Harvard Business School **9-701-006**
Rev. October 20, 2000

Embraer: The Global Leader in Regional Jets

By any standard, 1999 was a milestone year for Embraer. Our company earned a record US$230 million in net income and celebrated our tenth consecutive quarter of rising profitability. Total revenue reached US$1.89 billion, and our year-end backlog was US$6.4 billion in confirmed orders and US$17.7 billion including options – both all-time highs.

—*Mauricio Botelho,* Embraer´s CEO 1999 Annual Report

At the beginning of 2000, Embraer (Empresa Brasileira de Aeronautica S.A.) of Brazil was the fourth largest commercial aircraft manufacturer in the world behind Boeing of the U.S., the Airbus consortium of Europe, and Bombardier of Canada. Although Embraer was much smaller, it had been more profitable in 1999 (see **Exhibit 1**). Founded by the Brazilian Government in 1969, Embraer had been privatized in December 1994—a year in which it lost $310 million on sales of $177 million (see **Exhibit 2**). Since then, Embraer had become the global leader in regional jets. In 1999, as Brazil's largest exporter, the company delivered 97 such jets, compared to 82 for Bombardier of Canada, 23 for British Aerospace and 15 for Fairchild Dornier. Embraer posted revenues of $1.9 billion that year, of which the cost of sales accounted for 65%, operating expenses for 10% (with selling expenses representing 6%), financial and other nonoperating expenses for 13%, and net income for 12%. Its backlog at the end of 1999 included firm orders for 387 aircraft, of which 371 were regional jets, worth a total of $6.4 billion and options (orders subject to confirmation by customers 12-18 months before delivery) for 729 units, worth an additional $11.3 billion in sales.

Included in Embraer's figures were 175 orders—70 firm and 105 options—for a new family of larger jets announced in July 1999. This new family, projected to cost $850 million to develop, would, if successful, more than double Embraer's sales. In October 1999, Embraer announced that a consortium of French aerospace and defense companies would acquire 20% of its equity. In November 1999, the World Trade Organization (WTO) ruled against both Brazil and Canada for the financial support they had given Embraer and Bombardier respectively in regional jets. Both countries' compliance with the WTO's rulings would probably be audited in early 2000. And to add to the excitement, Embraer was also preparing for a foreign listing and equity offering, probably on the New York Stock Exchange.

Professor Pankaj Ghemawat, Gustavo A. Herrero, Executive Director, HBS Latin American Research Center, and Luis Felipe Monteiro, Senior Researcher, HBS Latin American Research Center prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

Promising Beginnings

Embraer's history was intertwined with the history of the Brazilian government's efforts to promote aeronautics—a priority for the country given its enormous land mass, wide rivers, and limited surface transportation infrastructure. In 1941, the Brazilian Government established an Aeronautics Ministry to oversee both civil and defense aeronautics. Between the mid-1940s and mid-1950s, it set up the Aeronautical Technical Center (CTA) to undertake projects in the aircraft industry, the Aeronautical Technology Institute (ITA) to train aeronautical engineers, and a research and development institute (IPD) to house 50 German aeronautical specialists hired after WWII. All three institutions were located in Sao José dos Campos (SJC), a small town 55 miles from Sao Paulo, Brazil's foremost industrial center. By one account, SJC became the hub of the Brazilian aeronautical industry because the air force officer who founded CTA had once been forced to land in a rice field nearby.

In August 1969, the Brazilian Aeronautics Ministry set up Embraer to manufacture military and commercial aircraft at SJC. Embraer was supposed to combine the resources of a state-owned enterprise with the entrepreneurial agility of a private-sector firm. The chief proponent of the new company, Ozires Silva, a graduate of ITA and an air force officer, became its first president. The Presidential decree establishing Embraer stipulated that the Brazilian government would control at least 51% of its equity. It also awarded the company some special privileges. Federal agencies were to purchase from Embraer rather than from competitors whenever possible. Embraer would pay no taxes or duty on imported raw materials, parts, and equipment unavailable locally. In addition, Brazilian corporations could invest 1% of their federal income tax obligations each year in Embraer's shares instead. This scheme helped Embraer raise an estimated $350 million in capital between 1970 and 1985.

Embraer quickly entered three segments of the aviation business: regional passenger aircraft, defense aircraft, and special purpose aircraft. Early product introductions included the Xavante (1971), a jet trainer and ground attack aircraft assembled under a licensing agreement with the Italian firm Aermacchi to fulfill an order that the Brazilian Air Force placed with Embraer; the Ipanema (1972), an agricultural spraying aircraft which CTA's research institute (IPD) had started to develop; and the Bandeirante (1973), a 19-seater turboprop passenger aircraft, also derived from an IPD design, which ultimately sold more than 500 planes. Aided by its privileged access to the large Brazilian market, Embraer also secured a production license for general aircraft from Piper. This angered Cessna, which had dominated the Brazilian market earlier on, and which subsequently led a lobbying effort against Embraer's attempts to sell Bandeirantes to U.S. airlines.

Embraer's first export orders were from Uruguay and Chile but the company soon began to look farther afield. The Bandeirante suited the requirements of a growing number of commuter operators in the deregulating U.S. skies. In 1978, Embraer persuaded one in Florida to buy three Bandeirantes and apply to the Federal Aviation Administration (FAA) for certification. Following FAA approval, U.S. sales increased from five planes in 1979 to 39 in 1981, which was when Embraer set up a wholly-owned U.S. subsidiary to focus attention on the sales function there. By then, Embraer had captured 46% of the commuter turboprop market and the Bandeirante, nicknamed the "Bandit" by competitors, had surpassed former leader Fairchild.[1]

In 1982, Fairchild filed a complaint before the U.S. International Trade Commission (ITC) requesting that a countervailing duty of 39-44% be imposed on Bandeirantes to offset the subsidies Embraer was receiving from the Brazilian government. The ITC ultimately rejected the complaint. By December 1984, 22 U.S. commuter airlines were flying 130 Bandeirantes, which Embraer had also exported to more than two dozen other countries.

After the success of the Bandeirante, Embraer began to work on the Brasilia, a 30–passenger pressurized twin turboprop. The company launched the Brasilia in 1985 and, through 1999, sold 350—a performance applauded as a commercial success but sometimes questioned financially. The

Brasilia was adopted as a workhorse by a number of U.S. commuter airlines that grew to be quite large: Skywest, ASA, Comair, etc. Skywest's fleet of Brasilias, for example, ultimately expanded to 90 planes. To meet demand, Embraer increased its cadence—its production rate, measured in units per month—from three planes to five-to-six in 1988.

Pressures and Privatization

In the late 1980s and early 1990s, Embraer's performance went into a tailspin for a number of reasons. In the international arena, the end of the Cold War, which led to the cancellation of billions of dollars of military programs worldwide, coincided with a world recession that hit commercial orders. Regionally, there was the disastrous saga of the next passenger aircraft that Embraer aimed to develop, the CBA123. In 1985, the new civilian presidents of Brazil and Argentina, Jose Sarney and Raul Alfonsin, each of whom had taken power after years of military rule, signed a cooperation agreement that marked the first step towards what would become the Mercosur (Southern Cone) Treaty. As part of their rapprochement, the two countries decided that Embraer would, with Argentine help, develop the CBA123, a shortened, 19-seat version of the Brasilia. The CBA proved to be advanced but far too pricey. The constraints associated with being a state-owned enterprise impeded the kinds of creative changes that might have salvaged the program. By 1990, the cumulated losses on the CBA123 program were calculated to amount to $280 million.

At the national level, Brazil, after growing faster than any other large country in the 20th century, started experiencing serious macroeconomic problems and running large deficits. Budgetary pressures constrained both procurement by the Brazilian Government and its export support programs. More broadly, inflation surged and, despite three attempts since the mid-1980s to stabilize prices, reached an annual rate of 37,000% by the beginning of 1990. Prices were not brought under control until the 1994 implementation of the Real Plan, which involved a new currency unit, the real, that was pegged to the U.S. dollar within a predetermined band.[2] Inflation had since stayed under control, although Brazil continued to rate very poorly on measures of international competitiveness (see **Exhibit 3**).

