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BOEING COMPUTER SERVICES: THE AI RESEARCH CENTER

In March 1986, George Roberts, Bruce Wilson and Janusz Kowalik were in Robert's Bellevue, Washington office to discuss the first two years of Boeing Computer Services' (BCS) Artificial Intelligence Associates program, which had been established as a way to quickly develop artificial intelligence (AI) expertise in the Boeing Company. Roberts pointed at a picture hanging above his desk of a U.S. Army Green Beret soldier, his gun pointed at the viewer.

> Remember when Bob Dryden gave me this? When he became president at BCS in 1981, Dryden set a goal of making BCS an aggressive technology leader for the company, instead of providing support services only. We were talking about this one day, and I said, "But Bob, if you want aggressive leadership, I'm going to need some weapons!" That appeared in my office not long after! We've done well in getting the Associates Program off the ground, but we need to review where we've been and where we're going against the backdrop of that goal.

Janusz Kowalik replied:

> We've made an excellent start. We can think of the Associates Program as involving three steps: 1) selection of high-quality people and important problems, 2) providing excellent training, and 3) facilitating re-entry of trained knowledge engineers and their projects back into the operating divisions. We're doing an excellent job on Number 2 at this point. Number 1 is a somewhat random process; there are pockets of enlightened managers identifying appropriate candidates, but results are inconsistent. Number 3 is beginning to show real problems.

This case was prepared by Research Associate Janis Gogan, under the supervision of Assistant Professor Melissa Mead, as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The names of some individuals have been disguised.

defensive, and tactical missiles. The company was a major contractor in the NASA space station program.

- Boeing Vertol Company (BVC) had produced over 1,000 military and commercial helicopters since the 1960s. Its largest customer was the U.S. Army.

- Boeing Electronics Company (BEC), created in early 1985, was responsible for most of Boeing's substantial electronics design and manufacturing work, both for the operating divisions and for markets outside the company.

- Boeing Computer Services Company (BCS) represented a move to both integrate information resource management and to diversify from the corporation's traditional bases in military and transportation. BCS served as the corporation's centralized information services provider, and also served commercial markets and government.

The 1984 Annual Report identified the challenge:

> Technology is a moving target and the company's challenge is to prepare for the next generation of military systems, spacecraft and commercial aircraft.... Regardless of past achievements no company can afford to relax its advanced development efforts while on-rushing technology is creating new opportunities in nearly every product area.

Boeing Computer Services

BCS was created as a subsidiary of the Boeing Company in 1970, consolidating 13 separate computing organizations into a single central organization. By 1986 it had grown from an initial staff of 2,000 to 13,000 employees; its base of computing equipment had risen from a value of about $100 million to $800 million worth of equipment, including IBM 3081 and 3033 mainframe computers, CDC Cyber 760s and 875s, and a Cray X-MP 24 Supercomputer.

With headquarters in Bellevue, a suburb of Seattle, BCS served more than 1,500 government and commercial customers in addition to the various operating divisions of the corporation. Five data centers, located in Bellevue and Kent, Washington; Wichita, Kansas; Philadelphia, Pennsylvania; and Vienna, Virginia, were connected in one of the largest private communications networks in the world. Other facilities included nine network control centers as well as sales and education offices in several countries.

As of 1986, support to The Boeing Company accounted for two-thirds of BCS' operations, but its commercial business was growing at a rapid rate. BCS products included network services, remote computing, software, education, and office information systems. Many of the commercial products were initially developed for internal applications. A highlight at that time was the award of a $216 million contract by NASA for

could not buy enough expertise, and we'd just have to make our own.

Wilson proposed that the ATAD group should create its own "graduate-level AI program." A small number of Ph.D. level AI experts would come to the firm and work as faculty/researchers. These and visiting faculty members from universities would staff an educational program whose mission would be to train people from all of Boeing's divisions. The participating employees would take one-year leaves of absence from their home divisions to participate as "Boeing Associates" in this program. Associates would spend 5 months in intensive classroom training to develop theoretical and technical expertise; the rest of the year would be spent working on a practical application of AI, under the supervision of one of the faculty members. At the end of their training, Associates were to make presentations of "proof of concept" prototypes of their applications to program faculty and to their own management.

