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Modelling Global Demand and Sales Forecast for Embraer Portugal - Estruturas Metálicas

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Abstract

Modelling global demand and sales forecast for Embraer Portugal - Estruturas Metálicas

by Diogo Sassetti, Nova School of Business and Economics, Lisbon, Portugal, 2015.

The objective of this project is to analyse the outlook for the aerospace manufacturing industry, in order to access how should Embraer Metálicas adapt and manage future growing volumes. *Modelling Global Demand and Sales Forecast for Embraer Metálicas* was achieved through a study of past performance and by defining and forecasting the behaviour of growth drivers for air travel. Although the results for the defence segment were inconclusive, we found a steady growth for the commercial and executive segments. The E-2 jets are the new generation of the commercial fleet of Embraer and will represent major source of labour of the plant by 2020.

Keywords: Aerospace; Sales Forecast; Air travel demand; Embraer;

Embraer Portugal - Estruturas Metálicas, SA

Client Overview

Embraer, Empresa Brasileira de Aeronáutica S.A., is one of the world's largest manufacturers in the aerospacial industry. Based in São Paulo, it operates in the commercial, executive and defence aviation industries. After the north american Boeing and the european Airbus, Embraer is the world's third largest manufacturer of aircraft (Andrews, 2015). It specialises in planes with less than 130 seats. To date, Embraer has delivered more than 5,000 commercial aircraft to more than 61 countries, spanning 90 airlines, according to the company's official website.

Boeing and Airbus share a very strong market position and powerful brand image. They have been increasing their operational performance and have been enjoying the growth in the aerospace market, especially in the commercial aviation sector (Marketline, 2014). However, the increasing competition from smaller-sized players, like Embraer or Bombardier, has put on some price pressure on them. Their positioning towards Embraer has been to target larger capacity aircraft, with more than 100 seats. Boeing and Airbus can be considered indirect competitors. Their larger vehicles usually operate linking primary cities worldwide with very high passenger demand, while Embraer tends to focus on regional or secondary connections.

The fleet of Embraer is manufactured today in Brazil, China, the US and Portugal (company webpage). In the latter, a modern excellence and research facility was opened in 2012, in the outskirts of the city of Évora. This complex is composed of two plants, being Embraer Portugal - Estruturas Metálicas SA (hereafter referred as "Embraer Metálicas") one of them. Embraer Metálicas is responsible for producing ready-to-assemble large aluminium parts for airplanes.

Our client serves an an outpost for Embraer (mother company) and competes against other external suppliers. This means that Embraer Metálicas needs to stay competitive in both price and quality in order to fight for business. As for its value chain, it presents today a medium level of power asymmetries and explicit coordination.

Briefly, Embraer Metálicas' fleet is composed today of two executive lines (the Legacy 600/650 and the new Legacy 450/500 models), two commercial lines (the E-jet E-175 and the new E-2 jet series — E-195, E-170, E-175), and one defence line (the new cargo military jet KC-390). The specifications and commercial outlook for each model will be discussed further in this report.

Market Overview

The core strength of Embraer Metálicas is the ability to manufacture large aluminium parts for airplanes (up to 22 meters long); this includes wing skins, vertical stabilisers, stringers, spars, spar ribs, and wing covers. In addition, the plant is also responsible for assembly of wings, stabilisers and painting[1].

We have selected three direct competitors with similar expertise in this industry: the Spain-based Aernova (employing 4.500 people), the North-American Triumph Group (employing 4.700 people), and the Bombardier plant in the UK (which employs nearly 600 people). Embraer Portugal (including the Compósitos plant) employs close to 300 people (Marketline, 2015).

The most striking observation is the number of key accounts for each manufacturer. While Aernova and Triumph have developed a well diversified portfolio of clients, with 5 each, Embraer Metálicas is solely dependent on Embraer SA (mother company). Although there is no exclusivity clause, the plant in Évora has yet to achieve the maturity and capacity needed to take on larger projects, in parallel with the orders of Embraer. The competitive landscape shows that Embraer Metálicas is still a small player in the market, with lower turnover and number of clients than its peers.

At the same time, and in light that the plant was only opened in 2012, the company seems to be competing successfully in this highly specialised industry. Both the strong ties with Embraer and state-of-the-art facilities can pose a serious competitive advantage and yield strong growth in the future. The need for continuous industrial innovation and superior offer are the key for the success of Embraer Metálicas and the quest of this business project.

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[1] Information collected during the plant visit on March 12th from Eng. João Taborda

Current Client Situation

Even though Embraer Metálicas is responsible to ship to Brazil ready-to-assemble airplane wings and stabilisers, around 95% of the parts it utilises are not produced in-house; instead, they are sourced from second-tier suppliers. This extensive number of external suppliers adds complexity and risk, namely (1) Supply Risk - production delays can be caused by low-value parts in the supply chain, (2) Quality Risk - the need to identify reliable suppliers, (3) Storage Risk - the storage of all parts must must be managed in a way that parts are not damaged.