The combined impact of these changes on Embraer in the early 1990s was devastating. Sales plummeted from $700 million in 1989 to $177 million in 1994 as deliveries dropped from six planes per month to two. Despite a reduction in the workforce from 13,000 to 6,100, average losses exceeded $200 million per year. Ozires Silva, who had left the company in 1986 to serve as president of Petrobras, the state-owned oil company, and then as Minister of State for Infrastructure, was brought back as president. Although he was unable to staunch the bleeding, he helped persuade the Brazilian government that privatization was the only way out for Embraer, just like many other state-owned enterprises that were being privatized.[3]

Protests delayed the privatization of Embraer, a symbol of Brazilian nationalism, for nearly two years. Approval by the Brazilian Congress came with a clause that prevented layoffs in the first six months following the transfer of the company's control to private hands. This restriction was estimated to cost the new owners as much as $45 million. However, the Brazilian government did assume $700 million of Embraer's debt, recapitalize another $350 million, set a low reserve price on the company's shares, and allow partial payment in bonds that traded at approximately 50% of their face value.

A consortium consisting of Companhia Bozano, Simonsen (CBS), a Brazilian group with a core in financial services that had led the way in Brazil's privatization process, two large public-sector pension funds, and Wasserstein Perella, a U.S. investment bank, acquired a 45% stake in Embraer on December 7, 1994 for $89 million. But problems continued to surface. Wasserstein Perella did not pay the money it had pledged; as a result, CBS had to provide bridge financing and in June 1995, bought it out. The more detailed information available after privatization suggested that sales of the Brasilia turboprop were declining faster than expected. The new shareholders also seemed to have

underestimated working capital cycles in the aircraft industry. For all these reasons, additional financing loomed large as an issue for them, especially since Embraer was already paying interest rates above 30%. CBS, in particular, had a history of being an aggressive restructurer that aimed for relatively quick exit with high returns on limited investments.[4]

Turnaround

A search by Embraer's new shareholders resulted in CBS director Mauricio Botelho, a 53 year-old mechanical engineer, being appointed the company's new CEO in mid-1995. Botelho had worked in one of CBS's businesses in the 1980s, had left to run it after it was spun off in 1987, but briefly rejoined CBS's board in early 1995. The only executive Botelho brought with him to Embraer was CFO Antonio Manso, who had worked with him since 1969. Over the next few months, however, Botelho changed Embraer's top management structure, bringing in about half of the senior managers from outside and promoting the rest from within.

Lower down in the organization, the number of managerial levels was reduced from seven to five. Managers and engineers who were underpaid because they had bumped up against the constraints imposed on state-owned enterprises received salary increases within one month. Botelho saw his key challenge in working with Embraer's managers as one of transforming a company driven by and organized around production and development into one that was more market-oriented. As he put it, "When you've got only 100 customers, you have to focus entirely on what they want." He and other top managers consistently emphasized that what mattered were not the traditional "line" functions of production and development but the line that ran from customers to shareholders. This message was backed up by a reorganization project, launched in 1996, that led to a matrix organization, structured around projects, that was supposed to enhance flexibility, interaction, and autonomy while reducing development times and costs.[5] See **Exhibit 4** for an organization chart for Embraer.

Dealing with the demoralized and embittered workforce was another key challenge. The day after the six-month moratorium on layoffs expired, 1800 people (30% of the workforce) lost their jobs, although they did receive the officially mandated severance pay. In addition, salaries in excess of market levels had to be brought under control. Since unilateral wage cuts were forbidden, the layoff program was targeted at people who had worked at Embraer for more than 15 years: they were the ones most likely to have been promoted, under the tenure-based system in place prior to privatization, as a way of getting around salary caps. But as the losses continued, Embraer had to reduce its workforce further: 400 (mostly indirect) workers were laid off in early 1996 while wage and overtime concessions were secured from the remainder through their unions; and another 400 positions were eliminated in early 1997.

Workers acquiesced, partly because they were afraid of even more sweeping cuts if they resisted, but for other reasons as well: the company had opened its books to their representatives and had offered compensation to the laid-off workers in excess of the statutory minimum. As a result of these changes in personnel policies, total headcount dropped as low as 3,200, in April 1997, and average salaries fell by nearly $500 a month from a preprivatization level of $2,100. The total employment cost to the company per worker was roughly twice this base salary.

By late 1997, Embraer started to hire additional people for the first time in nearly 10 years. Its emphasis on hiring young workers led to further reductions in the average basic salary, to about $1,100 per month by early 2000. Although only 25% of Embraer's workforce was unionized, the company negotiated contracts annually with the same strong metallurgical union that represented the automobile plants located near SJC. Negotiations with the unions were described as "not very rewarding" but Embraer considered its relationships with its employees good and had not experienced any serious labor disputes in recent years.

The good relationships with workers were due, in part, to Embraer's recognition that it had to energize its employees—managers, engineers and production workers—instead of simply cutting costs. Embraer instituted an incentive program that distributed to employees the equivalent of 25% of dividends paid out to shareholders. These payments were made twice a year, starting in 1998, on the basis of performance vis-à-vis agreed upon targets, and accounted, on average, for the equivalent of three months of salaries in 1999. The performance targets derived from a Strategic Plan of Action that laid out the company's objectives five years into the future and that was supplemented by yearly action plans elaborated by each division VP, Director, or Manager, with input from subordinates. This iterative up-and-down approach ensured internal consistency as well as serving as a basis for incentive compensation.

In line with Embraer's stated strategic objectives, the boundaries of the organization were also redrawn after privatization. There was more emphasis on outsourcing: of basic supplies and services such as catering and security, of training, of specialized technical services that could be transferred to the spin-offs set up by some of the (many) engineers who had been let go, and even of basic manufacturing and assembly to Embraer's extensive network of partners. On the production front, Embraer placed more emphasis on coordinating supplier relationships to improve quality and speed. Thus, the production lead time for the Brasilia turboprop declined from 14 months in 1995 to eight months in 1996 to six months in 1997. Embraer continued, however, to emphasize in-house design and development as well as service provision over the lifetime of the aircraft that it sold.

Operating losses were staunched relatively quickly, but net income remained stuck around zero, largely as a result of a heavy debt burden (see **Exhibit 5**). Embraer secured more cash from the controlling shareholders, increasing their total equity contribution to $520 million by the end of 1997, and arranged cheaper sources of financing for itself, reducing its average interest rate from 33% in early 1995 to 8% by 1999. But to improve performance to levels worth sustaining, Embraer also needed a hit product. The only immediate prospect was the ERJ 145, the 50-seat twin-engined regional jet on which work had begun in 1989.

The ERJ 145

The ERJ 145 had been conceived in 1989 as a stretched, jet-powered version of the 30-seat Brasilia turboprop that would also benefit from work carried out on the CBA123. The new plane was supposed to cost $300 million to develop and to tap increasing demand for short-range, regional flights and travelers' growing aversion to turboprops. Despite immediate interest in the marketplace, the project had languished as the CBA123 flopped and Embraer's finances deteriorated. After privatization, it was up to the new shareholders to decide whether to continue with the project, which was thought to require another $240 million to complete.

Prior to privatization, CBS had had consultants validate the market for 50-seat regional jets as well as the ERJ 145's likely prospects in it. After taking over as CEO, Botelho accelerated the pace of development. The new plane flew for the first time in August 1995 and was finally certified in December 1996. The Brazilian National Development Bank, BNDES, provided a loan of $115 million. Additional financing came from Embraer's four (nonBrazilian) risk-sharing partners in the project, who collaborated in the development of the new plane at their own cost—a contribution worth about $100 million—and were paid as units were sold. Several dozen smaller "partner suppliers" were eventually signed up as well. The high degree of reliance on external partners was illustrated by the fact that materials and equipment purchased from risk-sharing partners and other major suppliers came to account for 79% of production costs for the ERJ 145 and 85% for the ERJ 135, a 37-seater that was the second plane in the family.

The ERJ 145's principal competitor was the CRJ-200, sold by Bombardier of Canada. The CRJ-200 had been conceived at about the same time as the ERJ 145, had had its first flight in May 1991, and had been certified in January 1993. Despite the CRJ-200's head start, Embraer's

management was confident that the ERJ 145 would overtake it in winning new "campaigns" because of basic differences. From the passenger perspective, the CRJ-200 had four-abreast seating, compared to three-abreast for Embraer, and therefore offered less cabin width per passenger. The differences in profit potential for airlines were even more important. While the ERJ 145 reflected the design of the Brasilia, a passenger aircraft, the CRJ-200 was derived from Canadair's large Challenger business jet, originally designed in the 1970s. As a result, in Embraer's view, the CRJ-200 carried more than a ton-and-a-half of extra weight and had more complicated and expensive systems and unnecessary operating characteristics. In line with the industry rule of thumb that each extra ton cost $1 million and after allowing for differences in systems, Embraer estimated that the CRJ-200 cost $2-3 million more to produce than the ERJ 145—a cost differential that was reflected in reference prices of $17.6 million for the ERJ 145 and $21 million for the CRJ-200. In terms of direct operating costs, the ERJ 145 was significantly more economical—especially on shorter flights because it had lower fixed costs per flight than the CRJ-200 (see **Exhibit 6** for Embraer's estimates). According to the *Official Airlines Guide*, about 70% of all flights by "small" passenger aircraft (with fewer than 110 seats) covered less than 300 miles and another 20% ranged between 300 and 500 miles.