Bruce Wilson commented on the reasoning behind the Associates Program:

> At the time, there were only two firms offering any form of AI training, and it was about one molecule deep. If we were going to get into these technologies, we wanted to do it right. If Boeing were geographically close to Carnegie Mellon or MIT or Stanford, we might not have needed to develop our own program. Even then, in some respects educational institutions will lag behind industry; we have to take the lead in putting together practical applications.
>
> Early on in our thinking, we realized that you can't just present the textbooks. To be successful, our people had to work on real problems. I also was influenced by the history of the Boeing Scientific Research Laboratory (BSRL), which had conducted basic research until 1968. At that time, all research was cut out of the budget unless it could be identified as contributing to a specific product. I didn't want our program to be viewed as just another "ivory tower BSRL". Our unique advantage is that we require students to identify a real problem, one that AI technology can help with, before they enter our program.
>
> Our challenge was to accelerate the infusion of AI technologies into Boeing divisions. By requiring that AI applications be identified early on, people would go back to the divisions with a valuable product that would be completed quickly. This was a good means of spreading the word about AI technologies and of obtaining divisional management commitment. We also deliberately sought to bring in Associates from the greatest number of functions and divisions.

It was clear that for our purpose we had to give people pragmatic tools. But I insisted that they must also be given a healthy dose of theory. The technology is changing so fast that people must understand the fundamentals. If you teach them only rote application of today's tools, their skills will be obsolete tomorrow. It was also clear that Associates would need to make a substantial commitment. They're getting about 400 hours of classroom training.

The first class of Associates entered in March of 1984. These candidates had individually pursued leaves from their divisions and were then screened by ATAD. Applicants to the program were told in a flier,

> Acceptance to the program is based primarily on the candidate's proposal for applying AI to a project in his or her home organization.... The criteria that will be used in evaluation are:
>
> - Suitability--the likelihood that AI is an appropriate technology for the project.
> - Availability of a principal in the suggested area of AI.
> - Availability of space and computing equipment.
> - Strength of the candidate's background and the likelihood that he or she will succeed in accomplishing the proposed objectives.

Applicants were expected to have a bachelor's degree and substantial computing experience. A search of program archives yielded a roster of the first class of Associates, their home divisions, and their projects:

- Wes Anderson and Debra Arnold, BAC: an avionics diagnostic system, with training potential.
- Penny Clifford and Patrick Haid, BAC: an expert system to apply AI to software engineering.
- Denny Corelli, BAC: a space station expert system for fault diagnosis, maintenance, system reconfiguration, and subsystem monitoring.
- Angela Grayson, BCAC: techniques for computer-based optical analysis of moire patterns that reflect stress deformation in mechanical systems.
- Ben Murdock, BCAC: a system to assess the risk of weight growth during airplane design.
- Ron Parker, BCAC: a computer-resource advisory system for software developers.

need to do a better job of ensuring that these people's new skills are appropriately utilized.

Of the first class of 9 associates, five were sponsored by Boeing Aerospace Company (BAC), as noted earlier. George Roberts had worked closely with BAC management to ensure that these Associates entered the program with appropriate projects. In evaluating the projects, both potential for developing a successful AI solution and strategic importance of the problem were considered. Of these five, only one--Debra Arnold--returned to a position at BAC to continue working on the project she had started as an Associate. The other four were transferred to BCS budgets (three to ATAD), although most would continue to work on projects which were at least indirectly related to BAC activities.

The three Associates who came from Boeing Commercial Aircraft Company also failed to return to their home divisions. Angela Grayson was transferred to ATAD when BCAC management informed her that, although her project was well-executed, it was not relevant to their needs. "This was an awkward situation," said Roberts. "In the end, we found a good place for Angela back at ATAD. But we don't want to develop a reputation for stealing Associates from the companies."

Similarly, Ben Murdock had found at the end of his year as an Associate that the Boeing Commercial Airplane Company did not have a suitable spot for him. He was transferred to Huntsville, Alabama where he worked on applying AI techniques in space station development project. Ron Parker returned to BCAC but was assigned to projects that involved no AI technologies.

