Materiel Command and the Materiality of Commands: An Historical Examination of the US Air Force, Control Data Corporation, and the Advanced Logistics System

Jeffrey R. Yost

Materiel Command and the Materiality of Commands: An Historical Examination of the US Air Force, Control Data Corporation, and the Advanced Logistics System

Jeffrey R. Yost
Charles Babbage Institute, University of Minnesota

Abstract: In the late 1960s the US Air Force Logistics Command (AFLC) engaged in an unparalleled, real-time computer networking project to manage all its logistics (location, inventory, maintenance, and transportation of personnel, aircraft, weapons, components, spare parts, etc.), the Advanced Logistics System (ALS). The $250 million ALS project was substantially larger in size and cost than earlier real-time computer networking projects (including SAGE programming and SABRE), but it has received virtually no attention from historians of computing. Ultimately, the ALS project failed. Drawing from an oral history with lead contractor Control Data's (CDC) longtime ALS project manager, previously unavailable CDC documents, and documentation and an oral history from a leading external Air Force advisor on ALS, it shows how the AFLC pushed too far too fast in seeking to be a first-mover in creating a massive unified database and real-time computer network for highly complex logistics.

Keywords: Air Force Materiel Command (AFMC), Control Data Corporation (CDC), Advanced Logistics System (ALS), supply management, technological failure, real-time computing, and computer networking

1 Early Air Force Logistics and Information Technology Applications

The importance of Air Force logistics (managing the location, transportation, maintenance, and supply of personnel, aircraft, weapons, components, spare parts, etc.) to military operational effectiveness and cost containment is impossible to overemphasize.[1] The trade journal *Business Machines* reported that the Air Force Logistics Command in 1960 managed more assets than any organization in the world—more than General Motors, United States Steel, Metropolitan Life, and Western Electric combined [1]. Information systems and communication technologies have long been central to aiding Air Force logistics. In 1926 the Air Force Materiel Division installed its first punched card tabulator, at McCook Field in Dayton, Ohio [2]. Dayton has continued to be the home of Air Force logistics

1 Some weapons, or weapons systems, were managed by the Air Force Services Command (AFSC)—see footnote 2.

management for more than 80 years—under the name Air Materiel Command (AMC) up to the early 1960s, Air Force Logistics Command (AFLC) from the early 1960s to the early 1990s, and Air Force Materiel Command (AFMC) from the early 1990s to the present (all at Wright-Patterson Air Force Base from the late 1940s forward) [3].[2] Following this initial IT procurement in the mid-1920s, the AMC installed numerous mechanical and electromechanical tabulators during the inter-war years and throughout World War II. In July 1954 the AMC was an early adopter of digital computers, installing a UNIVAC I, which was soon followed by IBM 650s and 705s. Interestingly, in 1956, it first used an IBM 705 to manage personnel much like other inventory—a practice/plan that continued with ALS [1]. Without much central organization, the other five Air Materiel Areas (AMA)[4][3] also procured digital computers in the 1950s [5]. At this time, the data processing task of the Air Force's logistics headquarters and other AMAs were managed individually, and the data processing technology was very much distinct from the communication technology used to share logistics information.

At the end of the 1950s and the start of the 1960s the Air Materiel/Logistics Command engaged in efforts to achieve centralized authority over logistics. By the mid-1960s this also included efforts and planning to bring together data processing (digital computers) and communications. The task was daunting as the AFLC had 376 individual information systems—tracking/managing procurement, inventory, transportation, and maintenance—at headquarters and the other AMAs [6]. In late 1966 this effort was formalized in early planning for a massive automated system—a centralized database and network of computers—to provide real-time information to authorized personnel at different AMAs and command posts [7]. AFLC managers and data processing personnel, with the aid of consultants from the COMRESS Corporation, completed a "Master Plan" for the Advanced Logistics System (ALS) in March 1968 [7].