Bombardier was a much larger company than Embraer, with operating groups active in transportation equipment, motorized recreation equipment, and financing as well as aerospace. Aerospace was, however, emerging as by far the largest and most profitable business at Bombardier and included Learjets and De Havilland Dash turboprop transports as well as Challenger business jets and Canadair Regional Jets (CRJs). Bombardier had, with a three-year head start, already delivered close to 100 CRJ-200s by the time Embraer delivered its first ERJ 145. It responded aggressively to Embraer's entry by cutting prices significantly on the CRJ-200, circulating a detailed manual to potential customers comparing the ERJ 145 unfavorably with its own plane, and even luring away some of Embraer's engineers by placing help-wanted ads in a Sao José dos Campos newspaper. It also apparently used its connections—Bombardier Chairman Laurent Beaudoin was considered close to Canadian Prime Minister Jean Chretien[6]—to spur a complaint by the Canadian government to the World Trade Organization about the Brazilian development bank's role in financing ERJ 145 orders (as described below). Botelho countered, in part, that although the CRJ-200 cost more than the ERJ 145 to manufacture, its purchasers faced lower monthly payments because of even cheaper financing.

Despite Bombardier's aggressive response, sales of the ERJ 145 quickly took off, helped by an order for 200 planes—25 firm and 175 options—from Continental Express in fall 1996. Cumulated deliveries hit 100 within two years of the initial delivery, compared to three-and-a-half years for the CRJ-200. This required marketing and production capabilities as well as latent demand. The selling process was quite complex, involving prospecting by sales, proposal preparation by people from contracts under the leadership of sales, proposal negotiation by people from both sales and contracts, contract negotiation and writing led by legal and contractual people, and production and delivery, in which the industrial area took the lead. On the production side, Embraer had been able to ramp up production very quickly while shrinking production lead times—to five months by early 2000, compared to 12 months in 1995. The ERJ 145 accounted for 60% of Embraer's revenues in 1997 and pushed the company into the black in 1998. Its success prompted Embraer to launch two derivatives with high commonality: the ERJ 135, a 37-seat jet first delivered in 1999, and the ERJ 140, a 44-seater to be delivered from the first quarter of 2001 onward. Sales of the ERJ 145 and 135 combined to generate 83% of total revenues in 1999. The large orders by Continental Express and American Eagle were particularly pivotal: as of March 31, 2000, they accounted for 57% of firm orders for the ERJ 145 and 135, 46% of options, and 80% of deliveries since the beginning of 1999. Relatedly, the geographic mix of Embraer's business shifted towards the United States. Between 1997 and 1999, the Americas outside Brazil increased their share of Embraer's revenues from 39% to 65%. Brazilian revenues fell from 36% to 13% of the total and European revenues from 25% to 23%. Since total revenues themselves increased by more than 250% over this period, the Americas outside Brazil accounted for nearly three-quarters of the absolute growth in Embraer's revenues over this period.

The New Family

In mid-1999, Embraer committed to fill out its regional jet family by developing jets in the 70-110 seat range (see **Exhibit 7**). This development effort had been in the air ever since most of the work on the ERJ 145 and its derivatives had been completed. It received impetus in late 1998 from a survey of about 50 airlines, collectively accounting for more than one-half of the market, to gain a better understanding of their requirements for larger regional jets. The results of the survey made Botelho much more confident about the market opportunity. In January 1999, he brought the idea of developing a new family of regional jets to Embraer's board of directors, and received a green light to proceed "responsibly" toward the development of a business plan. Crossair, Europe's largest regional airline served as the launch customer for the new family, ordering 160 units—60 firm and 100 options—in June 1999. Embraer's board approved the project, and the new family was announced with fanfare at the Paris Air Show in June 1999. The commitment to deliver the first 70-seat ERJ 170s in December 2002 implied a 38-month target for certification that would set a new record for the industry, particularly since the ERJ 170 was the first of a new family. Executive Vice-President of Planning and Organizational Development Horacio Forjaz, who had worked at Embraer since 1974, compared this breathtaking pace with the possibilities prior to privatization: "We would have never been able to make the decisions we made, with the speed at which we made them, if we had still been a state-owned enterprise. Approvals are much slower when you deal with Government officials—we even had to get preapprovals for foreign trips in those days."

The Planes Substantial guidance about the design parameters for the new family emerged from the customer survey cited above:

- Regional traffic was expected to grow significantly faster than long-distance passenger traffic and up to three times as fast as GDP. And regional jet traffic would grow particularly rapidly as the shift from turboprops to jets continued—even though the latter could cost 50% more.

- In addition to macroeconomic factors, the demand for regional jets would depend on industry-specific factors. Would the scope clauses, negotiated with unions, that restricted many U.S. airline majors from farming out flights with more than 70 seats to their commuter affiliates (who generally paid less for labor) be relaxed and if so, at what rate? And would air traffic control systems be able to cope with the burdens of routing many more small jets?

- While low prices and operating efficiency were always key, airlines, particularly in Europe, were reemphasizing passenger comfort. Passengers themselves strongly preferred four-abreast configurations, with two seats on each side of the aisle, to five-abreast configurations with a "middle" seat. Also, environmental issues were increasingly important, with noise and fuel efficiency levels stirring the most concern.

Stretching the ERJ 145's body from 50 to 70 seats was out of the question given its relatively narrow fuselage. This allowed unconstrained optimization of the design parameters. Satoshi Yokota, the executive vice president of the industrial area, summarized some of the results:

> The ERJ 170 has optimal fuselage width, including adequate aisle space for roll-on baggage and service carts. Two roll-ons can be stored overhead for each row, and two can be squeezed underneath the seats in front. The seating configuration is flexible since there are no overwing exits. Engines under the wings allow for 4 doors, two in front and two in back, which translates into faster turnaround since the aircraft can be serviced through the rear doors. Below-wing engines are usually 5% lighter than the tail-mounted engines used in the ERJ 145, and leave more room for

passengers in the back. The greater height associated with below-wing engines also allows more room for cargo.

An analysis performed by a Miami-based consulting firm retained by Embraer indicated that the ERJ 170 outperformed both Bombardier's CRJ-700 and Fairchild's FD-728 in terms of profit potential as well as "cabin configuration/passenger appeal." According to that analysis, the ERJ 170 offered the shortest airfield requirements, the longest range, the lowest costs, the lowest break-even payload, and the highest potential net margin contribution of the three aircraft. See **Exhibit 8** for summary cost comparisons. The consulting firm's report also stressed the ERJ 170's advantages in terms of "design philosophy/family values:" a new aircraft design incorporating advanced technology, optimized for performance efficiency, and offering higher engine thrusts and lower noise levels as well as a true family concept. Embraer placed great emphasis on commonality across the three new products it was developing, starting with the 70-seater, since that helped airlines economize on parts inventories and training and, at the same time, reduced Embraer's development and manufacturing costs. Commonality was sacrificed only when it would have grossly compromised the designs of the individual products, as in the case of engines, wings, and landing gears. But cabin width, nose cones, and most navigational equipment were common to all three models being developed.

The three new models were to hold 70, 98, and 108 seats, with the last two carrying the designations of the ERJ 190-100 and the ERJ 190-200 respectively. Frederico Curado, the executive vice president of the airline or commercial (nondefense-related) market, explained that product sizing reflected the rule of thumb that commuter airlines operated profitably with average load factors in the range of 55-75%. Commuter airlines were supposed to break even with average load factors of 55%, but load factors of over 75% meant that too many passengers were being left on the ground—and a competitive vacuum being created. As a result, in the line-up of the ERJ 135, the ERJ 145, the ERJ 170, and the ERJ 190-100, each plane had roughly 77/55 or 1.36 times as many seats as the next largest. The size of the ERJ 190-200, however, was the exception to this rule: it reflected constraints on stretching the body also used for 70-seaters as well as competitive considerations.