Accuracy and precision are a first priority to Embraer Metálicas, as their products are highly relevant for airplane safety. It is fundamental to keep a low error rate, as the value of the product in backlog rises significantly in every stage of the production line, especially the milling and the surface treatments. In order to avoid the pile-up of inventory, parts are manufactured under a pull system, where each order triggers the production.

In the following table, you can find the breakdown of parts produced (or services provided) per aircraft model in Embraer Metálicas. The most profitable products are the wings and the stabilisers, especially for the commercial aviation segment.

Model	Description	Embraer Metálicas
Legacy 450/500	Mid-sized executive jet	Painting
Legacy 600/650	Super mid-sized executive jets	Wing skins, spar ribs, spars, …
E-175	Medium-range commercial jet	Wing skins, vertical stabilisers, …
E2-Jets	Medium-range commercial jet	Wing skins, wing covers, stringers, …
KC-390	Medium-sized military jet	Wing skins, vertical stabilisers, …

Table 1 - Production breakdown per aircraft model in Embraer Metálicas

The production of such parts follows a ten step process, synthesised below.

1. **Raw Material & Inventory**

   Weekly shipments of aluminium rectangular blocks from Alcoa (Germany), the sole supplier of Aluminium of Embraer Portugal since 2011.

2. **Milling**

   Core competency: A family of seven Makino machines is able to mill the very large metal blocks (up to 20 meters long) to their final volume.

3. **Surface Treatment**

   In a series of 18 Durr tanks, the recently cut aluminium parts are submerged on chemical baths for anodisation. This process is highly automatised.

4. **Visual Inspection**

   In a dark room, the parts are inspected for cracks and defects, which are highlighted by phosphorescent chemical substances . This process is semi-automatised.

5. **Shot peening**

   The metal piece undergoes a process of shot peening and peen forming to obtain the final shape. Microspheres are bombarded to strengthen or bend the metal.

6. **Dimensional Inspection**

   Optical metrology instruments assure that the aluminium parts meet the dimensional standards of the client. Little automation in the feeding of the machine.

7. **Assembly**

   Metal parts are put together in a highly automatised assembly line. High-precision perforation and fixation systems.

8. **Final Inspection**

   Final comprehensive and quality inspection. The process is labour intensive, involving around 15 people. Goal: assure no fuel leakages.

9. **Painting**

   Electrostatic painting assures an uniform white colour. The painting cabin is VOC controlled (filtered air, controlled temperature and humidity).

10. **Final Product Inventory**

    The products are ready to be shipped to Brazil for the final assembly line.

The Business Project Challenge

The placement in the product-process matrix (figure 1) shows that Embraer Metálicas operates in workshop-type processes for low-medium volumes. An analysis of the product itself, reveals that Embraer Portugal operates according to make-to-order, with batches typically low-medium. As for the processes, the products are processed one-by-one through the different production steps; even though not all of them are automated, some steps can handle several products simultaneously. The goal of Embraer is to move upwards and to the right in the given matrix, meaning that it aims to handle production in a more streamlined and automated way, while sustaining a gradual increase in volumes (as in the Business Project report).
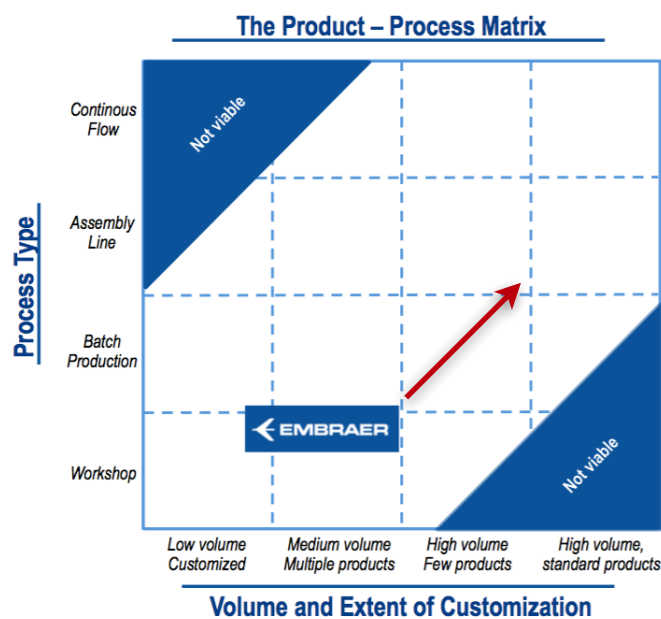

Figure 1 - Product-placement matrix of Embraer Metálicas

In line with Embraer's goal, **the objective of the business project is to design a technological roadmap for the plant** - highlighting the technological steps required to stay competitive and in the forefront of the industry for the next two decades (moving upwards in the matrix). At the same time, **it is key to understand the outlook for the aircraft-manufacturing market**, in order to access how should Embraer Metálicas adapt and manage future growing volumes (by moving to the right in the product-process matrix). Both these objectives come together in the end, when we present a commercial outlook for the plant, signalling when and why new technologies should be implemented throughout the next couple of decades.