2 An Examination of ALS and Its Failure

The following paper is a short history of ALS. Despite ALS being a larger and far more expensive real-time computer networking project than the frequently examined SAGE programming effort or the development of SABRE, it has been completely ignored in the existing computer history literature.[4] A self-published

---

2 In 1961, with the renaming of AMC as AFLC, the research and development and weapon system acquisition division of AMC was broken out as the Air Force System Command (AFSC). In early 1992, AFLC and AFSC were combined to form the AFMC.

3 In addition to the headquarters for logistics at Wright-Patterson Air Base, Ohio, the other five AMAs were: Tinker Air Force Base, Oklahoma; Hill Air Force Base, Utah; Kelly Air Force Base, Texas; McClellan Air Force Base, California; and Robins Air Force Base, Georgia.

4 Many scholars and writers have examined Semi-Automatic Ground Environment (SAGE—a computer and radar air defense system) programming and the development of the Semi-Automatic Business Research Environment (SABRE—a pioneering airline reservations system). Some of the best source publications and scholarly analyses include [8],[9],[10],[11],[12].

AFLC history of ALS [2][5] uses Air Force documents almost exclusively, and places much of the blame for the project's shortcomings with lead computer contractor Control Data Corporation (CDC) [2].[6] My paper takes advantage of a host of new resources, and seeks to provide a more nuanced and balanced interpretation as to why this project failed. It also places this important story within the broader framework of the history of computing and history of technology.[7]

Air Force historian William Elliott, author of the AFLC published history of ALS, presents strong approval of the ALS plan by the Air Force, coupled with brief mention of a few prominent skeptics. Throughout, he stresses that the Air Force trusted the experts—this included outside advisors, consultants from the computer services industry (COMRESS and Computer Sciences Corporation), and computer firms looking to bid for the primary ALS contract [2].

Elliott mentions the RAND Corporation's early experience in computer time-sharing and a presentation by RAND to the Air Force on this topic in 1966 [2]. However, he neglects to discuss RAND's role as a longtime top IT advisor to the Air Force. The RAND Corporation, spun off from the Air Force's Project RAND in the early post-World War II era, was a prominent advisor to the Air Force on many scientific, technical, military, and strategic matters from the late 1940s through the 1970s. While the RAND Corporation, during the 1960s, shifted from a near exclusive focus on military research and development to include a broader social and economic research agenda, it continued to be a top advisor to the military, and especially the Air Force, throughout that decade and beyond.[8] By the start of the ALS project, RAND had conducted pioneering research on inventory management for nearly a decade [15]. The Computer Science (CS) Department (and earlier, the Mathematics Department) at RAND advised the Air Force on computing and software systems throughout the 1950s, 1960s, and 1970s.[9] RAND's head of CS, Willis Ware, led a RAND advisory committee on ALS. In reflecting on the advice he and his committee provided to Air Force leaders prior to the project and in its early stages, Ware stated:

---

5 There are only several publicly available copies of this history worldwide.

6 Elliott, while acknowledging shortcomings and failed goals with the project (attributing most of these to Control Data Corporation's inexperience and mistakes), does not present ALS overall as a failure. At times, he in fact stresses the benefits of ALS—emphasizing the importance of the Air Force's early commitment to massive computer infrastructure to future logistics efforts. He, however, generally neglects to provide concrete evidence of direct substantive connections. Nor does he explore what alternatives might have looked like to expand IT infrastructure for Air Force logistics outside of the ALS project.

7 These new resources include an oral history interview I conducted with the ALS project manager for Control Data (Fred Laccabue); CDC documents, including correspondence with government officials; and an oral history I conducted and documents from the leading external Air Force computer advisor of the time, RAND computer scientist Willis Ware.

8 For the early history of the RAND Corporation, its broadening scope in the mid-1960s, and its continuing relationship with the Air Force see [13]. A more popular history of RAND covers some similar ground [14].

9 Prior to the 1970s, computing research and expertise resided within the RAND's Mathematics Department.

The Air Force did have a big problem to retrofit the logistics institution with an advanced computer system. Unfortunately the primary message that we delivered to the Air Force at the time was, "whatever you think you're doing, you're doing it poorly and you're not organized to do it well." Which is not a pleasant message to deliver, but the fact of the matter is that Air Force at that juncture…had never faced or managed the conversion of a huge computer system. And this was a huge operation [16].

