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BY THE U.S. GENERAL ACCOUNTING OFFICE
Report To The Secretary Of The Air Force

Air Force Global Weather Central Initiates Positive Action To Assess Adequacy Of Software Inventory

As a result of GAO recommendations and General Services Administration directives, the Air Force Global Weather Central has initiated a software improvement program to determine the adequacy of its current software inventory. Over the next 5 to 8 years, the Global Weather Central will inventory, analyze, and assess all software and develop a strategy for improving its software in preparation for upgrading its general purpose computers.

GAO suggests that, if successful, the approach being used should have wider Air Force applicability.



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INFORMATION MANAGEMENT
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B-197338

The Honorable Verne Orr, Jr.
The Secretary of the Air Force

Attention: Assistant Deputy Auditor General (AFAA/A1)

Dear Mr. Secretary:

This letter is a followup to our report "Better Software Planning Needed at The Air Force Global Weather Central," (AFMD-81-24, Feb. 24, 1981).

Our objective was to evaluate the response to our recommendation that the Administrator of General Services require the Air Force assess of the technical, economic, and operational value of application software over its remaining life cycle before upgrading its general-purpose computers. We made the review at the Air Force Global Weather Central (AFGWC), Offutt Air Force Base, Nebraska; Air Force headquarters, Washington, D.C.; and the Military Airlift Command, Scott Air Force Base, Illinois. The review was performed in accordance with generally accepted government auditing standards.

Our review showed that the Air Force has made a good start in improving AFGWC's software. The approach being used, if properly implemented, should have wider Air Force applicability. Although it is still too early to assess the significance or benefits of the results, we believe the program objectives and the methods of achieving those objectives are systematic, thorough, and consistent with our earlier recommendations.

The substance of our 1981 report was that a bias in the cost-benefit studies for procuring new computers favored the incumbent vendor. The bias occurred when the Air Force, without adequately assessing the technical, economic, and operational value of the software inventory over its remaining life cycle, decided to retain about 70 percent of the existing software inventory during a major hardware upgrade (five computers). Also, we were concerned that retention of obsolete software into the 1990's might adversely affect AFGWC's mission performance.

We recommended that sole-source procurement of computers from the incumbent vendor be suspended until the Administrator of General Services determined whether competitive or sole-source procurements were in the government's best interest. Further, we recommended that the Administrator, to make that determination, require the Air Force to provide an assessment of the technical, economic, and operational value of application software over its remaining life cycle. (See app. I for the complete recommendations.)

The Air Force, on July 17, 1981, acknowledged the need for modernizing AFGWC's software but insisted that the sole-source procurement of computers provided the lowest cost, least risk, and most prudent approach to achieving that goal.

Following our review, the General Services Administration (GSA) conducted an investigation of the AFGWC software. Its findings agreed with those in our report. GSA stated in a letter to AFGWC

"...that improvements clearly must be made in software management at AFGWC. A long range software improvement plan must be undertaken by AFGWC with the objectives of reducing specific (vendor) automatic data processing machine dependency and improving software maintainability and control."

After AFGWC agreed to institute an improvement program, GSA delegated procurement authority to AFGWC in 1981 to acquire computers from the incumbent vendor for 5 to 8 years--the estimated time to complete the improvement program.

AFGWC HAS STARTED A SOFTWARE IMPROVEMENT PROGRAM

As a result of our report and GSA's directive, AFGWC formulated a comprehensive software plan and has started to carry out a 5- to 8-year software improvement program. A key element of the plan is to establish a base line that will describe the current AFGWC software relative to the state of the art and develop a strategy for implementing improvements. A \$774,216 contract for industry assistance was issued in September 1982, and work leading to the software inventory description has started.

The program's primary objectives are to reduce software maintenance costs and dependence on the incumbent hardware vendor, and to ensure AFGWC is in a position to take advantage of new automated data processing (ADP) technology. To achieve its objectives, the AFGWC program incorporates the following four concepts:

1. Inventory all software. A written list by name and function will be compiled for all the technical components of the software inventory. The list will be reviewed and a

structure charted to show the functional relationships among the components. On the basis of the structure, each component will be assigned a unique functional identifier.