In order to foresee how Embraer Metálicas should adapt and account for growing order volumes, assessing how aircraft sales will behave in the future is another core component of the business project. Given this is a work project in Finance, this report will focus on this analytical study, rather that the technological steps the plant should undergo in the future.

Global Demand and Sales Forecast

Collecting Data

Before architecting the forecast on sales volumes, it is key to understand how such figures have been evolving. Having this in mind, we collected quarterly data for every Embraer aircraft produced in Embraer Metálicas since 2010 - orders, deliveries and backlog[2].

It was challenging to work exclusively with public information. All figures were extracted from shipping databases such as GAMA, official Embraer releases and online industry reviews.

Since every Embraer E-175, E-2 Jet (E2-190, E2-195, E2-175), Legacy 450/500, Legacy 600/650 and KC-390 were partially produced in Évora, it was reasonable to assume that the rate at which Embraer SA can deliver an aircraft is similar to the rate which Embraer Metálicas operates.

Assumptions

The designed forecasting model took into account some other premisses. We assumed fixed exchange rates (most clients of Embraer operate in emerging economies, very exposed to currency fluctuations), a constant world GDP CAGR of 3,3% for the next 20 years (IMF, 2015), and low-volatility WTI crude oil prices (ticking 58,23 USD - May 2015).

At the same time, we assumed that ground infrastructure worldwide will support demand growth and that Airbus' order cancelation ratio to be similar across its competitors. We assumed one year as the time required to complete one commercial aircraft (from order to delivery) (Boeing website) and that airlines will battle to meet environmental targets.

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[2] Backlog can be defined as unfinished inventory. After a client orders an aircraft, it is accounted as backlog during the manufacturing stage. Backlogs can decrease either through deliveries or order cancelations.

Natural disasters, health outbreaks, terrorism attacks and airplane accidents have a minimal impact on airplane sales, according to Paula Canada, Marketing Director of TAP Portugal.

Hypothesis

Airplane sales will growth steadily in the medium-long term. This is the hypothesis that needs to be tested. It is important to understand how fast should Embraer Metálicas adapt to growing volumes, and how efficiently are the facilities being used. Expanding the current plant or subletting some machinery to third party manufacturers would open new business opportunities for the company.

Define Growth Drivers

There are two main groups of factors affecting the demand for aircraft worldwide: the **economic factors** and the **non-economic factors**. Our analysis will mainly focus on the economic (or financial) factors, such as GDP growth, oil price, middle class growth and number of billionaires. These are easier to measure, to model and are more relatable to the global demand of aircraft.

On the there hand, environmental regulations, infrastructure, competition and market regulations make up the remaining non-economic factors, which will also be briefly discussed further in the report.

- *GDP Growth*

Historical trends have shown that growth in commercial air travel (measured by RPK[3]) is approximately twice as much as the annual growth rates of Gross Domestic Product (P. Belobaba et al., 2009). This strong relationship indicates that air travel activity changes in a trackable way with world GDP, please confer chart I in the appendix.

Emerging Economies will drive the world GDP growth in the medium-long term. China and India grew 7.4% and 5.6% in 2014, respectively. In such economies, aircraft sales are driven by fleet expansion programs (cf chart II). Inversely, mature economies in Europe or North America with lower GDP growth rates, aircraft orders are triggered by fleet renewal programs.

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[3] RPKs (Revenue Passanger Kilometers) is a measure of air traffic, calculated by multiplying the number of revenue-paying passengers by the distance travelled. Also known as RPMs (Revenue Passanger Miles)

A study conducted by the Saudi Arabian Bechtel company (1979) revealed that air traffic volume for domestic passengers had a correlation with ΔGDP between 0.936 and 0.997. When modelled with international passengers instead, the study revealed a correlation between 0.970 and 0.993.

The following table was designed for every growth driver in this section. It describes the relative weight of each growth driver for every aircraft segment (high relative weight translates into a more meaningful parameter: from 0 to 5). The short and long term outlook are a forecast of how will this parameter evolve in the future and affect propensity to fly, being +2 "accentuated growth" and -2 "accentuated decrease". The scores were defined by finding consensus in academic reviews or industrial outlook reports.