Markets and Market Shares Under Curado, a new market intelligence department in the commercial area had developed its own market analysis methodology to supplant the assessments by outside consultants on which Embraer had previously relied. This methodology integrated a top-down approach based on expected GDP growth, demographics, independent sources of information, etc. with bottom-up estimates involving airline customers (see **Exhibit 9**). The global market forecast that resulted was then to be combined with an analysis of Embraer's position vis-à-vis its competitors to yield market share forecasts for Embraer products in each market segment.

Embraer's market analysis methodology suggested that total demand for regional jets and turboprops between the years 2000 and 2009 would be 4,800 units, of which 55% (2,360 units) would be accounted for by the market segments that Embraer's new family sought to address: jets in the 70- to 110-passenger band. The U.S. was expected to account for 60% of unit demand, Europe for 25% and the rest of the world for 15%. Bombardier's forecasts were similar, whereas Fairchild Dornier's were a bit higher, at close to 3,000 planes.[7] Some analysts worried, however, about the economy weakening, or about the regional airlines, who had traditionally ordered aircraft one or two at a time, now acting like majors in seeking to outdo each other with huge orders.[8]

Forecasting Embraer's market share involved additional judgments about competitive factors: the relative timing of entry, product positioning, and broader assessments of strengths and weaknesses. The first delivery of Embraer's 70-seater (ERJ 170) was scheduled for December 2002, of its 108-seater (ERJ 190-200) for June 2004, and of its 98-seater (ERJ 190-100) for June 2005.

Based on this timeline and competitors' public announcements, the first delivery of the ERJ 170 would trail that of Bombardier's CRJ-700 by one year, and that of Fairchild Dornier's FD-728 by one month. This sequencing coincided with backlogs of firm orders as of the end of 1999: 99 for the

CRJ-700; 60 for the FD-728; and 40 for the ERJ 170. However, Embraer's management thought that the lower direct operating costs for its 70-seater (see **Exhibit 8**) would more than make up for this lag. In specific relation to Bombardier, Embraer stressed that the CRJ-700's narrower/longer fuselage was likely to lower passenger comfort and slow ground turnaround (aisles would be only 15 inches wide rather than 19 inches, for example). The company also cited its own ability to overcome a three-year first-mover advantage for Bombardier in the 50-seat segment. It recognized, however, that Bombardier had a powerful sales force and that the CRJ-700 would benefit from commonality with the CRJ-200.

In relation to Fairchild Dornier's product, Embraer emphasized the suboptimality of the five-abreast configuration, which had led CrossAir—which accounted for 86% of the firm orders for Embraer's new family and 95% of the options as of March 31, 2000—to cancel its original order for the FD-728 in the first place. It also pointed out that Fairchild was supposed to have been the first manufacturer to deliver an aircraft in the 70-75 seat range, but that financial difficulties had already led to significant delays (as they had for Fairchild's only other regional jet, the FD-328, which the ERJ 135 had beaten to the market as a result). Looking forward, though, Fairchild Dornier was to be acquired by Clayton Dubilier Rice, the leveraged buyout firm, and Allianz, the German insurer, for $1.2 billion. This deal was expected to be finalized by April 2000, after due diligence, and would probably give Fairchild Dornier more degrees of freedom.

For the larger (81-110 seat) planes, competitive dynamics were expected to be quite different. Embraer had 30 firm orders for ERJ 190-200s, compared to zero for Bombardier and Fairchild Dornier. In early 2000, Bombardier was still considering the launch of a 90-seat derivative of its already stretched 70-seater—which would presumably be extremely elongated if it materialized. Fairchild Dornier *had* announced another 90-plus seater, the FD-928. However, it was quite uncertain when, if at all, this would happen given the small size of the company's regional jet business—by one estimate, it sold around $600 million worth of FD-328s in 1999—and the ambitiousness of its development programs. It was already engaged in two, the 728 and the 428 (a 44-seater), the second of which it had farmed out to Israel Aerospace Industries. It had also announced a new 528 (50-seat) program as well as the 928. The uncertainty was compounded by yet another change in the company's ownership and management. It was also unclear how much commonality there would be between an eventual 928 and the 728. Thus, the 428 that Fairchild Dornier was developing was a distinct aircraft from its 328.

Irrespective of whether these and other entries materialized, Embraer's larger planes were bound to compete with the 106-passenger Boeing 717-200, and the 107-passenger Airbus 318—the smallest planes in the two largest manufacturers' product lines. Embraer thought that their approach of providing shrunken versions of big planes would not offer the desired performance characteristics and pointed to weight—the ERJ 190-200 would end up being five tons lighter than the Boeing 717 and 13 tons lighter than the Airbus 318—as just one indicator. It also reckoned that the small planes wouldn't be nearly as profitable for Boeing and Airbus as their larger ones, especially at the pricing levels at which they had won some recent contracts for the former. Some corroboration came from Boeing's experience with DeHavilland, a turboprop manufacturer which it purchased in 1986 and sold to Bombardier in 1992 after losing $1 billion.

Based on competitive considerations of this sort, Embraer developed three basic market share scenarios for both the ERJ 170 and the ERJ 190. In the 61-80-seat market, the base case or middle scenario involved a struggle for the number one position between Bombardier and Embraer, with Fairchild Dornier a relatively close third: Embraer's market share was projected to be 35%. In the 81-110 seat market, Boeing and Airbus were expected to play a significant role in the market and, as a result, Embraer's base case scenario projected its market share at 18%.

Project Economics The market share scenarios could be combined with assumptions about both the timing of deliveries/payments and prices over time to generate projections for financial inflows. Both demand and Embraer's ability to supply it would determine the time-path of deliveries.

Embraer expected that deliveries for the new family would hit a steady-state level within three or four years, the pattern exhibited so far by the ERJ 145, rather than, say, the pattern exhibited by the Brasilia, whose sales built up more slowly, but had been longer-lived. In terms of prices, the level Embraer was targeting implied a price-per-seat of about $280,000, blended across the three new products, which compared favorably to the $330,000 or so per seat for the ERJ 145 family. Embraer's targeted levels also incorporated a discount relative to the prices assumed for Bombardier and Fairchild Dornier's planes, reflecting both its intended positioning in the market and its belief that its planes would be slightly cheaper to manufacture.

The financial outflows would include large upfront investment costs as well as ongoing production costs. Development of the three larger regional jets could cost $850 million in total, compared to an estimate of $500 million for developing just the first plane in the family, the ERJ 170. Satoshi Yokota, executive vice president of Embraer's industrial area, guessed that the development of the CRJ-700 cost Bombardier $400 million, while other estimates ranged from $300 million to $450 million.[9] Especially toward the high end of the range, this represented limited savings for Bombardier from stretching an existing aircraft compared to the new one that Embraer was developing. Yokota thought that the ten million engineering man-hours involved in developing the new family might have made Embraer's development effort cost $100 million more had it been carried out in Canada (assuming a $10/hour difference in the costs of engineers in Canada and Brazil). Fairchild Dornier's costs of developing its 75-seater were considered likely to be higher than Bombardier's since the FD-728 was a new plane rather than a derivative, since Fairchild had limited jet development experience but was engaged in multiple development programs, and since the costs of its mostly German R&D establishment were considered high.

In addition to the $850 million in total development costs, a comparable aggregate amount might be required to tool up for $2 billion-plus in extra sales per year that the new jet family was supposed to generate—although the actual costs of investment in fixed assets would clearly depend, in part, on the market share scenario realized. By way of comparison, Embraer's own investments in the program, measured roughly as the sum of its investments in product development in regional jets and all its investments in fixed assets between 2000 and 2004, were expected to amount to $900 million (see **Exhibit 10**). Suppliers who were Embraer's risk-sharing partners would shoulder much of the balance and would also account for most of the ongoing production costs, as described below. Labor would be the other important component of ongoing costs. As of early 2000, Embraer employed 8,000 people at its Sao José dos Campos plant at an average monthly salary of $1,100. In addition, it had to pay 100-120% of the basic salaries to the government for social charges, etc.