In sum, most of the Associates in the first class continued to work on AI-related projects, but only Patrick Haid actually transferred his project back to his sponsoring division, "and he had to fight to stay alive there," noted George Roberts. "This trial run of the Associates program made us realize that technology transfer involves a significant human component that must be managed."

The second class of thirteen Associates, which started in July, 1984, included Shawn Gardner and Fred Jansen, both from Boeing Commercial Aircraft Company. Shawn had been with Boeing since 1979. Fred had worked for Boeing for six years, then taken a five-year leave of absence to care for his young children, as well as to build a house and write a book about his experience. He had returned to Boeing expressly to enter the Associates program. "The advantage for me," he commented, "was that I was not bothered by calls from the home division to put out this fire or that. I could really concentrate on my project." Shawn, on the other hand, noted, "I only spent about 60% of my time at the AI Center; I still had many responsibilities back at BCAC. But I liked that. A lot of people who went 100% into the program returned to their divisions at year end and nobody knew what to do about them."

Fred first developed an expert system called the Resin Advisor. "But BCAC management didn't see it as having great potential compared with a project Shawn was working on. So they asked me to collaborate with him."

Once Associates left the program, no formal mechanism existed to trace their progress. However, other Associates in the second class had fared as follows:

From BCAC: Tom Klein: continuing work on a 737 Diagnostic System, back at BCAC.

Donna Turner: transferred to ATAD

Robert Johnson: still at BCAC

From BCS: Rita Weldon: transferred to ATAD (in BCS)

Dick Selman: transferred to ATAD (in BCS)

From Boeing Vertol: Jan Wheatley: transferred to ATAD

The third class had begun in March of 1985. George Roberts felt that Janusz Kowalik and his team were doing a better job of picking candidates and projects as they gained experience with the program. For example, Mike Danson, from Boeing Electronics Company, had just graduated and was about to return to his sponsoring division. He was working on a Connector Assembly Specifications Expert System, that would help shop floor personnel select the correct tooling and materials for electrical connector assembly. Connector assembly is a very important job; as Mike put it, "an incorrect crimp can have major implications for an airplane. You have to get it just right." He estimated that the expert system, which was expected to be production-ready by mid-1986, could save the company as much as $10 million per year.

Alice Kirschner, from the commercial side of BCS, had come to the Associates program with a different agenda:

> AI is critical to the Commercial Services Group's product line. My project was to assess the technical feasibility, market potential, and requirements for incorporating AI into our products and services. I had to ask two key questions: Can AI help solve this problem? Can we make money on the solution? By graduation, my management had given me a promotion to a first-line management job, heading up a technology delivery and product development program.

Both Alice Kirschner and Mike Danson were lobbying for "junior" AI staff to help them in their projects. They argued that there was a need for individuals with some knowledge engineering training, but who would not need the level of technical depth offered in the Associates program.

The fourth class had begun in September, 1985 and the Center was gearing up for the fifth class of AI Associates to begin shortly.

resources. This concern could be alleviated by including in the existing skills inventory systems information on AI skills."

Dick Garinger also had concerns about retaining graduate Associates:

> The company offers competitive salaries, an excellent working environment, good tools, and generally challenging assignments, and so has not had an attrition problem. But as the market for AI skills heats up, the graduate Associates are bound to be targets of headhunters and raiders from other companies. We need to prepare, but the changes that we need to make will not come about easily, if at all. The Boeing compensation system is highly structured, with the payroll including exempt and nonexempt, and represented and nonrepresented employees. Changes affecting graduate Associates could impact the collective bargaining process and agreements. It is an obvious challenge to maintain equity regardless of payroll category, and also remain competitive with the outside labor market.
>
> While in the short run it might make sense to exempt graduate Associates from some compensation and retention policies and practices, it could result in raising labor relations issues and in disparate treatment of non-AI peers working in the same organization.
>
> Overall, graduate Associates present a dilemma.