Segment	Relative Weight	Short Term Outlook	Long Term Outlook
Commercial	5	2	1
Executive	5	2	1
Defence	4	2	1

Table 2

- *WTI Crude Oil Price*

Jet fuel is the largest single operational expense in a commercial aircraft, 30% on average, according to Bombardier (2014). It closely tracks WTI crude oil price, to a degree that it is reasonable to assume they are perfectly correlated (Carson et al., 2010).

Earlier this year, we witnessed a plummet in oil prices (cf chart II). Such macroeconomic environment can boost economic growth in the long run, stimulating executive and commercial jets sales worldwide. However, airlines are usually hedged against oil volatility, which is why we attributed a lower weight for commercial aviation in this parameter (executive and defence aircraft is still exposed). At the same time, lower oil prices mean that new more efficient airplanes are not as attractive, thus reducing short-term demand (Boeing Market Outlook, 2013).

Segment	Relative Weight	Short Term Outlook	Long Term Outlook
Commercial	1	-1	2
Executive	3	-1	2
Defence	1	-1	2

Table 3

• *Middle-class Growth*

Within the next 20 years, the world's middle-class is expected to more than double to 5.3 billion people (Capgemini, 2011). This suggests that more families will be able to afford tourism and more companies will be able to afford business trips. While today only 33% of the world can be categorised as middle-class, this figure will rocket to 63% before 2033 (cf Business Project, page 40). When we consider that 85% of this rise is originated from Asia, there is a tremendous growth opportunity from Embraer to grow in the commercial segment in this region (especially with low-cost carriers in south-east Asia and domestic flights in both India and China).

A study conducted by Abed et. al (2001) revealed a high correlation between demand for international air travel with private consumption expenditures ($\rho=0,960$) and imports of goods and services ($\rho=0,940$). In its turn, population size had a slightly lower correlation of 0,850.

Segment	Relative Weight	Short Term Outlook	Long Term Outlook
Commercial	5	2	2

Table 4

• *Number of Billionaires*

Similarly to the influence of middle class in commercial aviation growth, the number of billionaires are a strong indicator of the market size for executive jets. Around the world, this figure is expected to rise by 53% within the next five years. In China alone, the number of billionaires will double by 2019.

Segment	Relative Weight	Short Term Outlook	Long Term Outlook
Executive	3	2	1

Table 5

• *Environmental Regulations*

The pressure of environmental agreements will stimulate fleet renewal, especially in mature economies. Airlines across the world have agreed to halve carbon emissions before 2050, improve fuel efficiency by 1.5% annually until 2020 and achieve a carbon neutral growth by the same year. These targets can only be achieved through a purchase of 12,000 new commercial aircraft worldwide, at a projected investment of 1.3Bi USD (Air Travel Action Group, 2014).

This parameter affects especially the commercial aviation segment, improving the outlook for modern airplanes such as the E2-jets, but decreasing the demand for aged aircraft models such as the E-175.

- *Infrastructure*

Investment in ground infrastructure will not only support demand growth worldwide, but also open new markets in secondary and tertiary connections. Demand can only rise as long as countries are ready to handle the logistics of growing air traffic. China and India have been investing aggressively in the construction of paved airports nationwide (cf Business Project, slide 44). Infrastructure is specially meaningful for commercial aviation. Since most multinational firms and high-net-worth individuals are located in large urban centres, the relative weight for executive aviation is smaller for this parameter.

The outlook for this parameter is positive worldwide, except in Brazil, where some specialists feel it may enter a saturation of its ground facilities by the early 2020's (CIA, 2015).

- *Competition and Technology*

This parameter was used to simulate the effects of the competitive environment in each segment, the natural impact of technological obsolesce in the long term for the E-175 jets, as well as a boost to newly released models such as the E-2 Jets or the Legacy 600/650.

Growth Drivers	Segment	Relative Weight	Short Term Outlook	Long Term Outlook
Env. Regulations	Commercial | E1	2	-1	-2
	Commercial | E2	2	1	2
	Executive	1	0	1
Infrastructure	Commercial	2	2	1
Competition	Commercial | E1	2	-2	-5
	Commercial | E2	2	2	5
	Executive	2	1	2
	Defense	1	0	2

Table 6 - Outlook for non-economic growth drivers of aircraft demand

Architecture of the model

With the scores of the growth drivers for every segment Embraer Metálicas produces, we were able to stimulate the data we had for orders and deliveries for every upcoming year, until 2033.

- Let GD_t be the Growth Driver for the quarter t, where t=0 is the first quarter of 2015;

- Let O_t , B_t and D_t be the number of Orders, Backlog and Deliveries for the quarter t.

- Let ρ be the yearly order cancelation ratio;

- Let δ_{G280} be the deliveries trend of Gulfstream G280;

Orders Forecast

Given the scarcity of data available regarding orders of executive aircraft (for the Legacy 450/500 and Legacy 600/650), this simulation will focus on commercial aviation, where the history of orders is public and easier to track.