Ware's correspondence and reports in the RAND Corporate archives fully corroborate these comments. Repeatedly, RAND computer scientists conveyed to the Air Force the great risks of implementing such a massive, real-time, third generation computer networked system—with which the Air Force had no prior experience. As the project moved forward, Ware and other RAND computer scientists provided advice regarding specific areas—such as file conversion, performance analysis and test simulation, and computer security—to improve the likelihood for success with ALS, but did not waiver from their assessment of the major risks involved.[10] While COMRESS and Computer Science Corporation, two computer services firms serving as pre-project consultants, undoubtedly presented less dire assessments,[11] no organization (given JOSS—RAND's pioneering time-sharing system—and RAND's connection with its spin-off, System Development Corporation) was better equipped to advise on a massive, pioneering real-time computer and software project than RAND.[12]

Prior to the launch of the ALS project, the House Appropriations Committee asked the General Accounting Office (GAO) to produce an assessment report on the Air Force's ALS plans. The report cited a number of potential difficulties [4]. Specifically, it reported that "there are strong indications that problems may be encountered in obtaining and implementing computer software."[4] The GAO cited a recent major airline's canceling of a $56 million contract with a computer vendor for a large-scale, multifunction data processing system (less ambitious than ALS)—resulting from recurrent delays and problems with software implementation and data security [4]. The AFLC leaders did take some suggestions, such as implementing a pre-bid benchmark test, but they did not seem to take to heart the direct warnings regarding software challenges [4]. While Elliott cites this report, he only uses it for the Air Force data and projections it presents, or to record early project delays, not to convey the GAO's reservations regarding ALS software [2].

Following a Request for Proposals (RFP) for ALS, meetings in spring and summer 1968 were held at Hanscomb Field (near Bedford, Massachusetts) with firms likely to bid for the project's primary computer contract.[13] Elliott highlights

---

10 This is based on examining numerous reports and extensive correspondence files of Willis Ware while conducting research at the RAND Corporate Archives in 2004.

11 There were current and potential future financial incentives for these software consultancies to favor continued exploration and development of what became ALS.

12 The RAND Corporation's early pioneering work and considerable expertise in computer networking and time sharing, computer security, and other areas is documented in [17].

13 The computer firms that attended these meetings were IBM, Sperry Univac, Control Data, Burroughs, and RCA.

the enthusiastic reception to the RFP by the computer industry, yet one of Control Data Corporation's representatives, future CDC ALS project manager Fred Laccabue, remembers discussions at Hanscomb Field far differently.[14] He and other CDC officials believed the plan had a major design error: that the Air Force was writing the central control system using COBOL rather than machine code. COBOL could not approach the efficiency of assembly language (native language of a particular computer). The use of COBOL was to try to provide operating system-like functionality, such as job scheduling, to ALS. The small CDC team, including Laccabue, expressed a few general concerns and requested a subsequent private meeting with the developers of the RFP in 1969 [18]. There, the CDC team explained in detail what they saw as problematic elements (including the use of COBOL) in the RFP specifications that would be "real impediments to achieving success for the program." [18] In Laccabue's words, the CDC team was "not so politely rebuffed." [18] They were told that the Air Force had "employed many experts in the computer field" regarding the central control system and unified database, and were "absolutely confident they were going down the correct path." [18]