Options

Roberts, Kowalik and Wilson spent several hours reviewing the Associates program and considering ideas for strengthening it. All agreed that the basic concept of developing AI skills in-house was still sound. The supply of individuals with these skills remained small in comparison with the growing demand for them. The three men also agreed that the Associates program offered training on a par with all but a very few graduate programs worldwide.

Roberts summed up the group's diagnosis of the re-entry problem:

> The real problem here is change. Some managers don't want to change, especially since they don't feel anything is broken. But it might as well be broken, because tomorrow we won't be able to compete unless we successfully absorb new information technologies throughout the company. Senior management is with us on this. But we have to convince middle management that the Associates program is a key solution; we have to motivate them to change. And in this company, top managers won't tell middle managers how to do their jobs.

Bruce Wilson reminded the group that the decisions relative to the AI Associates program would set the tone for forays with other emerging technologies as well. "We'll have the same issues with parallel processing and other critical technologies."

Roberts wondered if the group had exhausted the possibilities for improving the Associates program. If so, then how should they go about implementing some or all of these suggestions? If not, what were the alternatives? Glancing back at the Green Beret he remarked, "Are we ready to go out shooting? Or do we need more weapons?"

Exhibit 1 (continued)

Consolidated Statement of Net Earnings
(dollars in millions except per share data)

Year ended December 31,			
Sales	**$10,35**	$11,129	$9,035
Other income	241	179	171
	10,595	11,308	9,206
Costs and expenses	**9,998**	10,797	8,811
Earnings before federal taxes on income	**569**	475	364
Federal taxes on income before DISC adjustment	179	120	72
	390	355	292
Adjustment of prior years' federal tax provisions on DISC earnings	**397**		
Net earnings	**$ 787**	$ 355	$ 292
Net earnings per share:			
Primary	**$8.09**	$3.67	$3.02
Fully diluted	**$7.74**		
Cash dividends per share	**$1.40**	$1.40	$1.40

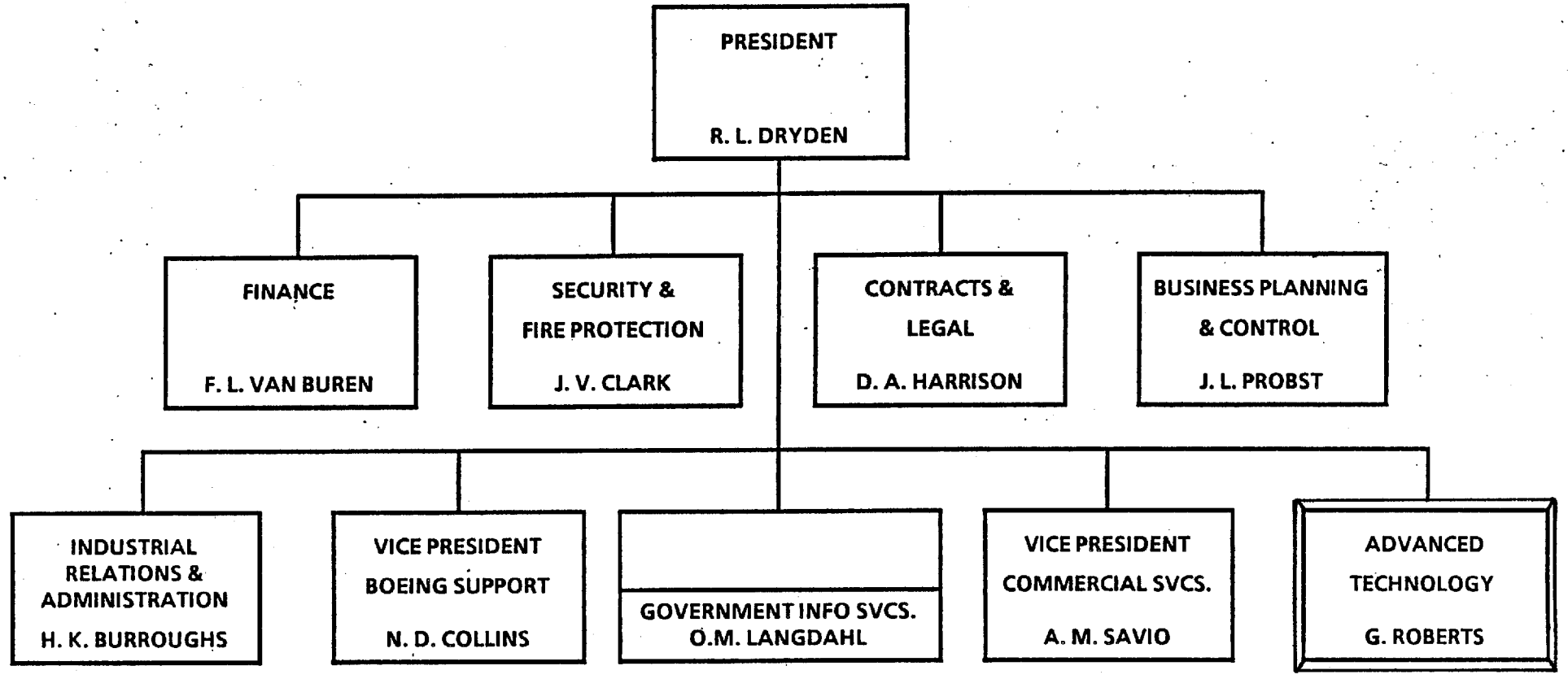
Consolidated Statement of Financial Position
(dollars in millions)