2. Analyze all software. Quantitative evaluations of all software components will be made to describe the degree to which the software meets current state-of-the-art technical concepts and maintainability standards and to compute remaining life-cycle costs. State-of-the-art concepts and maintainability standards include (a) use of computer languages that are common to most computer systems and not limited to a specific computer, (b) isolation of the computer code that is programmed to make decisions, (c) isolation of computer programs that depend on a language or hardware designed by a specific vendor, and (d) a top-down design technique in which computer programs are organized into a hierarchy of easily connected, single-entry, single-exit modules.
3. Assess all software. A computer program will be developed to use the quantitative evaluations in providing a list that reflects the relative need to improve each software component. This program will be made part of an automated system and will compute and display a numerical ranking for each software component.
4. Develop a strategy for improving software. Alternatives for improving the software will be identified, and such factors as commercial availability of software and AFGWC hardware and software plans will be considered. The alternatives will include total replacement by commercial hardware and software, replacement through federal sharing, and/or the use of in-house resources.

AIR FORCE TACKLES MOST SERIOUS PROBLEM FIRST

We commend the Air Force for developing a detailed technical inventory of AFGWC's approximately 2 million lines of application code (software). As we pointed out in our 1981 report, management must consider this software when procuring upgraded computer equipment. We also like the management controls and distribution of work between the in-house and contractor resources. For example, the contractor was tasked to develop a standardized documentation framework that could be used to record and catalog the detailed technical inventory in a format suitable for computerized analysis. The proposed framework was reviewed and approved by AFGWC and its parent organizations (the Air Weather Service and the Military Airlift Command). Using the approved framework, AFGWC personnel are now making a detailed inventory of the key technical features of all their computer application programs.

If their efforts are successful and if the analytical computer programs work as planned, AFGWC will be able to automate much of the process for assessing the current software's technical state of the art and for identifying that which is technically obsolete. Economic and mission related information can then be applied in a deliberate way to estimate the remaining useful life for each of the major software components. With this type of information, management decisions about future software redesign, modification, replacement, and sharing can be coordinated with hardware plans and adequately reflected in cost-benefit studies supporting computer system procurements.

According to AFGWC officials, the use of new software technology should reduce AFGWC's current software maintenance efforts by 20 percent, or about 7,000 staff hours annually. Further, by adhering to new programming and documentation standards, AFGWC should reduce machine dependency and increase control over the software organization, content, and format.

AIR FORCE ADP PLANNING GUIDE IDENTIFIES SOFTWARE PLANNING AS SERVICE-WIDE PROBLEM

The need to institute an Air Force-wide software improvement program similar to AFGWC's was identified in the July 1982 Air Force Planning Guide. According to this document, much of the Air Force's current software inventory is over a decade old and (1) is difficult to change, (2) requires excessive staff hours to revise, (3) increases hardware processing time and costs, and (4) generally causes reliability problems. The document stated that, because of these problems, the software has deteriorated to the point where it threatens the Air Force's wartime responsiveness and economy and efficiency objectives.

According to the guide, the above problems were caused by the Air Force's focus on hardware obsolescence, which tended to detract from the more critical problem of software management. The guide stated that new software technology must be applied to overcome these problems and to properly utilize the capabilities of new hardware being acquired. The guide concluded by stating that each major Air Force component must undertake a long-range software improvement program, with the objectives of reducing machine dependency and improving software maintainability and control.

CONCLUSION

The Air Force has made a good start in improving Air Force Global Weather Central's software. We believe the program objectives and the methods of achieving those objectives are systematic, thorough, and consistent with our earlier recommendations.

Because the conditions described in the Air Force ADP Planning Guide are similar to those we observed at AFGWC in 1980-81, we believe the corrective actions taken by AFGWC can be helpful to others. For example, the very difficult problem of redesigning and upgrading a large, obsolete software inventory without disrupting current mission performance is being approached by AFGWC in increments over a 5- to 8-year period; a working system is preserved at each increment. Another technique that might be useful to others is the framework for cataloging and documenting the software inventory described earlier. Still another tool that might be useful, if successful, is the set of computer programs being pulled together and developed for computerized analysis of the software inventory. We believe that others who start a software improvement program should consider all these steps and techniques and that AFGWC's experience in this area may be very valuable in assisting others.

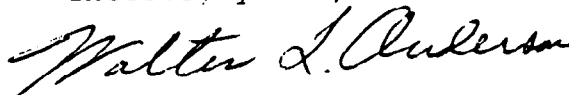
AGENCY ACTIONS

In a September 27, 1983, reply to our draft report, the Under Secretary of Defense (Research and Engineering) advised us that the Department of Defense concurred with GAO's positions. (See app. II.) He also detailed Air Force actions on the matters discussed in the report, including their potential for Air Force-wide application. We consider these actions to be fully responsive to our work.