Elliott correctly acknowledges that CDC had emerged as the number two computer firm (behind only IBM) in profitability by the late 1960s, but he generally presents CDC in an unfavorable light. He suggests that CDC was a relatively new, untested, and risky company that "almost went bankrupt before its first computer was delivered." [2] This vision of CDC contrasts sharply with what CDC was when it bid for ALS. By the late 1960s, CDC had emerged as the world leader in supercomputers, owing in large part to the skill of arguably the most gifted computer design engineer alive, Seymour Cray. It had established a profitable computer peripherals division and was thriving as it concomitantly sought to extend its success in scientific computing and build its capabilities in business data processing hardware, software, and services [19]. Though Elliott mentions a qualifying ALS benchmark test for which specifications were distributed in July 1969, he fails to disclose that CDC was the only firm to pass this ALS test in its first, and originally its only planned, incarnation. IBM (using dual System 360/67 computers), Sperry Univac, RCA, and Burroughs all failed [2]. Despite the Air Force's overarching goal to move quickly with ALS (after all, the nation was at war in Vietnam), it decided to delay the contract award process roughly six months to allow other computer firms to qualify to bid. This extension upset leaders at CDC [18]. Control Data had invested heavily to set up a huge complex at their Sunnyvale, California facility to house the mass storage disk drives and mainframe computers to meet the benchmark. In fact, they had computers and mass storage sufficient to run the test transactions in roughly twelve minutes, when the benchmark was sixteen minutes [18]. The dozen or so Air Force officials had already watched the other firms fail, and initially, were elated to see CDC's results. Top Control Data officials believed extending the testing for a half year for a second round was just a means to drive down the end price for the contract [18].

---

14 Evidence indicates not only CDC, but other potential vendors cautioned "that there was a serious question on the availability of adequate software and that it might be beyond the state-of-the-art." [6]

Ultimately, IBM dropped out of the competition due to conflicts regarding liability specifications, and Sperry Univac (having passed on its second try) was the only firm competing against CDC for ALS [20].[15] CDC was awarded the initial computer and software contract for $87.4 million in April 1972 [21]. This was one of the very largest government computer contracts to that time, but well justified to AFLC leaders—they believed ALS would result in savings of $250 million, through automation and greater efficiencies, in the succeeding decade [22]. It was also, by far, CDC's largest contract to date [23].

The Control Data contract called for 21 CDC Cyber 70 computers, three each at the AMAs, with the remaining six at the Logistics Command headquarters at Wright-Patterson. The agreement specified a complex monthly lease with right-to-purchase structure for the stipulated seven-year life of ALS [21]. Approximately 700 AFLC personnel were working on ALS by this time at Wright-Patterson and about 400 at other AMAs, and these numbers escalated rapidly in succeeding years. The Air Force would develop the central control system and applications software, while CDC would contribute a transaction-based operating system named ZODIAC. The central control system, written in COBOL, was an essential piece of *system* software standing between ZODIAC and any applications software [24].

The CDC Special Systems Division ALS team, managed by Laccabue, was overseen by a high level ALS Program Management Board at CDC that included Robert Price, President, Special Systems and Services Division, and other senior CDC executives [25]. Laccabue joined CDC as a programmer analyst in 1960 after a short stint as a dynamics engineer at Convair. He had participated in the preparation, bidding, and early phases of a CDC Special Systems Division project for the Worldwide Military Command and Control System. This involved discussion and preliminary research on transaction oriented operating systems. His experience, on the promising but young technology of transaction oriented operating systems, made Laccabue a strong choice for CDC's ALS project manager position [18].

Given CDC leaders' uneasiness with the central control system software being programmed in COBOL and with some other Air Force specifications, they carefully crafted their proposal and the lease-to-purchase contractual terms. Purchase credits were greater if the Air Force executed a purchase at an earlier date. In effect, if the Air Force delayed in purchasing the CDC Cyber 70 computers (beyond the initial target date), it would end up paying significantly more money for the systems. Control Data contract vice president H. D. Clover was the mastermind behind this structure that protected CDC if the AFLC could not deploy the system successfully, and on schedule. As Laccabue later recalled, the GAO subsequently prohibited government contracts being structured this way. Laccabue emphasized that this was not to pull one over or be unfair to the Air Force, which CDC hoped to do future business with; it was merely a protective mechanism given what Control Data leaders saw as a risky project and CDC's dependence on the Air Force for project success [18].