Discounted cash flow analysis based on these assumptions suggested that the optimistic scenario, which had Embraer leading in both the 61-80 and 81-110 passenger segments, implied extremely positive returns. Conversely, the pessimistic scenario, which had Embraer trailing badly as number two in both segments, implied very low returns. Embraer directed more attention at exploring the middle scenario, which envisaged a 35% unit share for the company in the 61-80 passenger segment, and an 18% unit share in the 81-110 segment—i.e., selling 425 ERJ 170s and 250 ERJ 190s between 2000 and 2009. At the average price-cost markup (i.e., contribution margin per plane) that Embraer was projecting, the different specifications of the middle scenario generally yielded positive NPVs. They also suggested that less than 400 units would have to be sold to break – even, an objective that might be achieved by the year 2007.

Partnerships Operationally, moving ahead required, as first steps, the selection of risk-sharing supplier-partners and the initiation of joint development with them. Risk-sharing was obligatory for Embraer's largest suppliers—particularly the ten that would account for more than $200,000 per plane—rather than optional. Requests for proposals were sent out to 85 potential partners, of which 58 submitted tenders and 16 were finally selected (see **Exhibit 11** for a partial list). Other smaller partners were added as the project progressed, and it was estimated that close to 100 suppliers would be involved as partners of one sort or another. Compared to the ERJ 145/135/140, the partnerships were structured so as to give risk-sharing partners responsibility for supplying entire systems,

instead of components, and thereby encourage the development of closer relationships with a smaller number of suppliers. Bombardier, in contrast, was thought to place less emphasis on external partnerships because it was larger and more vertically and horizontally integrated, and Fairchild Dornier because financial and ownership issues had probably limited its ability to establish and maintain long-term relationships.

Given the deliberate aggressiveness of the launch program, speed and flexibility proved important in the supplier selection process. Thus, when Rolls Royce, the engine supplier for the previous Embraer family, insisted on basing its proposal on the BR710/715 engine (used for the Boeing 717 but deemed "too heavy and thirsty for the ERJ 170" by Yokota), GE won that role—even though it was also supplying the engines for the CRJ-700 and the FD-728. Commonality permitting, Embraer attempted to combine bidding by suppliers on the ERJ 170 and the ERJ 190. Suppliers were supposed to shoulder the development work for their particular pieces of the project(s), a contribution on their part, with no recourse to Embraer, that was valued at $200-250 million of the total development expenditures for the three new planes. In addition, they were also expected to make cash contributions to help fund Embraer's portion of the development costs, although Embraer would have to refund these contributions if it failed to secure a certificate of airworthiness for the new aircraft. They would also be involved in offering financing and residual value guarantees to buyers. Embraer evaluated potential suppliers' proposals, including contributions in cash and kind, in terms of their cash flow implications, discounted at an annual rate of 16% into an NPV. After Embraer had valued different proposals in such terms, further negotiations occurred, often taking several rounds (up to 20, for major items such as engines).

The selected suppliers received a previously agreed upon fixed sum per unit sold, escalated in line with industry-related cost indexes, plus most of the spare parts business. For some products or subsystems such as tires and brakes, spares could generate much larger revenues than the OEM (original equipment manufacturer) business. There was, however, no profit- or revenue sharing with suppliers. According to Yokota, whose area encompassed internal and external supplier management in both the development and production phases, this reflected the difficulty of contracting on profits or revenues in the commercial aircraft environment: "What's cost or net price? Given sales costs, warranties, residual-value guarantees etc., we will know only 20 years from now!" The arrangement also had the effect of appealing to suppliers who thought that Embraer's base case market share scenario was too conservative. Since the ERJ 145 program had proved much more successful than Embraer had originally projected—580 firm orders to date versus the 400 projected—this view was not uncommon. According to Embraer, potential risk-partners had bid much more aggressively on the ERJ 170/190 family than on the ERJ 145 family.

The early phases of the development process necessitated particularly close coordination with risk-partners. As of the second half of 1999, a JDP (Joint Definition Phase) team with 350 engineers and technicians from Embraer and 250 from risk-partners worked side by side in SJC. This group received additional support from Embraer's 1,000 staff engineers and its Virtual Reality Center, which became operational in February 2000 and let engineers and operators "walk through" three-dimensional prototype designs as if the aircraft had been physically completed. At that time, there were only 20 such installations at manufacturing companies around the world.

Hosting so many employees from very different cultures for stays of several months posed some management challenges. These were only partly addressed by making each partner primarily responsible for its own employees. Yokota recalled that the competition for desirable hotel rooms had been particularly intense. After the finalization of a preliminary design for the ERJ 170 at the end of the joint definition phase in early 2000, significant decentralization could be expected. However, there would be ongoing communication with suppliers about development and eventually, procurement—a function which employed about 200 people at Embraer.

Embraer was willing to outsource anything that was not integral to its longer term strategy of concentrating on the provision of "intelligence systems." In a shift from the traditional focus on the

supply of physical goods, the core areas were now defined to include design, project direction, the engineering of the more sophisticated navigational systems ("We would never outsource the cockpit—that is where design and functionality come together," said Yokota), final assembly, and orchestrating customer support. In addition, the outsourcing of 50% of product value to foreign suppliers and the fact that 96% of revenues in 1999 were dollar-denominated hedged "Brazil risk," although they did increase the importance of import and export financing. CFO Antonio Manso figured that a devaluation of the Brazilian real would increase rather than decrease gross margins in the short run, but not by much. The base case financial analysis took the neutral stance of assuming that changes in exchange rates would reflect interest rate differentials which would, in turn, reflect inflation differentials.

The WTO Dispute

A dispute between Bombardier and Embraer concerning export financing had evolved into a major source of tension between Brazil and Canada and an important test of the World Trade Organization's (WTO's) dispute settlement mechanisms. This dispute, like many others in the industry—e.g., between Boeing and Airbus—was rooted in the extensive governmental financing of commercial aircraft exports and exporters at concessional rates. What was new was the application of the WTO Agreement on Subsidies and Countervailing Measures ("SCM Agreement"), which outlawed most forms of export subsidies. Export credits and credit guarantees were the most prominent exceptions: there was a "safe harbor" for them if they met guidelines agreed upon in November 1979 by the OECD countries. Thus, it was permissible, in December 1999, for Chase Manhattan to finance the sale of Boeing 737s to a Chinese purchaser at Libor (the London interbank offer rate) plus .03% on the basis of guarantees by the U.S. government's ExImBank.

Bombardier sparked the WTO proceedings by persuading the Canadian government to mount a challenge, in June 1996, to the role of Brazil's PROEX program in financing Embraer's exports. PROEX, created in June 1991, was an interest-equalization program keyed to the fact that even after adjusting for inflation, real interest rates in Brazil (as in many other emerging countries) were much higher than in advanced countries. PROEX was meant to offset part of the extra financial cost (up to 380 basis points a year) incurred by Brazilian exporters and to offer them access to longer-term funds than were otherwise available domestically. In the commercial aircraft industry, PROEX helped foreign buyers finance purchases of Embraer aircraft at subsidized rates—a concession Bombardier estimated to have been worth more than $4 million, in nominal terms, over the life of a plane. After the consultation with Brazil requested by Canada under the WTO rules failed to yield a settlement, Canada requested, in September 1996, a panel to hear its complaint about PROEX.

Canada withdrew its request for a panel later in 1996 when, prompted by Embraer's allegations that the Government of Canada and its provinces had subsidized Bombardier, the Brazilian Government prepared its own complaint. In March 1997, Brazil formally filed a request with the WTO for consultations with Canada about alleged Canadian export subsidies to Bombardier. Two received particular attention: the risk capital that Technology Partnerships Canada (TPC) offered at the beginning of the development cycle, with no expectation of any return until break-even; and the financing of export sales by Canada's Export Development Corporation (EDC), both directly and through its secret Canada Account. According to the Brazilian side, the ability to lease a Bombardier plane for the same monthly payment as its counterpart from Embraer, when the Bombardier plane cost more to manufacture, constituted *prima facie* evidence of a sub-market rate for EDC financing. It calculated that the large residual-values guaranteed by the EDC played a key role in trimming financing costs without triggering any immediate transfers of official funds.

After another year of fruitless negotiations, the Brazilian and Canadian Governments filed requests on the same day in July 1998 before the WTO, moving that panels be formed to rule over the other's infringement of WTO rules in subsidizing the export of commercial aircraft. Later that month, the Dispute Settlement Body of the WTO established two different panels to pursue these requests. The

European Community and the United States reserved their rights to participate in both panel proceedings as third parties.