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We are sending copies of this report to the Director of the Office of Management and Budget; the Chairmen of the House and Senate Committees on Appropriations, House Committee on Government Operations, and Senate Committee on Governmental Affairs; the Secretary of Defense; the Administrator of General Services; the Secretary of Defense; and other interested parties.

Sincerely yours,



for
Warren G. Reed
Director

RECOMMENDATIONS FROM OUR REPORT ENTITLED
"BETTER SOFTWARE PLANNING NEEDED AT THE
AIR FORCE GLOBAL WEATHER CENTRAL"
AFMD-81-24, February 24, 1981

We recommended in our 1981 report that the Administrator of General Services require the Air Force to provide the information listed below on the AFGWC software inventory.

- The following documentation for each significant software component in the current software inventory:
 - The estimated aggregate costs for such items as maintenance, modifications, enhancements, and redesigns over the remainder of the software's full life cycle.
 - Projected assessments of its technical status relative to the state of the art for each remaining year of its full life cycle.
- Plans for new software for the period 1982-92.
- Estimated costs and technical criteria that will be used to reduce dependence on the present manufacturer.
- A long-range plan of the software-sharing arrangements that it will propose and/or implement with other federal agencies.
- A comparative analysis that estimates the technical, financial, and operational advantages and disadvantages of sole-source and competitive acquisition over the life cycles of both hardware and software.



RESEARCH AND
ENGINEERING

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

27 SEP 1983

Mr. Wilbur D. Campbell
Acting Director, Accounting and
Financial Management Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Campbell:

This is the Department of Defense (DoD) response to your draft letter report to the Secretary of the Air Force, Follow-up to GAO's February 24, 1981, report "Better Software Planning Needed at the Air Force Global Weather Central", dated June 24, 1983, OSD Case #6299 (GAO Code No. 913704).

The DoD is pleased to note the favorable views of the GAO for the Air Force efforts to implement the software improvement program (SIP) at the Air Force Global Weather Central. Also, the Air Force has already begun investigating the potential for Air Force-wide application of the SIP concept. Therefore, DoD concurs, in general, with the draft report's findings, conclusions and recommendations, and the detailed response is enclosed.

Sincerely,

A handwritten signature in cursive script, appearing to read "Rich A. Lauer".

Enclosure

ATTACHMENT FOR GAO DRAFT LETTER REPORT
FOLLOWUP TO GAO'S FEBRUARY 24, 1981, REPORT
"BETTER SOFTWARE PLANNING NEEDED AT THE AIR FORCE
GLOBAL WEATHER CENTRAL," DATED JUNE 24, 1983
(GAO CODE 913704 -- OSD CASE NO. 6299)

STATEMENT OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

FINDING A: Air Force Has A Good Start In Improving AFGWC's Software. GAO found that the Air Force has made a good start in improving the Air Force Global Weather Central (AFGWC) system computer software and that (if properly implemented), the approach used should have wider Air Force applicability. GAO also notes that while it is still too early to assess the significance or benefits of the results, the program objectives and methods of achieving them are systematic, thorough, and consistent with its earlier recommendations, but to ensure maximum benefits and evaluate this effort's potential for service-wide use, GAO believed the Air Force needs to carefully monitor it. (p. 1, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING B: Following GAO's 1981 Report, An Investigation by GSA, and a Delegation of Procurement Authority from GSA, AFGWC Agreed to Institute An Improvement Program. In the 1981 report, GAO recommended that sole-source procurement of computers from the incumbent vendor be suspended until the Administrator of General Services (GSA) determined whether competitive or sole-source procurements were in the best interest of the Government and further, that to make that determination, the Administrator require the Air Force to provide an assessment of the technical, economic and operational value of the application software over its remaining life cycle. (The complete recommendations are included as an enclosure to the current report.)

In the current review, GAO found that (1) on July 17, 1981, the Air Force acknowledged the need for modernizing AFGWC's software but insisted that the sole-source procurement of computers provided the lowest cost, least risk, and most prudent approach to achieving that goal, (2) GSA then conducted an investigation of the AFGWC software and its findings agreed with those in GAO's report, (3) GSA stated in a letter to AFGWC "...that improvements clearly must be made in software management at AFGWC. A long range software improvement plan must be undertaken by AFGWC with the objectives of reducing specific (vendor) automatic data processing machine dependency and improving software maintainability and control...", and