Unlike the initial harsh response CDC received at Hanscomb field at the pre-contract phase, some top AFLC officials subsequently understood CDC's

---

[15] RCA and Burroughs did not attempt second round benchmark testing.

concerns. However, they thought these challenges could be readily overcome by AFLC data processing personnel. The Air Force had thousands of programmers and initially the focus was on central processing unit (CPU) cycle time: beating benchmarks. The Air Force was far from alone in the late 1960s and early 1970s in underestimating the delays and challenges of major programming projects. Project delays and cost overruns were essentially the norm for this time period—it was a lesson that most organizations learned the hard way, and a fundamental element to a perceived and real "software crisis" throughout much of the 1960s and 1970s. When IBM's OS/360 project manager Frederick Brooks documented challenges from major programming projects—including the lesson that adding additional programmers to a late project can actually further delay a project's completion—in the *Mythical Man Month*, the book became an instant classic [26]. Brooks had outlined fundamental pitfalls in managing software engineering that all too often victimized organizations. The book, which changed the landscape of software engineering, drew on lessons from the 1960s, but was not published until the mid-1970s.

In 1972, just after awarding CDC the contract, AFLC officials visited CDC's Sunnyvale facility. Laccabue emphasized the substantial work yet to be done before deployment. AFLC officials were surprised, but generally understood and took the attitude that with substantial cooperative effort, these challenges could be met. Several weeks later Laccabue met with General James Bailey, who in July 1971 had become the deputy chief of staff, comptroller, Headquarters AFLC, overseeing ALS for the Air Force [27]. He conveyed to Bailey that to be successful, the central control system had to be written in machine code. He offered to submit a CDC proposal to add this. General Bailey's view was that CDC and the AFLC continue to work closely together, and as they got to next steps, the AFLC would entertain providing a contract to CDC to write the central control system in machine code—but this never happened. While CDC soon began to deliver Cyber 70 computers to Wright-Patterson and the other AMAs (in the second half of 1972), the AFLC leaders, in spite of CDC efforts to inform them, did not grasp the gravity of the software problem. Late in 1972, in an early test at Kelly Air Force Base, Texas, a simple transaction to replenish a part got caught in a loop and took 23 hours. This led to AFLC leaders' general recognition of the severity of the problems with ALS. The system clearly did not work efficiently in real-time. The AFLC leaders made the decision to redefine the project.

This redefinition of the ALS project occurred during renegotiations held between the AFLC and CDC in January and February of 1973. Terms included giving CDC later delivery dates in exchange for added work on the software and hardware [6]. While Elliott generally presents CDC as falling down on original specifications, this is, at best, distorting. There were some issues with hardware reliability, but the greatest problems were with the software, and system integration—namely integrating the Air Force's central control system and CDC's ZODIAC. These problems extended directly from what the CDC team had expressed concerns about to the Air Force from the bidding process forward. At the renegotiation, the AFLC abandoned the concept of a unified data base and real-time computing system in favor of multiple databases and batch processing. Both CDC's and AFLC's work on the project was significantly redefined to build a workable batch processing system. CDC had little choice but to agree to the change and receive the extensions—but it was a bitter pill, as CDC had delivered a system specifically designed to handle real-time processing efficiently that would now be used for batch processing 90 percent of the time [28]. The redefinition greatly reduced the sophistication of the ALS system [7]. Both Elliott's study, and a GAO assessment report after ALS was shut down, stressed that CDC got the better of the Air Force in this renegotiation [2][6]. CDC would provide a version of its SCOPE operating system (developed for its 3000 and 6000 series of computers)[6] and "Multiple Data Base" (originally developed by CDC for the NASA Skylab project) that were better suited to a batch environment than ZODIAC (a transaction-oriented processing system)[24]. CDC leaders saw its offer of these two programs as helping with the Air Force's ALS "get well plan."[24]

