to force them to do something which might possibly have been clarified easily or at little cost prior to execution.

Because the accuracy and completeness of technical data is critical, program offices need to devote time, money, and effort to researching a potential supplier's ability to comply with U.S. TDP requirements. Comprehensive reviews of technical data and drawings are the absolute minimum required. A survey of the potential supplier's manufacturing process and configuration control systems are also extremely important.

The real key to success in this area is

the determination that the production process in use by the potential supplier satisfies several requirements. First, the process in use must comply with the process that the manufacturer says (and documents historically) it is using. Second, the process in use must clearly produce the product in conformance with the applicable drawings. Finally, there must be an effective management system in place to monitor and document configuration management.

Clearly the most difficult problem to overcome is that of 'outside' meddling...

The responsibility to ensure that our suppliers are fully aware of U.S. Government-peculiar requirements rests on the U.S. procurement officials involved with the acquisition. Without a clear understanding of these requirements the supplier may very well find that, like Royal Ordnance, it is willing to comply but it is unable to do so. In the case of the L119, Royal Ordnance was already producing the system and their customers were very satisfied with the results. It was only when the U.S. tried to enforce compliance with its TDP standards that Royal Ordnance started to have problems. Early and continuous interface involving representatives from both sides can be an effective problem resolution technique. The program office and Royal Ordnance did, in fact, meet repeatedly, but it was after the contracts were signed. By that time, Royal Ordnance was committed to standards with which it could not comply.

The purpose of every acquisition should be to get the piece of equipment which best satisfies the user's need in a timely manner. In order to satisfy that purpose, we have a structured and methodical approach by which we procure items. By using selected strategies, such as NDI, we can efficiently reduce the lag time between requirement identification and need satisfaction. Unfortunately, our acquisition strategies are often distorted by political realities. Clearly the most difficult problem to overcome is that of 'outside' meddling in the procurement process.

Procurement professionals need to be shielded from the unrealistic demands imposed by 'interested' parties. A solid, logical, and realistic baseline schedule and process by which the program office gathers information and makes decisions is critical in preventing outside meddling. Program members need to be especially attuned to the political winds and their effects on the program. Early identification of potential problems are a significant step towards rational solutions.

Early identification of potential problem areas is a key to success. As with technical data transfer, all aspects of contract performance need to be explored early in the process in order to identify and resolve issues prior to award. In that way, potential sticking points between the two parties can be resolved in a cooperative atmosphere, rather than in an adversarial conflict revolving around interpretation of a contract clause after the fact. Had the U.S. conducted a detailed investigation into the practices employed by Royal Ordnance (i.e., technical drawing, configuration management, and documentation control procedures) before select-

ing the company as the source for its new howitzers, perhaps the outcome would have been different. If done prior to award, the changes to Royal Ordnance's process could have been made a condition of the award. If Royal Ordnance declined to accept 'our way of doing business,' we would be free to find another source or solution.

With the decision to replace the existing fleet of M102 howitzers, the Army hoped to procure a major weapon system under the NDI approach. This approach, it was hoped, would get the howitzer into the field much more quickly than if the weapon were to be developed from scratch. However, due to multiple factors, it was decided that only a portion of the weapons would be produced offshore, with the remaining weapons being produced within the U.S. arsenal system. This plan, while not unsound, ran into some difficulty. From the inception of the program, three relatively senior General Officers applied and maintained pressure on the program office to get the howitzer fielded quickly. As a result, the process, already shortened by the removal of development, was rushed further. With the selection of the Royal Ordnance L119 as the weapon of choice, events came together to portend trouble. The combination of the processes by which Royal Ordnance made the L119, the need for domestic U.S. production, and the time pressure being applied were directly at odds with each other. Because time was not available to investigate and assess the methods Royal Ordnance used to manufacture the L119, the program office never knew that the British manufacturing philosophy was radically different than that required for U.S. Government contractors. Additionally, it did not know that the drawings being used by Royal Ordnance did not really reflect the products being produced in any true engineering sense of the word. Finally, because the time was not available to explore Royal Ordnance's ability to provide an American standard TDP, the U.S. Government did not know until after the contract was signed that Royal Ordnance would not be able to provide a Technical Data Package suitable for use in a U.S. production facility. Thus, we entered into a contract with a party who was unable to complete their portion of the agreement. The program office was rushed into getting the system on contract without being given adequate time to investigate the full impact that the transfer of the Royal Ordnance TDP would have on our acquisition. The fault does not lie with Royal Ordnance. They had proven, over time, that they could produce a quality weapon system. However, the methodologies and requirements of the U.S. acquisition community were totally foreign to the decision makers at Royal Ordnance. This, coupled with unrealistic time demands on the decision makers on the U.S., led to a TDP problem which had, and continues to have, a significant impact on the M119 program. Although the acquisition of the M119 has been called a "model of future procurement" (Reece, 1991, pg. 718), it is

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also correct to state that the acquisition of the M119 howitzer should serve as a 'how not to' model for the problems associated with the transfer and management of technical data.

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