In relation to the KC-390 model, there has been one order of 28 aircraft for the Brazilian Air Force. Other countries have signed a treaty of understanding, demonstrating interest for 32 additional airplanes. Unfortunately, this history is not enough to support a forecast of this kind.

Please find below the process behind the order forecast model of the commercial models produced in Évora.

Embraer E-175

$$O_t = (1 + GD_t).\sum_{i=1}^{4} \frac{O_{t-i}}{4} \qquad t \le 20 \text{ (until 2020 Q1)}$$
$$O_t = 0 \qquad 20 < t \le 64 \text{ (until 2030 Q4)}$$

Equation 1

Embraer E-2 Jets[4]

$$O_t = (1 + GD_t).\sum_{i=1}^{4} \frac{O_{t-i}}{4} \qquad t \le 64 \text{ (until 2030 Q4)}$$

Equation 2

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[4] For simplicity, all E2 models were treated as one product, even though their introduction will be phased (E2 E-190 on June 2018; E2 E-195 on December 2018; E2 E-175 on December 2018).

Backlog

The backlog is especially important for commercial aviation. It gives us information regarding how many aircraft are in the current manufacturing process (unfinished inventory). At any time t, the current backlog is the backlog of the preceding period, corrected by cancelled orders, plus the new orders, subtracted by the deliveries at quarter t.

$$B_t = \frac{B_{t-1}}{1 + \rho} + O_t - D_t \qquad\qquad \text{Equation 3}$$

Growing backlogs are a sign of saturation of manufacturing processes, either by inefficiencies in production or unexpected rising sales volumes.

Deliveries Forecast

For Embraer Metálicas delivery count is on the most useful forecasts. It is the number of orders which effectively were shipped to the mother company.

Legacy 450/500

$$D_t = \delta_{G280_{t-12}} + D_{t-1} \qquad t \leq 12 \ \text{(until 2017 Q4)}$$
$$D_t = (1 + GD_t).D_{t-1} \qquad 12 < t < 64 \ \text{(until 2030 Q4)}$$

Equation 4

The most recent executive jet of Embraer has a short history. For this reason, we could not rely on past deliveries to model the commercial outlook for this model. Instead, we studied the release of Gulfstream G280 in 2012, which we assumed to be similar to the Legacy 450/500 during the first 3 years of the program. From that moment onwards, the growth drivers and the known data until 2017 would support the simulation.

Legacy 600/650

$$D_t = (1 + GD_t).\sum_{i=1}^{4} \frac{D_{t-i}}{4} \qquad t \leq 64 \ \text{(until 2030 Q4)}$$

Equation 5

Embraer E-175

$$D_t = (1 + GD_t).\sum_{i=1}^{4} \frac{D_{t-i}}{4} \qquad t \leq 20 \ \text{(until 2020 Q1)}$$
$$D_t = 0 \qquad t \leq 64 \ \text{(until 2030 Q4)}$$

Equation 6

Embraer E2 E-Jets

$$D_t = (1 + GD_t).\sum_{i=1}^{4} \frac{D_{t-i}}{4} \qquad t \leq 64 \ \text{(until 2030 Q4)}$$

Equation 7

The results obtained were plotted in the chart below. The number of aircrafts delivered is expressed by quarter.
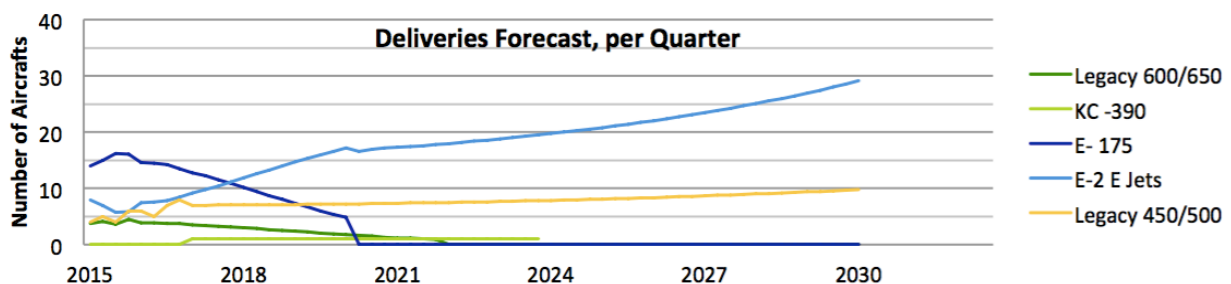