General Bailey retired early in 1974 and General Louis Alder succeeded him as deputy chief of staff, comptroller, Headquarters AFLC, overseeing ALS beginning in May 1974 [29]. By August, with continuing ALS problems, Adler presented a briefing to the AFLC Commander, General Catton. Catton proceeded to halt future programming efforts on ALS on August 23, 1974 and launch an internal assessment [2]. He wrote to General David Jones, chief of staff, Air Force that he had "placed too much confidence in General Bailey," who had long been "overly optimistic" about ALS [2]. Catton summarized three reasons for the projects severe shortcomings: 1) the unified data bank was unproven (size precluded efficient processing); 2) the hardware and the software (both vendor and Air Force) were generally untested; 3) concurrent development of the operating software by the Air Force and CDC has "proved impractical." [2] Catton retired later that year and cited the ALS implementation effort as his greatest career disappointment [2]. The problems were soon disclosed to the US Congress and the Secretary of Defense [2].[16] A congressional investigation followed and in December 1975 the ALS project was terminated. From planning to shut down, it had been a nine-year effort with an expenditure of approximately $250 million. The Secretary of Defense, Donald Rumsfeld, soon authorized a plan for a new inventory management system using machine independent software [6].[17]

Once the whistle was blown on ALS, the GAO completed a report on the project [6]. While the report does cite some issues with CDC hardware and software, it overwhelmingly places the blame for the project's failure with the Air Force. In summary, the GAO stated:

> *Many factors contributed to the Air Force's unsuccessful system design and development efforts. But the major factor was that the Air Force did not manage the system as a complex, high-risk program that stressed computer equipment capabilities and software technology. Although the Air Force was aware of potential technological… [problems]… it did not exercise prudent management when system development problems occurred [6].*

---

[16] An earlier disclosure to Congress was made in April 1974 by two employees at McClellen Air Force Base (Sacramento, California) in a letter to California Senator Alan Cranston. This correspondence indicated that the project was a waste of money and not achieving its goals.

[17] Subsequent efforts in applying advanced IT to logistics moved at a more measured pace.

Even though the overwhelming blame in the GAO Report was placed with the Air Force, CDC leaders took issue with the fact that the report neglected to emphasize (mentioning only briefly) the "serious inadequacies" of the original Air Force specifications. In a response letter to the GAO, Robert Price cited a government contract panel that had evaluated and reported on ALS in 1974 stating:

> *The Contractor [CDC] has delivered the hardware and software in accordance with the contract specifications…. however, there are serious deficiencies in these Government drafted specifications which cause them to fall short of satisfying the ALS objectives [30].*

3 Conclusion

The materiality of commands, both the Air Force officers' commands to primary computer contractor Control Data regarding strict adherence to the original design specifications and system limitations on integrating software commands and functionality, were fundamental to ALS' failings. From early meetings with potential bidders, throughout the contracting phase, and into the project, CDC personnel were straightforward about their perception of the limitations and risks involved with specifications established by the AFLC. Given the early frustrations of the CDC team, after being rebuked when they questioned the Air Force computer/software specifications at the pre-proposal stage, CDC managers were particularly careful to document developments and keep AFLC personnel informed about activities and problems with the project. Additionally, both prior to and in the early phases of ALS, RAND advisors had cautioned the Air Force. Ultimately, the combination of the project's complexity and the challenges it posed to the existing state-of-the-art in computing and software, coupled with the well intentioned, but poorly conceived original specifications stubbornly adhered to by the AFLC leaders, resulted in severe shortcomings of the ALS project. Attempts for mid project redefinitions and recovery were made earnestly by the Air Force and CDC, but fell short, and led to the project's demise. The AFLC was left with far more advanced computing infrastructure, but the ALS project was not a cost-effective means to achieve this modernization of computing equipment, and it would be years before the Air Force had a fully operable system roughly comparable to the lofty ambitions initially designated for ALS.