(4) upon AFGWC's agreement to institute an improvement program, in 1981, GSA awarded AFGWC a Delegation of Procurement Authority to acquire computers from the incumbent vendor for 5 to 8 years--the estimated time to complete the improvement program. (pp. 1 and 2, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING C: AFGWC Has Started a Software Improvement Program. GAO found that as a result of its report and the directive by GSA, (1) AFGWC completed a comprehensive software plan and started to carry out a 5- to 8-year software improvement program; (2) a key concept of the plan was to establish a base line that would describe the current AFGWC software relative to the state-of-the-art and develop a strategy for implementing improvement; (3) a \$774,216 contract for industry assistance was issued in September 1982; and (4) work leading to the software inventory description started. (p. 2, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING D: Program Objectives and Concepts. GAO found that the primary objectives of AFGWC's improvement program were to reduce software maintenance costs and dependence on the incumbent hardware vendor, and to ensure AFGWC was in a posture to take advantage of new ADP technology. GAO also found that the AFGWC program incorporates the following four concepts to achieve its objectives:

1. Inventory all Software - A written list by name and function will be compiled for all the technical components of the software inventory. The list will be reviewed and a structure charted to show the functional relationships among the components. On the basis of the structure, each component will be assigned a unique functional identifier.
2. Analyze all Software - Quantitative evaluations of all software components will be made to describe the degree to which the software meets current state-of-the-art technical concepts and maintainability standards and to compute remaining life cycle costs. State-of-the-art concepts and maintainability standards include the (a) use of computer languages that are common to most computer systems and are not dependent upon the limitations of a specific computer, (b) isolation of the computer code that is programmed to make decisions, (c) isolation of computer programs that are dependent on a language or hardware designed by a specific vendor, and (d) a top down design technique where the computer programs are

organized into a hierarchy of easily connected, single entry, single exit modules.

3. Assess all Software - A computer program will be developed to use the quantitative evaluations to provide a rank-ordered list that reflects the relative need to improve each software component. This program will be made part of an automated system and will compute and display a numerical ranking for each software component.
4. Develop Strategy for Improving Software - Alternatives for improving the software will be identified considering such factors as commercial availability of software and AFGWC hardware and software plans. The alternatives will include total replacement by commercial hardware and software, replacement through Federal sharing, and/or use of in-house resources. (pp. 2 and 3, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING E: Air Force Tackles Most Serious Problem First.
GAO commends the Air Force especially for the way its program starts at the beginning and tackles the most serious problem--developing a detailed technical inventory of AFGWC's approximately 2 million lines of application code. As pointed out in GAO's 1981 report, management must consider this when procuring computer equipment upgrades. GAO also likes the management controls and distribution of work between the in-house and contractor resources, citing, for example, the contractor being tasked on September 30, 1982 to develop a standardized documentation framework that could be used to record and catalog the detailed technical inventory in a format suitable for computerized analysis. GAO found that the proposed framework was reviewed and approved by AFGWC and its parent organizations (the Air Weather Service and the Military Airlift Command), and that using the approved documentation framework, AFGWC personnel are now performing a detailed inventory of the key technical features of all their computer application programs. GAO further found that if their efforts are successful, and the analytical computer programs work as planned, AFGWC will be able to automate much of the process for assessing the technical state-of-the-art for its current software and identifying that which is technically obsolete. GAO notes that economic and mission related information can then be applied in a deliberate way to estimate the remaining useful life for each of the major software components, and that with this type of information, management decisions about future software redesign, modification, replacement, and sharing can be integrated with hard-

ware plans and reflected adequately in cost-benefit studies supporting computer system procurements. (GAO notes that AFGWC officials advised that the use of new software technology should reduce AFGWC's current software maintenance efforts by 20 percent or about 7,000 staff hours annually, and that further, by adhering to new programming and documentation standards, AFGWC should reduce machine dependency and increase control over the software organization, content, and format). (pp. 3 and 4, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING F: Recent Air Force Planning Guide Identifies Software Planning as a Service-Wide Problem. GAO found that the need to institute an Air Force-wide software improvement program similar to AFGWC's was identified in the July 1982 Air Force ADP Planning Guide, and that according to this document, much of the Air Force's current software inventory was over a decade old and was characterized by software that (1) is difficult to change, (2) requires excessive staff hours to revise, (3) increases hardware processing time and costs and, (4) generally causes reliability problems. GAO further found that because of these problems, the document stated that the software had deteriorated to where it threatened the Air Force's wartime responsiveness, and economy and efficiency objectives. (p. 4, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING G: Long Range Software Improvement Program Must be Undertaken by Each Major Air Force Component. GAO also found that according to the recent Air Force planning guide, the problems were caused by Air Force focus on hardware obsolescence which tended to detract from the more critical problem of software management; that the guide stated that new software technology must be applied to overcome these problems and to properly utilize the capabilities of new hardware the Air Force was acquiring; and concluded by stating that a long range software improvement program must be undertaken by each major Air Force component, with the objectives of reducing machine dependency and improving software maintainability and control. (p 4, GAO Draft Report)

DOD RESPONSE: Concur.

