Cost price calculation based on a Greenfield analysis

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Graduation Thesis “Cost price calculation based on a Greenfield analysis”
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Preface

This graduation thesis report constitutes the final part of the Industrial Engineering and Management curriculum at University of Twente. I conducted my thesis assignment at Stork Fokker AESP B.V. at Papendrecht, The Netherlands.

The thesis assignment concerns a Greenfield Analysis Approach to the production of Carbon Fiber Reinforced Thermo Plastic Composite parts. A cost price of these Composite parts is calculated on the basis of the Stork Fokker AESP production process in a Greenfield production facility.

There are many persons I need to thank for their support and valuable advice. First, I want to thank my graduation commission, existing out of:

Dr. J.M.G. Heerkens, university supervisor graduation project, University of Twente

Ing. W.W.A. Beelaerts van Blokland, university supervisor graduation project, University of Delft

Dr. P.J. Kortbeek, Stork Fokker AESP supervisor graduation project.

I also want to thank L. de Vaal and A. Daudey for their help, guidance and advice throughout my graduation trajectory at Stork Fokker AESP. Finally, I want to express my gratitude to all the other people who helped, encouraged and advised me.

Maarten Oosterbaan

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Abbreviations

ABC	Activity Based Costing
AESP	Aerospace
AIDT	Alabama Industrial Development Training
AS4D/PEKK	Type of carbon-fibre laminate
B2B	Business to Business
BC	Business Case
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CFRTP	Carbon Fibre Reinforced Thermo Plastic
EGC	Enhanced Growth Credit
EN	European Norms
FTE	Fulltime-equivalent
GFA	Greenfield Analysis
GLARE	Glass Reinforced aluminum
IT	Information Technology
LCF	Large Cargo Freighter
LEF	Lean Enterprise Fokker
N.V.	Naamloze vennootschap
NDO	Non destructive inspection
QA	Quality Assurance
QC	Quality Control
S/S	Ship Set
SFA	Stork Fokker Aerospace
UK	United Kingdom
USA	United States of America

Abstract

The composite parts made from CFRTP offer a good opportunity for Stork Fokker AESP to position themselves as a partner for their respective costumers. It also provides these costumers with a product that they are looking for: light weight, durability and strength.

Stork Fokker AESP can offer this product when they start a separate factory for the production of these beams or they can choose to produce them within the current Stork Fokker AESP organization. For this separate factory option a cost price is calculated. This is done on a Greenfield basis, in essence starting with a green field and building the factory from the ground up.

The production process is analyzed and all different production steps are identified. The cost are divided in capital cost and activity cost. For every production step these cost are calculated for one beam and for a ship set of beams. Furthermore the overhead costs are calculated on a price per beam and per s/s basis.

The cost price is based on information provided by Fokker on the production process, up to date information on material costs, labour cost, real-estate cost and offers for machinery.

The thesis is concluded with an overview of a number of possible locations for the factory. These are scored on a selection of criteria (reachable of the road, availability of personnel etc.), which give a limited view on which location is more or less suitable. Based on these criteria China looks like the best choice, however the raw materials comprise a large part of the cost price (52 percent). Cheap labor is therefore not top priority.

The author concludes that building a separate Stork Fokker Beams factory should provide the Stork Fokker organization with a better chance than keeping it inside the current structure, on the basis of cost (lower overhead) and production facilities (no room at the current facilities).

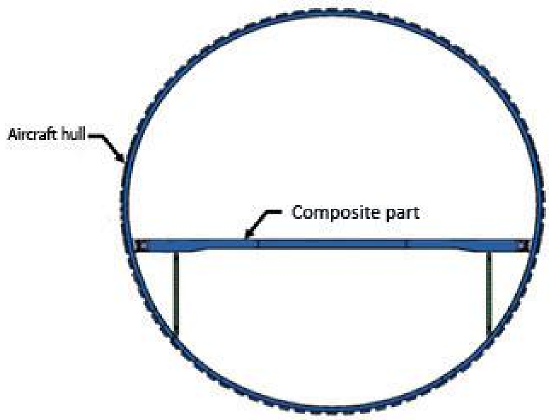
1 Introduction and problem definition

1.1 Introduction to the problem

In 2003 Stork Fokker AESP identified an opportunity to acquire a work package on a new airplane from a Integrator they partner with: the composite parts. The base line was thermoset composite with a weight of about 29 Lbs/beam. Fokker engineered a beam of thermoplastic material with a weight of about 22 Lbs, to be precise a Carbon Fibre Reinforced Thermo Plastic (CFRTP) beam. The work package included the design and build the composite parts for the Integrators new airplane, which is predominately built out of composite materials. Stork Fokker AESP had designed a composite part that met or surpassed all of the Integrators requirements[1]. Due to some difficulties, which lie outside the scope of this graduation project, Stork Fokker AESP did not receive the order for composite parts.

The composite part project became active again when the Integrator expressed some informal interest to Stork Fokker AESP for the beam it had designed. Besides the interest shown by this Integrator, some other Integrators also expressed interest in composite version of the product. Stork Fokker AESP has decided it wants to do more extensive research on the 'Composite part's Business Case'. Calculating the cost price is a part of this research.

The composite part (picture 1.1.) is a support beam, often an I-beam but shape and form varies per aircraft, it supports the floor that is built into an aircraft and often is used as a suspension for (electronic) cables and hydraulic systems.