December 31,	1984	1983
Assets		
Cash and certificates of deposit	$ 1,067	$ 877
Short-term investments, at cost which approximates market	528	218
Accounts receivable	639	479
Current portion of long-term customer financing	138	62
Inventories	7,107	6,182
Less advances and progress payments	(3,309)	(2,656)
Total current assets	6,170	5,162
Long-term customer financing	541	539
Property, plant and equipment, at cost	3,916	3,659
Less accumulated depreciation	(2,245)	(1,988)
Investments and other assets	103	99
	$ 8,485	$ 7,471
Liabilities and Stockholders' Equity		
Notes payable to banks	$—	$ 65
Accounts payable and accured liabilities	2,528	2,239
Advances and progress billings in excess of related costs	644	288
Federal taxes on income, principally deferred	853	596
Current portion of long-term debt	15	17
Total current liabilities	4,040	3,205
Long-term debt	284	301
Deferred taxes on income	322	743
Deferred investment credit	144	184
Stockholders' equity:		
Common shares, issued at stated value-- 1984: 97,619,785; 1983: 97,589,588	843	838
Retained earnings	2,854	2,203
Less treasury shares, at cost-- 1984: 394,789; 1983: 628,169	(2)	(3)
Total stockholders' equity	3,695	3,038
	$ 8,485	$ 7,471

BOEING COMPUTER SERVICES

A Division of *The Boeing Company*

(as of March 1986)



- BEC ENGINEERS INC.
- EMPLOYEE SERVICES & LICENSED TRANSPORTATION
- FACILITIES
- INDUSTRIAL RELATIONS
- MEDICAL
- PUBLIC RELATIONS & ADVERTISING

- ADMINISTRATIVE SERVICES
- BCAC AND CORPORATE SUPPORT
- DEFENSE & SPACE SUPPORT
  - BAC
  - BMAC - SEATTLE & BECO
  - BMAC - WICHITA
  - VERTOL
- MATERIEL