Chart 1 - Delivery forecast of Embraer Metálicas (per quarter) by aircraft model

Analysis

Executive Aviation

While the Legacy 600/650 is phasing out of production before 2022, the Legacy 450/500 is the new face of Évora's executive fleet. According to Boeing's research (2014), the small-sized jet segment is expected to grow by 25% globally within the next decade. Comparatively, our model was conservative, by projecting a 18% growth, from 7 Legacy 450/500 deliveries per quarter in 2016 to 8.5 deliveries (on average) in 2026.
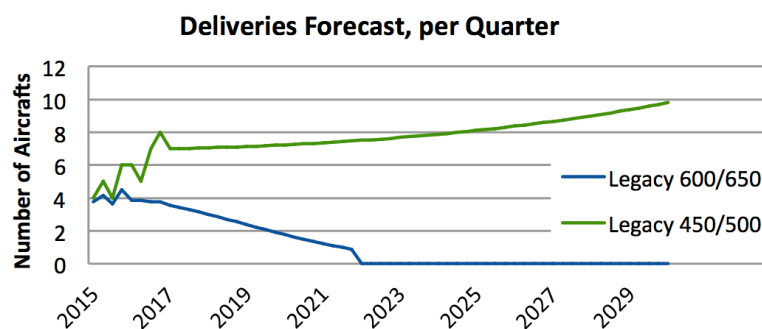

Chart 2 - Deliveries forecast (executive aviation)

Unfortunately, the Legacy 450/500 has less value added by Embraer Metálicas (painting) when compared with the 600/650 model (spars, spar ribs, wing covers).

Defence and Security

On January 2017, Embraer will deliver the first KC-390 military aircraft (partially produced in Évora). From that moment onwards, the plant will keep on producing the remaining 27 planes ordered by the Brazilian Air Force.

The lack of history and the uncertainty concerning the rate at which this production is done, makes it imprudent to forecast future deliveries with our model. However, the 32 additional order intentions by 6 other countries signal a promising future for this line (company website).

Frederico Curado (CEO) announced earlier this year that Embraer projects a potential of 140-210 deliveries throughout the lifetime of the program (company website).

Commercial Aviation

The second generation of E Jets is expected to take over the E-175 as the primary source of labour of the plant before 2020. During this transition period, Embraer Metálicas is expected to deliver an average of 23 commercial aircraft per quarter. From this point onwards, the delivery trend of E-2 jets is comparable to one of E-175 in the period 2012-14.

There have been 270 confirmed orders for the new E-2 jets produced in Évora, whose release will be phased between 2018 and the end of 2019 (Gama, 2015).
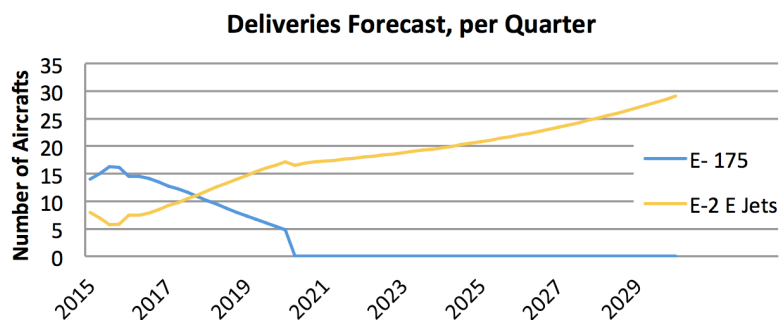

Chart 3 - Deliveries forecast (Commercial aviation)

The E-2 jets are economically competitive against the Bombardier CRJ family, and although they have a shorter range, the E-2s have a better fuel performance than Bombardier's C-Series - positive outlook for future demand.

Plant Capacity and Recommendations

Embraer Metálicas is currently at 80-85% capacity, according to information collected during the plant visit on March 12th. Using the sales forecasting model for the plant, we were able to foresee the rise in sales and demand hypothesised. Volumes will increase, moving Embraer Metálicas to the right of the product-process matrix (page 8). The chart below tracks the production volumes of the executive and commercial segments in Évora until 2030[5].
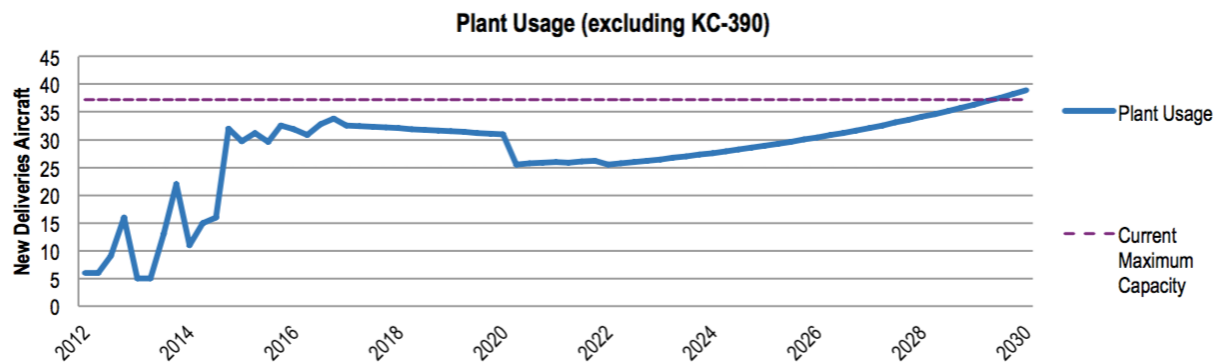