In the hearings that began later in 1998, PROEX and the alleged Canadian infringements were debated simultaneously but separately before the two panels. In the hearing before the PROEX panel, Canada argued that Embraer's increase in its production of regional jets to 12 a month was enough to satisfy, on its own, the demand for regional jet aircraft in its market segment for the foreseeable future and that the PROEX program enabled Embraer's dominance. Canada also introduced evidence that airlines such as Comair, Skywest, and ASA had acknowledged that Brazilian export subsidies brought down their financing costs by about 1.8 to 3.5 percentage points below market-based costs of financing. Brazil argued that even if PROEX payments were found to be prohibited export subsidies, the SCM established special and differential treatment for developing country members, permitting them to maintain export subsidies for a period of eight years from the date of entry into force of the WTO agreement. Canada agreed that Brazil was a developing country, but argued that PROEX had been expanded instead of being phased out, as the SCM required.

With regard to the alleged Canadian infringements, Brazil argued, among other things, that the provision of TPC risk-capital to the Canadian regional jet industry was explicitly conditioned on its high export-propensity and, therefore, constituted a banned export subsidy. It also maintained that there was evidence of financing at submarket rates by EDC that warranted further investigation. Canada countered that TPC focused on general economic benefits to Canada rather than export propensity *per se*, but that it would change the TPC's statutes to make this clearer. Canada also claimed that the EDC's export credit guarantees were offered at rates that had been clearly adequate to cover its costs, and were therefore permitted under WTO rules. It declined, however, to submit detailed information on the terms that EDC offered on the grounds that such data were competitively sensitive and therefore to be held confidential. Brazil described the changes in TPC statutes as cosmetic, and found the cloak of company confidentiality around EDC's rates unconvincing.

In March 1999, the panel looking into the PROEX program ruled that payments on exports of regional aircraft under the PROEX interest rate equalization scheme were inconsistent with the SCM Agreement and recommended that Brazil withdraw them without delay, i.e., within 90 days. In April, the panel looking into Canadian measures affecting commercial aircraft exports ruled that TPC assistance to the Canadian regional aircraft industry and export financing through the Canada Account were inconsistent with the SCM agreement and also recommended that they be withdrawn without delay. It did not, however, find sufficient cause to pursue Brazil's complaints about submarket-rate financing by EDC. Neither country was happy, and each appealed the decision of the panel charged with looking into its conduct. Both rulings were upheld three months later by the WTO's Appellate Body, with a time frame for achieving compliance that now ran through November 1999.

In November 1999, within one day of each other, Brazil and Canada submitted status reports on their respective implementation of the WTO rulings. Brazil indicated that the interest rate equalization payments under PROEX would be granted only to the extent that the net interest rate applicable to a transaction under that program was brought down to the appropriate international market "benchmark"—instead of being pushed lower, as had sometimes happened in the past. Canada indicated that it was discontinuing Canada Account financing of regional aircraft exports effective immediately, as well as terminating all existing obligations to disburse TPC funds to that industry. Each side rejected the other's report. Canada stressed how large the residual subsidy element in PROEX would be even if Brazil implemented its proposal. Brazil faulted the Canadian proposals for being cosmetic or easily reversible once the spotlight had passed elsewhere. The two submissions and comments were referred back to the original panels, which were scheduled to meet with the parties at the beginning of February 2000. Final reports were expected in April 2000.

What would happen afterwards was uncertain, even if one were willing to predict the content of the final reports. Technically, if one country persisted in noncompliance with WTO rules,

another could request authority from the WTO to retaliate in "equivalent" measure by imposing countervailing duties on its imports from the offender. This had never happened to date. Relevant to how such possibilities might play out in reality were the facts that Canada was running a positive trade balance with Brazil and was investing more there—some of which was financed by the Brazilian development bank—than the other way around.

From Embraer's perspective, even more important than the terms finally agreed upon for PROEX was whether the agreed terms would be applied retroactively. Bombardier argued that any reduction in PROEX should be applied both to new orders and to orders contracted for but not yet delivered, involving 900 planes and $3.7 billion in financing. Embraer rejected such recontracting and, in any case, regarded Bombardier's numbers as wildly inflated. According to Henrique Rzezinski, recently hired from Xerox to be Embraer's first vice-president of External Relations, fewer than 300 planes would be affected by retroactivity even if it were mandated.[10]

The French Connection

On October 25, 1999, Embraer announced that a group composed of French aerospace and defense companies Aerospatiale/Matra, Dassault Aviation, Thomson-CSF, and SNECMA would acquire 20% of its voting shares. No new equity would be issued: rather, the French would buy existing shares, and the controlling Brazilian shareholders' total stake would fall from 85% to 69%. The pricing of the deal valued Embraer at about $2.4 billion.

Aerospatiale/Matra (5.7%) was seen by many as the designated French "pole" in aerospace: it owned the French interest in the Airbus consortium, what was formerly the French government's 46% stake in Dassault, and ATR, which made turboprops and had marketing and service coverage complementary to Embraer's. Aerospatiale was in the process of merging with two of its three partners in Airbus, the Dasa unit of DaimlerChrysler, and Construcciones Aeronauticas of Spain—but not British Aerospace—into a pan-European aerospace group, European Aeronautic Defense and Space Company. Dassault Aviation (5.7%) was a leading manufacturer of fighter jets such as Mirages and business jets such as Falcons. Thomson-CSF (5.7%) was the fourth largest supplier of defense systems in the world, a business in which Matra was also important, and was already a partner of Embraer's on its AEW&C (Airborne Early Warning with Command and Control Capability) surveillance aircraft. SNECMA (3%), an engine supplier, was the junior partner in the group.

This international alliance, Embraer's first involving equity interests, reflected CEO Mauricio Botelho's belief that the company had to tap additional scale to thrive. Botelho recalled starting to think about this objective in late 1997, when it had become clear that the ERJ 145 family would be a tremendous success. Being acquired was out of the question: a 40% limit on foreign ownership of Embraer was imposed at the time of its privatization; the government could still veto such ownership with its golden share; and there would probably be public protests, with all the uncertainty that entailed. Thus, a strategic alliance seemed to be the only alternative. Embraer started discussions about alliances with British Aerospace and with Dassault, but they were interrupted by external events, most notably the Russian crisis in summer 1998, which had a large aftershock in Brazil. In June 1999, Dassault approached Embraer once again, with the rest of the French group in tow, and proposed an alliance along the lines eventually adopted.

The alliance with the French was endorsed by Embraer's shareholders—including the Brazilian government, which took advantage of this opportunity to further reduce its small stake in the company. But there was opposition to the deal as well, not just among radical politicians and unions but also, reportedly, among certain elements of the Brazilian air force. Botelho found nationalistic opposition to the deal ironic because, as he testified to a Congressional committee, its main focus was on bolstering Embraer's defense-related capabilities and only secondarily on other business areas and on geographic expansion.

The defense market was a complex one. Project lead times were much longer: it was not uncommon for military projects to run over ten or even 20 years, compared to a typical development period of three to four years for civilian aircraft. Adaptation of aircraft to comply with stringent, high-tech customer requirements was quite costly as well. Supersonic aircraft, which Embraer did not assemble, were particularly prohibitive, with project development costs that ran to billions of dollars. Purchases were subject to multilateral and bilateral restrictions and involved more people who turned over relatively rapidly, especially when account was taken of longer project life cycles. Specifications, definitions, and funding were all more complex, with the latter always subject to the pressures of national budgets. However, unit sales prices and contribution margins continued to be much higher in the defense business, although the market had become more price-sensitive and less performance-sensitive over time. The defense business did not fall under the purview of the WTO restrictions on export subsidies.

Botelho was intent on expanding rather than contracting Embraer's defense business. While defense sales had accounted for nearly one-third of cumulated sales since 1970, they had dipped to 7% of Embraer's revenues by 1999—although over 50% of the Brazilian Air Force's fleet was still based on Embraer products, and 20 other air forces also used Embraer's military aircraft. Botelho was convinced that if Embraer wanted to keep its strategic role within the Brazilian system, it needed another program—especially given the advanced state of the $1.5 billion AMX subsonic fighter program, jointly undertaken with Alenia and Aermacchi of Italy for the Brazilian and Italian air forces.