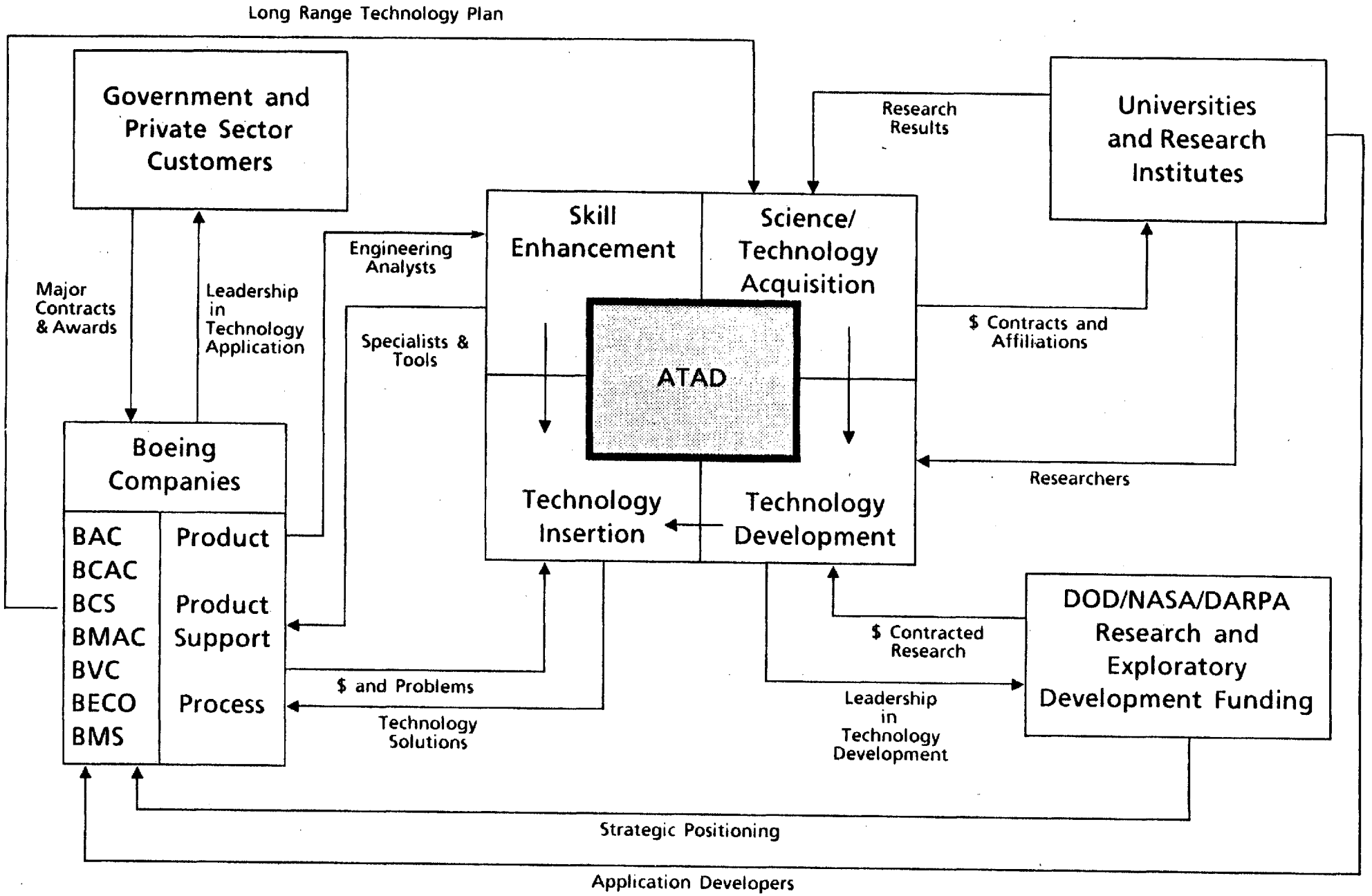
- BCSS
  - NASA COMPUTING
  - NASA PSC
- BCS RICHLAND
- BUSINESS DEVELOPMENT
- ENERGY CONTROL SYSTEMS
- MAJOR SYSTEMS OPPORTUNITIES
- SALES
- SYSTEMS

- COMMERCIAL INFO SVCS.
  - INTERNATIONAL
  - MARKETING
  - PROFESSIONAL SVCS.
  - SALES
- COMPUTER INTEGRATED MANUFACTURING
- ENG. TECH. APPLICATIONS
- INFORMATION SERVICES
- NETWORK SERVICES
- SOFTWARE & EDUCATION PRODUCTS
- THRIFT SERVICES
- WORKSTATION DEVELOPMENT & STRATEGIC ALLIANCES

FEBRUARY 1986

Exhibit 5

MISSION/OVERVIEW



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