FINDING H: Air Force Should Consider New Software Management Controls. GAO found that even though the current Air Force ADP Planning Guide required that obsolescence of both software and hardware resources be considered during annual planning efforts, GAO's experience at AFGWC demonstrated the need for

more explicit management controls at AFGWC and perhaps throughout the Air Force. For example, as GAO reported in 1981, the Air Force's decision to use sole-source procurement was supported by cost-benefit studies which did not include appropriate software planning criteria. GAO further found that criteria was now being used in the AFGWC software planning approach, and that until AFGWC completes its current planning tasks and has schedules that show the timing, scope, and cost of its software modernization efforts, the validity of the earlier cost-benefit studies and the decision made by management based on the studies will not be known. (GAO notes that in this assignment, it did not determine if other Air Force units were using appropriate software planning criteria before acquiring new computers, but that since Air Force readiness was threatened by widespread software management problems, GAO believed that the Air Force should look closer to determine if more explicit management controls are needed in this area throughout the Air Force.) (pp. 4-5, GAO Draft Report)

DOD RESPONSE: Concur

FINDING I: New Management Controls Should Require Application Software Assessment. GAO found that the new management controls should require completion of a comprehensive application software assessment (as now being done by the AFGWC), before computer equipment procurements are authorized GAO also indicated that these new controls would help ensure that: (1) cost-benefit studies were not biased in favor of the incumbent vendor, (2) software inventory would meet current and known future operational requirements, (3) software designs would help establish a posture to take advantage of new hardware technology, and (4) planned software inventory would be integrated with the hardware procurement. (pp. 4 and 5, GAO Draft Report)

DOD RESPONSE: Concur.

CONCLUSION

Conclusion 1. GAO concluded that because the conditions described in the Air Force ADP Planning Guide were similar to those observed at the AFGWC in 1980-81, it believed the corrective actions taken by AFGWC can be helpful to others; for example, (1) the very difficult problem of redesigning and upgrading a large, obsolete software inventory without disrupting current mission performance is being approached by AFGWC in increments over a 5-8-year period; a working

system is preserved at each increment; (2) another example of a technique that might be useful to others is the framework for cataloging and documenting the software inventory described earlier; and (3) still another tool that might be useful (if successful), is the set of computer programs being pulled together and developed for computerized analysis of the software inventory. GAO indicated that all these are steps and techniques that others who start a software improvement program will have to consider, and that AFGWC's experience in this area may be very valuable in assisting others. (p. 5, GAO Draft Report)

DOD RESPONSE: Concur.

RECOMMENDATIONS

Recommendation 1. GAO recommended that the Secretary of the Air Force monitor the results of the AFGWC software improvement program to ensure its success and to evaluate its potential for use Air Force-wide. (p. 6, GAO Draft Report)

DOD RESPONSE: Concur. The Air Force Office of the Assistant Chief of Staff for Information Systems is monitoring the AFGWC Software Improvement Plan for the Secretary of the Air Force. The AFGWC experience is being included in the Air Force study outlined in the response to recommendation 2.

Recommendation 2. On the basis of its experiences at AFGWC and the concerns expressed in the Air Force ADP Planning Guide, GAO also recommended that the Secretary of the Air Force initiate his own analysis to determine the need for a new Air Force-wide management control policy; specifically, GAO suggested a policy that required completion of a technical, economic, and operational assessment of the existing application software components over their remaining life cycles before computer equipment procurements are authorized. (p. 6, GAO Draft Report)

DOD RESPONSE: Concur. The Air Force Data Systems Evaluation Center was tasked in October 82 to conduct an analysis of the Air Force software obsolescence problem. They are also preparing a guideline for Air Force wide use in assessing the degree of software obsolescence and procedures and techniques for conducting software studies. We expect a preliminary report in August 83 and the final guidelines and techniques to be completed during fiscal year 84. These guidelines, as appropriate, will be incorporated in the new series of Air Force Information Systems Regulations now under development.

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