According to Embraer's Executive Vice-President for the Defense Market, Romualdo Monteiro de Barros, the company was shifting from being a manufacturer of military aircraft to a supplier of intelligent defense systems. It accordingly sought the transfer of defense software and systems technology from its new French partners, with the objective of ultimately moving beyond military aircraft into other systems for naval and ground defense as well. High on its list of current targets was Brazil, which was considering placing a multibillion-dollar order for fighter aircraft. Embraer and the French understood, however, that their tie-up did not guarantee that they would win the Brazilian fighter contract.

When pressed, Botelho elaborated on Embraer's commitment to the defense business in general and meeting Brazil's defense needs in particular:

> Reliance on Brazilian governmental support is critical. They are the ones that count. The U.S. won't support us, even though it is our biggest market and our biggest source of imports. We want to keep on being the technological and industrial arm of the Brazilian government although, of course, we also have to make profits.

While Embraer had long been the object of national pride for its engineering prowess, these feelings seemed to have intensified recently. Brazil's main business magazine, *Exame*, had selected Embraer as its company of the year, describing it as a "national icon" and praising its success at "competing with powerful foreign companies."[11]

Exhibit 1 Major Commercial Aircraft Manufacturers ($ millions)

	Total Company						Commercial Aircraft					
	Sales		Net Income (Loss)		Total Assets		Sales		Operating Income(Loss)		Assets	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Boeing	56,154	57,993	1,120	2,309	37,024	36,147	36,880	38,409	(266)	2,016	11,003	8,075
Airbus	13,300	16,700	(200)	(194)	NA	NA	NA	NA	NA	NA	NA	NA
Bombardier	7,716	9,204	365	486	9,447	11,757	4,324	5,492	458	611	2,089	1,986
Embraer	1,308	1,889	109	230	1,701	1,935	NA	NA	NA	NA	NA	NA

Note: NA refers to either not available or not applicable. In 1999, commercial aircraft accounted for all of Airbus Industrie's business, and 85% of Embraer's (not including the 8% of its revenues attributable to spare parts and services).

Source: Annual reports.

Exhibit 2 Embraer's Financials ($ millions unless specified otherwise)

	90	91	92	93	94	95	96	97	98	99
Sales	582	402	333	261	177	295	380	833	1,581	1,889
Export Market (%)	37	32	32	38	40	39	35	84	89	95
Domestic Market (%)	63	68	68	62	60	61	65	16	11	5
Assets	1,092	1,435	1,227	1,125	1,067	1,107	1,221	1,424	1,701	1,935
Net Worth	126	324	86	156	281	188	281	305	346	390
(Loss)/Profit	(265)	(241)	(258)	(116)	(310)	(253)	(123)	(33)	109	230

Source: R. Bernardes & Embraer.

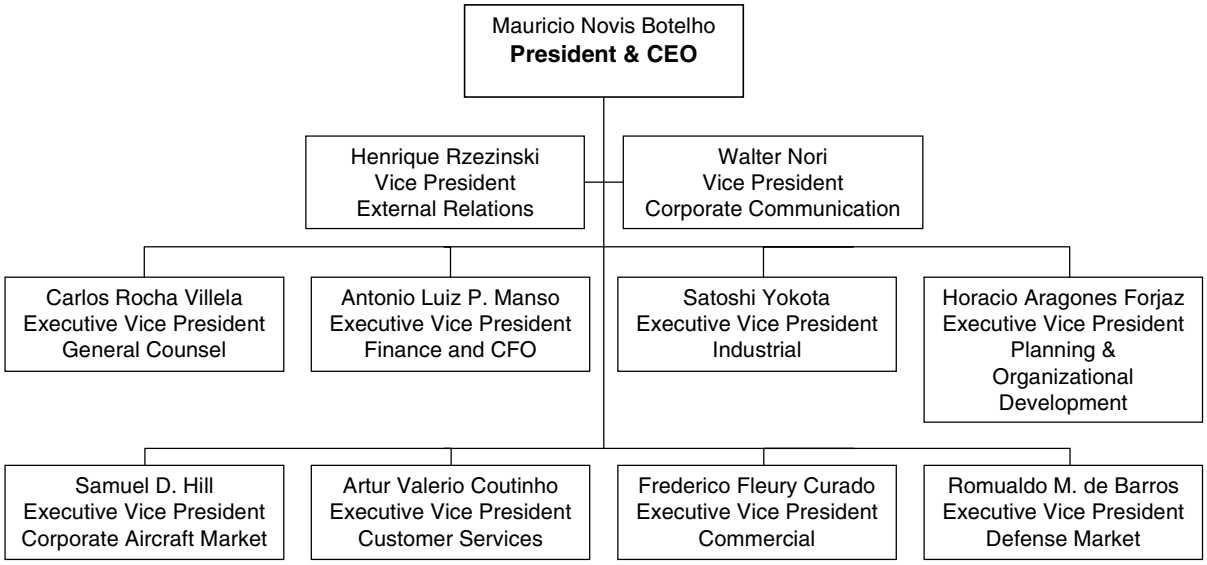
Exhibit 3 Brazil's International Competitiveness

Criterion	Rank*
Openness	53
Government	50
Finance	53
Infrastructure	44
Technology	37
Management	29
Labor	53
Institutions	41
Overall ranking	51

* Out of 59

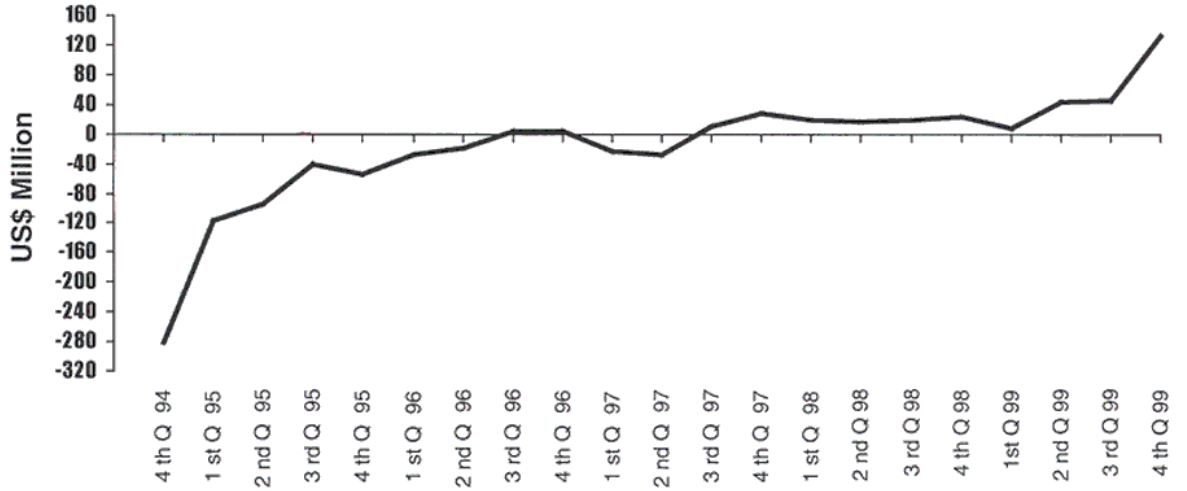
Source: Globalization Competitiveness Report, 1999.

Exhibit 4 Organizational Chart



Source: Embraer company documents.

Exhibit 5 Net Profits



Source: Embraer.

Exhibit 6 Summary Comparison of 50-Seaters

Plane Characteristics	ERJ 145		CRJ-200	
Standard Single-Class Seats	50		50	
Length (ft)	91.7		80	
Minimal Runway Length (ft)	4605		4850	
Normal Cruise Speed (Mach)[a]	0.78		0.80	
Maximum Range (nm)[b]	2000		1900	
Basic Operating Weight (lbs)	27,400		30,900	
Maximum Payload	12,800		14,000	
Structural Design Efficiency[c]	0.47		0.45	
Total Stowage Volume (ft^3)	525		485	
Reference Price ($ mil)[d]	17.6		21	
Trip Economics				
Nautical Miles	**200**	**500**	**200**	**500**
Flight Time[e]	43	86	43	86
Fuel Costs	175	363	183	379
Crew Costs	138	272	138	272
Landing Fees	47	47	52	52
Hull Insurance Costs	34	67	41	81
Maintenance Costs	188	348	245	356
Total Cash Costs	582	1097	659	1140
Aircraft Ownership Costs[f]	398	787	475	939
Total Trip Costs	980	1884	1134	2079

[a] Mach refers here to the air speed of sound: approximately 750 miles or 652 nautical miles per hour.
[b] 1 nautical mile equals approximately 1.15 standard miles. Figures for ERJ 145 are for the XR version.
[c] Structural design efficiency equals maximum payload divided by basic operating weight.
[d] In the nature of a list price; most planes are sold at discounts to this price.
[e] Includes 10 minutes of taxiing time; operational time difference between the two aircraft assumed to be zero.
[f] Calculated as 0.78% of aircraft price per month (or the equivalent of about 210 flight hours given the assumed total of 2500 flight hours per year).
Source: Embraer.