More broadly, the ALS story is particularly meaningful to the history and historiography of computing. It was an unprecedented IT effort in logistics and it was a failed project. Logistics is one of the fundamentally important applications of IT but has received very little attention in the existing historical literature. In James Cortada's trilogy of books surveying the history of computer applications to various industries, *The Digital Hand*, logistics and electronic data interchange (EDI) between organizations make brief appearances (there is significant discussion of logistics and EDI in roughly a dozen pages of this more than 1400-page study) [31][32][5]. In most histories of computing, logistics is not even mentioned. Nevertheless, computers and computer networking were absolutely fundamental to realizing possibilities for efficiencies in logistics, most notably with realizing just-in-time (JIT) inventory management. While contemporary debates exist as to whether IT (including the core area of IT applications to logistics) can still be a source of competitive advantage, it unquestionably was for some organizations (such as Dell and Walmart) in earlier decades [33]. In the 1960s the AFLC was not only the largest purchaser in the US government, but of all organizations worldwide.[18] Given this, it is not surprising that the AFLC sought to be a first-mover in applying a massive unified database, and a network of computers operating in real-time, to centralize the task. Like many other organizations of the period, it learned the hard way the great difficulty of managing massive computer programming and system integration projects.

This paper also stands as an all too rare study of technological failure, combating the "progress talk" that frequently dominates histories of technology—a problem articulated by historian John Staudenmaier more than two decades ago [34]. "Progress talk," or presenting technology's history as continual and unwavering progress, holds an even greater stronghold in the history of computing where hardware progress has been quantified as if it were a scientific law (Moore's law—chip capacity/processing capability doubling every year or 18 months) and software, growing to fill ever cheaper memory and add functionality, is frequently perceived as following suit.[19] ALS is a case where project design extended too far out on the technological frontier, and software (with the central control system in COBOL rather than machine code) presented limitations on system integration that could not readily be overcome.

Failures in oversize, massively complex, networked computing systems, such as the FBI's abandonment of a $170 million dollar system in early 2005, continue to persist. At the time of the September 11, 2001 terrorist attacks, FBI computing and networking were horribly antiquated. Using a mainframe operating system three decades old, some field offices were without network connections and unable to transmit digital images of terrorist suspects. A major computer system project was quickly launched to create a networked system, Virtual Case File, to replace the FBI's paper files and aid with tracking criminal cases [35]. Primary contractor, computer services firm Science Applications International Corporation (SAIC), wrote more than 730,000 lines of code and received more than $100 million as the project grew increasingly complicated. SAIC continued to "meet the bureau's requests despite clear signs that the FBI's approach to the project was badly flawed," according to individuals involved with the project and those who later reviewed it for the government [35]. With serious security problems and high error rates, the FBI shut the project down. In a response eerily similar to statements by General Catton and Donald Rumsfeld's in the mid-1970s in aftermath of the ALS failure, FBI Director Robert Mueller took responsibility for "not having put appropriate persons in a position to review… [the]… contract and assure that it was on track."[36] Further, he indicated that "the FBI would now start from scratch, and look for a more updated, flexible system using off-the-shelf software."[36] Similar difficulties have occurred with recent large-scale networked computer systems for air-traffic control, electric energy grid management, and other major IT projects both within and outside of government. These

---

18 Furthermore, the AFLC managed Air Force personnel as inventory.

19 Moore's Law, initially a speculative prediction by Gordon Moore in 1965, evolved into a company (Intel) and industry-wide (trade association) benchmark. As such, it became a managerial tool shaping investments and outcomes.

developments clearly suggest that lessons from failures with the design, development, implementation, and oversight of massive computer networked management systems are yet to be fully learned.[20]