Chart 4 - Total deliveries per quarter

With the gradual introduction the E-2 series, batch sizes are expected to increase. Undoubtedly, the ongoing expansion plan for the factory is a priority. It will unlock further business opportunities, given that the plant would be almost saturated in the medium term (until 2020) without such upgrades. In parallel, (and depending on the success of the KC-390 line) there is a need to secure the manufacturing of new products in the future, with better automation systems, triggering productivity even further.

To my view, it would be advisable to set up a small commercial team to work on this challenge, and to find other clients to whom Embraer Portugal could sublet some of its unused machinery in periods of reduced traffic.

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[5] The KC-390 was excluded in this projection due to insufficient data for a reliable forecast of deliveries and because commercial aviation is, by far, the main source labour in the plant - being also the most meaningful for this analysis.

Reflection On Learning

Masters Content Applied and Adjusted

From the start, the business project was oriented towards strategic and technological improvements of the plant. Mapping such milestones for the upcoming years was the main goal. In fact, the access to financial information or any technical data regarding the processes inside the factory was very restricted. With this being said, it was challenging to elaborate on a analytical/ financial topic about Embraer Metálicas in specific for this work project.

To my view, the idea of forecasting global demand and sales for Embraer Metálicas would bridge the Business Project with finance the closest way possible; especially given the resources we had.

By working with public information alone and investigating some information disclosed by competitors, I was able to design a simple yet methodical approach to this challenge.

Although there was little explicit master content applied to this project in specific, there were several tools and knowledge that was possible to adapt. The great extent of it came from analytical courses like Financial Econometrics, or financial markets courses, such as Hedge Funds or Investments.

It is important to explicitly state that this was not an econometrics project. Still, understanding the dynamics behind variables such as correlation, significance levels, weighting parameters or moving averages were very useful to work out the growth drivers of demand.

In a second stage, the model took use of the same principles and some procedures behind modelling an investment strategy. Learning how to manipulate an excel sheet and simulate a time series on my masters in Finance were key for me to be able to develop this project for Embraer.

To what is more, in Finance, I was continuously pushed to excel, to be rigours and to be an effective team player. These learnings were carried forward to this business project.

Shortcomings

There were two main challenges in this project: the definition of the topic and the access to information. I believe that having a business project with an undefined problem can be very interesting. It allows us to be flexible and autonomous. In a way, it was possible to tailor our path, as there were no goals clearly defined by Embraer. However, it also means that during the first weeks of work, instead of researching, we are haunted by the duty of choosing the right topics to cover. In fact, we took nearly 5 weeks to structure our project and define what would be the challenge we would like to address.

Simultaneously, every time we sought numerical information or data related to the processes inside the plant, we were turned down. The company was very protective - which is understandable given competitive nature of this industry: there are few players operating and most investments on innovation and upgrading of processes are considerable.

My first idea for this work project would be to use the sales forecast model to estimate future cashflows for Embraer Metálicas - and hopefully value the business. This would require an estimate of the value of every part produced: wings, stabilisers, and so forth. Not only this information is highly classified, but we were also unable to obtain the value of the outsourced parts either (the majority of the parts assembled in Évora are outsourced to second-tier suppliers). All financial information available was consolidated for the Embraer Group.

If these figures were known, I would simplify the exercise and focus on commercial aircraft parts, which represent the major source of labour of the plant, and is where most of the value is added by Embraer Metálicas. By discounting the cashflows of selling E-175 and E-2 jet parts to Embraer it would be possible to roughly estimate the value of the business.

Personal Experience

For someone with a background in Physics Engineering like myself, working for the aero-spacial industry was very appealing from the start. Getting to know a business from the inside in an environment that I can relate to is very motivating. I acknowledge that sometimes my peers have more experience with business frameworks than me, so I aimed to balance it out by contributing to the group progress in some other way.

My key strengths during this project were coordination and organisational skills. Scheduling meetings, structure our work or set intermediate goals were tasks that I usually took charge. Gladly, the group was very balanced; we contributed equatively and were all motivated from the start. It was easy to work with my peers.