Exhibit 7 The Planned Family

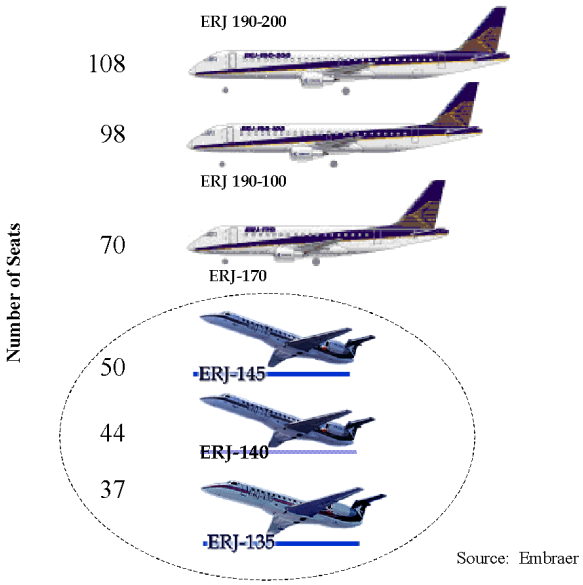


Exhibit 8 Summary Comparisons of 70-75 Seaters[a]

Plane Characteristics	ERJ 170		CRJ-700		FD-728	
Standard Single-Class Seats	70		70		75	
Length (ft)	97.4		106.3		87.3	
Minimal Runway Length (ft)	4132		4658		4526	
Normal Cruise Speed (Mach)	0.78		0.77		0.78	
Maximum Range (nm)	1740		1470		1625	
Basic Operating Weight (lbs)	41,116		43,500		46032	
Maximum Payload	20062		18800		20767	
Structural Design Efficiency	0.49		0.43		0.45	
Total Stowage Volume (ft^3)	842		654.6		876.3	
Reference Price ($ mil)	22.3		25.6		26.5	
Firm Backlog (12/31/99)	40[b]		99		60	
Trip Economics						
Nautical Miles	**200**	**500**	**200**	**500**	**200**	**500**
Flight Time[c]	45	87	45	88	45	87
Fuel Costs	281	479	272	465	283	489
Crew Costs	303	586	304	594	303	586
Landing Fees	123	123	117	117	133	133
Hull Insurance Costs	18	34	20	40	21	41
Maintenance Costs[d]	195	377	226	441	227	439
Total Cash Costs	920	1599	939	1657	967	1688
Aircraft Ownership Costs[e]	711	1374	816	1595	844	1632
Total Trip Costs	1631	2973	1755	3252	1811	3320

[a] Absolute costs may not be strictly comparable with the ones reported in Exhibit 6 because of different dates of comparisons. Also refer to notes for Exhibit 6 for a more complete discussion of notation and assumptions.

[b] In addition, 30 firm orders had been received for the ERJ 190-200.

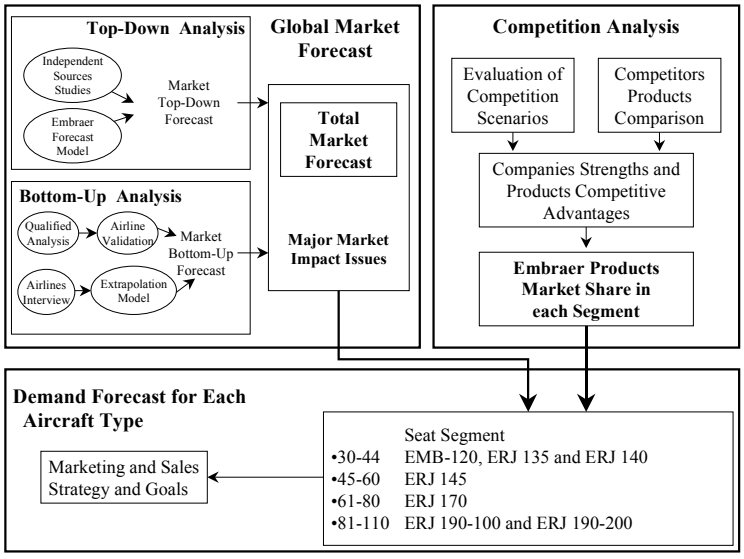
[c] Slightly longer flight times than for 50-seaters reflect more allowance for maneuvering while airborne and, in the case of the CRJ-700, slightly slower speeds.

[d] Figures based on preliminary estimates by Embraer's Maintenance Engineering Department.

[e] Calculated as 1% of aircraft price per month (or the equivalent of about 210 flight hours given the assumed total of 2500 flight hours per year).

Source: Embraer.

Exhibit 9 Market Forecasting



Source: Embraer.

Exhibit 10 Investment Patterns*

(US$ Millions)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Product Development		**92**	**96**	**67**	**90**	**81**	**158**	**204**	**139**	**230**	**144**
Regional Program		69	84	45	48	44	87	132	89	140	47
Corporate Program		0	0	0	0	0	3	5	3	0	0
Military Program		23	12	22	42	37	68	67	47	90	97
Other R & D		**1**	**2**	**3**	**5**	**3**	**6**	**5**	**5**	**5**	**5**
Fixed Assets		**12**	**4**	**11**	**17**	**53**	**123**	**86**	**60**	**60**	**57**
Data Processing Equipment		9	2	9	6	12	28	34	31	31	27
Facilities/Others		3	2	2	11	41	95	52	29	29	30
TOTAL	**56**	**105**	**102**	**81**	**112**	**137**	**287**	**295**	**204**	**295**	**206**

* Data for 2000 on are projections.

Source: Embraer.

Exhibit 11 Selected Risk Sharing Partners for ERJ 170/190

Country	Company	System Responsibility
Belgium	Sonaca	Wing slats
France	Latécoère	Center fuselage sections
Germany	Liebherr	Landing gear
Japan	Kawasaki	Wing stub, control surfaces and engine pylon
Spain	Gamesa	Stabilizers, rudder, elevators, rear fuselage
United States	General Electric	Engines and nacelles
	Grimes Aerospace (Allied Signal)	Exterior and cockpit lighting
	Hamilton/Sundstrand	Tail cone, auxiliary power unit, electrical and air management systems
	Honeywell	Avionics
	C&D	Interior

Source: Embraer Prospectus, ADR Issue, July 20, 2000.

Map graphic source: http://www.graphicmaps.com reprinted with permission.

Endnotes

[1] James E. Austin, "Empresa Brasileira de Aeronautica S.A. Teaching Note," HBS No. 5-390-205.

[2] For additional details, see "Brazil: Potential Unraveled, Becoming the Country of the Present," HBS Case No. 798-107 prepared by Cristina Marghales, Dureka Carrasquillo, Andrea Pinnotti Cordeiro, Caio Alencar (MBAs 1998) and Professor Huw Pill.

[3] See Pankaj Ghemawat, "Note on Privatization in Brazil," HBS Case No. 799-025, for further background.

[4] See HBS Case "Cia, Bozano Simonsen of Brazil: Partnering in Privatization," 799-037, written by Pankaj Ghemawat in 1998, for more background on CBS.

[5] Roberto Bernardes, NPGT, Universidade de São Paulo, "The Embraer Case, Privatization and Management Change From Technological Imperative to Market Focus," pp. 26-28.

[6] "The Transportation Giant up North," *New York Times*, December 25, 1998, p. C1.

[7] "Regional Ramp Up," *Flight International*, June 9, 1999, p. 144.

[8] "Bombardier Profits Rocket but may Mask Regional Venture Risk," *Flight International*, April 21, 1999, p. 20.

[9] "Bombardier's Master Builder," *Forbes,* April 19, 1999, p. 163, and "Sky King," *Maclean's,* August 11, 1997, p. 31.

[10] "Brazil Loses WTO Ruling on Aircraft Subsidies," *Financial Times,* April 29-30, 2000, p. 4.

[11] "Aircraft Builder Embraer Flies the Flag for Brazil," *Financial Times,* August 2, 1999, p. 16.