References

1. World's Largest Purchasing Agency. Business Machines 10, 62--63 (October 1960)
2. Elliott, W.: To the Third Generation: A History of the Advanced Logistics System, 1967-1977. Office of History, Air Force Materiel Command, Dayton, Ohio (1997)
3. Air Force Materiel Command History, http://www.afmc.af.mil/library/history.asp
4. GAO Report to the Congress. Potential Problems in Developing the Air Force's Advanced Logistics System. United States General Accounting Office, Washington, DC (1971)
5. Cortada, J.W.: The Digital Hand, Volume 3: How Computers Changed the Work of American Public Sector Industries. Oxford University Press, New York (2008)
6. GAO Report to the Congress. Problems with Developing the Advanced Logistics System. United States General Accounting Office, Washington, DC (December 1975)
7. GAO Draft Report to the Congress. Should the Air Force Continue to Develop Its Advanced Logistic System. (April 1975)
8. Baum, C.: The System Builders: The Story of SDC. System Development Corporation, Santa Monica, CA (1981)
9. Copeland, D.G., Mason, R.O., McKenney, J.: Sabre: The Development of Information-Based Competence and Execution of Information-Based Competition. IEEE Annals of the History of Computing 17:3, 30--57 (1995)
10. Head, R.V.: Getting Sabre Off the Ground. IEEE Annals of the History of Computing 24:4, 32--39 (2002)
11. Campbell-Kelly, M., Aspray, W.: Computer: A History of the Information Machine. BasicBooks, New York (1996)
12. Campbell-Kelly, M.: From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry. MIT Press, Cambridge, MA (2003)
13. Jardini, D.: Into the Wild Blue Yonder: The RAND Corporation's Diversification Into Social Welfare Research, 1946-1968. Dissertation: Carnegie Mellon University (1996)
14. Abella, A.: Soldiers of Reason: The RAND Corporation and the Rise of the American Empire. Harcourt, Inc., Orlando, FL (2008)
15. Internal correspondence, RAND Corporation [Willis Ware is likely the author]. Memo entitled Inventory Management. RAND Corporate archives (December 1971)
16. Willis H. Ware Oral History. Charles Babbage Institute, University of Minnesota. Conducted by Jeffrey R. Yost. RAND Corporation, Santa Monica, California (August 11, 2003).
17. Ware, W.H.: RAND and the Information Evolution: A History in Essays and Vignettes. RAND Corporation, Santa Monica, CA (2008)
18. Fred Laccabue Oral History. Charles Babbage Institute, University of Minnesota. Conducted by Jeffrey R. Yost. Cupertino, California (December 4, 2009)
19. Worthy, J.C.: William C. Norris: Portrait of a Maverick. Ballinger Publishing Company, Cambridge, MA (1987)
20. Correspondence [to CDC] from T.L. Meyers (November 9, 1971). Copy provided to author by Fred Laccabue.

---

[20] One potential lesson is to forego new, path breaking, massively complex, custom systems in favor of existing state-of-the-art systems with proven performance.

21. $87.4 Million AF Contract Awarded to Control Data. Electronic News, 1-37 (April 10, 1972)
22. McConnell, A.G. (Lt Colonel USAF): Management of Information Systems Development: The Advanced Logistics System. Unpublished paper completed at the Naval War College, Newport, Rhode Island (May 12, 1975)
23. CDC Newsletter, No. 57 (May 1972). Provided to author by Fred Laccabue.
24. Fred Laccabue to G.S. Weller (July 15, 1975). Copy provided to author by Fred Laccabue.
25. ALS Project Organization (1974). Document provided to author by Fred Laccabue.
26. Brooks, Jr., F.P.: The Mythical Man Month: Essays on Software Engineering. Addison-Wesley Publishing Company, Reading, MA (1975)
27. Major General James A. Bailey, http://www.af.mil/information/bios/bio.asp?bioID=4579
28. Letter from Robert Price to Fred Shafer (GAO, Director). (July 18, 1975) Copy of document provided to author by Fred Laccabue.
29. Major General Louis O. Adler, http://www.af.mil/information/bios/bio.asp?bioID=4492
30. Letter from Robert Price to Fred Shafer (GAO, Director). (September 10, 1975) Copy of document provided to author by Fred Laccabue.
31. Cortada, J.W.: The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries. Oxford University Press, New York (2004)
32. Cortada, J.W.: The Digital Hand, Volume 2: How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries. Oxford University Press, New York (2006)
33. Carr, N.G.: Does IT Matter? Information Technology and the Corrosion of Competitive Advantage. Harvard Business School Press, Boston, MA (2004)
34. Staudenmaier, J.M., S.J.: Technology's Storytellers: Reweaving the Human Fabric. MIT Press, Cambridge, MA (1985)
35. Eggen, D., Witte, G.: The FBI's Upgrade That Wasn't. The Washington Post (August 18, 2006)
36. Borger, J.: FBI Chief Admits $170 Million Computer Failure. The Guardian (March 10, 2005)