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Appendix

Table1- History of Orders, Deliveries and Backlog

Embraer Metalicas Orders, Deliveries and Backlog		2012				2013				2014			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Legacy 450/500	Deliveries	0	0	0	0	0	0	0	0	0	0	0	3
Legacy 600/650	Deliveries	1	2	1	13	4	3	4	10	2	6	0	10
KC-390	Orders	0	0	0	0	0	0	0	0	0	0	28	0
	Deliveries	0	0	0	0	0	0	0	0	0	0	0	0
E-175	Orders	0	2	6	7	11	0	15	18	15	15	24	61
	Backlog	35	33	31	35	188	149	155	161	167	173	181	172
	Deliveries	5	4	8	3	1	2	9	12	9	9	16	22
E jets E2	Orders	0	0	0	0	0	100	50	0	50	0	70	0
	Backlog	0	0	0	0	0	100	150	150	200	200	210	210
	Deliveries	0	0	0	0	0	0	0	0	0	0	0	0

Chart I - Correlation between GDP and RPM (Revenue Passenger Miles)
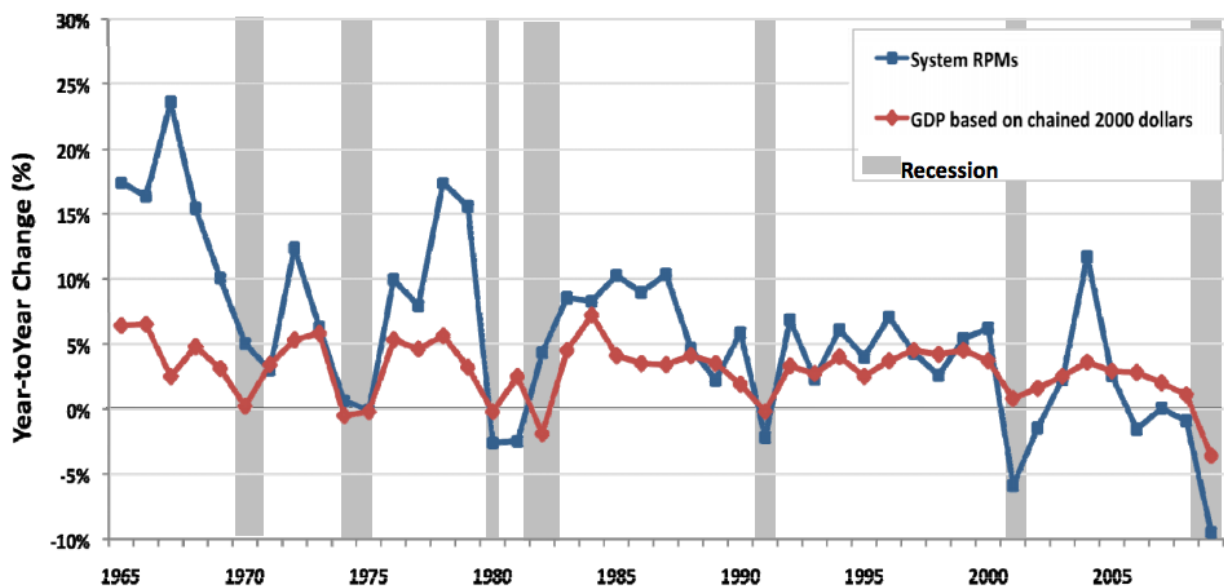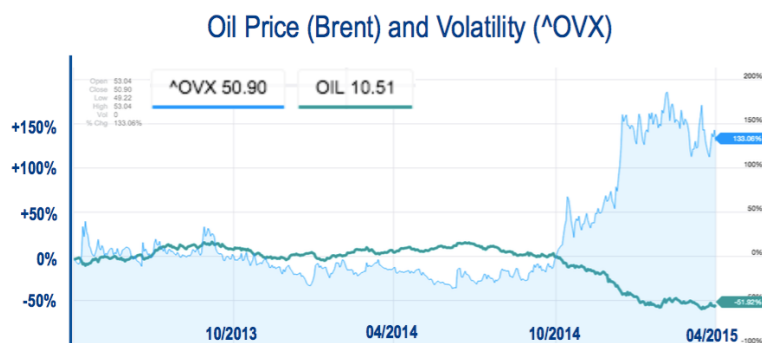

Chart II - Oil Price and Volatility

Chart III - Projection of Plant usage 2014-2033

Executive

Legacy 450/500
Legacy 600/650

2015   2020   2025   2030   Volume

2022: Cease production

Commercial

E-175 E-Jet

2015   2020   2025   2030   Volume

2020: Cease production

Commercial

E2 E-Jets

2015   2020   2025   2030   Volume

October 2014: First Metal Cut E2-190

March 2015: Start Manufacturing E2-195

March 2016: Start Manufacturing E2-175

Defense

KC 390

2015   2020   2025   2030   Volume

January 2017: First Delivery