Picture 1.1

[1] According to tests executed by Stork Fokker AESP: F-ORC 04-081, Manufacture of composite parts no3 to 8

1.2 Production Location

To produce the composite parts it is necessary for Stork Fokker AESP to build a new production facility, as the current production capability/capacity is not sufficient. At this moment Fokker has only produced a small series of beams and the current facilities are not capable to mass produce the composite parts, there is also not enough space available within current production facilities to realize the required production volume. Stork Fokker AESP believes that it will be more economical if the new production facility is kept physically and financially out of the current cost structure of Stork Fokker AESP. The reasoning for this assumption is that Stork Fokker AESP has a product portfolio of structural assemblies, whereas this composite part is basically a monolithic part. Stork Fokker AESP therefore wants a cost price calculation for composite parts produced in a separate production facility[2].

The development of a business model for the new production facility is the overall scope of this graduation project. The composite parts business case will be approached as a Greenfield (GF) situation, based on production in the Netherlands. Furthermore some study is done in the possibilities for Stork Fokker to start a production facility outside the Netherlands, part of this study will focus on Dollar versus Euro advantages and low wages in contrast to western wages.

1.3 Problem identification

This chapter will serve as a starting point for the graduation thesis, as such it will deal with the problem identification and identifying stakeholders and decision makers. The following topics are discussed; current situation, desired situation and model for GFA calculation. Furthermore the stakeholders for the problem are identified and the problem definition is discussed.

Current situation:
Stork Fokker believes that a dedicated company for composite parts production with its own cost structure will be better capable of meeting the cost targets. Stork Fokker wants a new cost price calculation done on the basis of a Greenfield production facility.

Desired situation and model for GF calculation:
The desired situation is a transparent (cost price) calculation of the composite parts factory. This means that the calculation is understandable to everyone inside the Fokker organisation and acceptable by financial institutions (i.e. banks). As discussed the composite parts will be produced at a new facility and calculations will be done on the basis of a GF. The accuracy of the calculation should be within 5% of actual figures.

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[2] As is described in 'Fabrieksconcept CFRTP' Report no: F-ORC 04-028

The cost price calculation is done using a model, this model is build up from the following elements:

- Production cost:
  - Material cost
  - Manufacturing cost
- Development cost (tooling and non-recurring)
- Administration / sales overhead cost

These elements are based up on a study done by Layer (2003) [3] on cost estimation. Further discussion on the model can be found in chapter four.

The most important stakeholders for the composite parts project are as follows:

Stakeholders:

- **Peter Kortbeek**, program director Stork Fokker AESP responsible for BCA activity. Company supervisor of the graduation project.
- **Proposal team**, responsible for the whole project.
- **Frans Baan**, estimator. In charge of developing latest estimating calculation for the composite part (member of the proposal team).
- **Jan Westra**, Manager Financial Program Control Stork Fokker AESP. Responsible for sound financial planning of projects.
- **MT Stork Fokker AESP**,
- **Stork Naarden** *Board of directors* of Stork Fokker AESP are in charge of approving capital investments needed for the composite parts, in case of a new separate entity also the *Supervisory Board* had to be consulted.
- **The Integrators** as customers are interested in good composite parts for a competitive price.

[3] Case-based Cost Estimation: A Building Block for Product Cost Management and Design-for-X. Ph.D.Thesis A. Layer 2003.

Decision makers

The following people/persons are the most import in deciding on the way ahead for the composite parts project. The proosal team prepares the business case. The MT of AESP judges the viability of the case. The management board of Stork approves the case. The supervisory board is involved if a new legal entity will be founded

- Peter Kortbeek
- Proposal Team
- MT Stork Fokker AESP
- Stork Naarden:
  - Board of Directors
  - Supervisory Board

Problem definition:

Calculating the cost price for CFRTP parts; based on a Greenfield production facility and made transparent for all stakeholders.

Research questions

The research questions are constructed in such a way that they represent the chronological flow through the graduation project. First off all elements that are needed for a model are researched and then the build up of the cost price is reviewed. Once a model is constructed the model needs to be fed with information (input data), then the model can be tested. The thesis is concluded with a study into foreign locations for the factory. This build up of the project has led to the following research questions:

- What elements are needed for cost price calculation model?
- How should the cost price be calculated?
- What information is needed to calculate the cost price?
- Can the model cope with radical changes in input data, i.e. is it flexible?
- What are the criteria for location selection?

2: Graduation project buildup

A graduation thesis needs to be based on a number of verifiable steps and scientific models to be able to retrace the steps taken by the author. In the following sections these steps are reviewed:

- The breakdown of the project.
- The theoretical frameworks that were used.
- The interview process.

2.1 Project steps

The steps described below were followed throughout the graduation period to answer the research questions. It provided a basis for the gathering of information and was used in an iterative way.

1. Determine the information needed, i.e. what knowledge question is pursued?
2. Identify the appropriate people within the company for interviews or research for theoretical frameworks
3. Consult the theoretical frameworks or have interview(s) with knowledgeable employees
4. Incorporate information gained from theory or interviewees into the model

The author uses the order of the research questions as a logical buildup for the graduation thesis. First the necessary elements of the model needed to be determined (1), the following step was determining the technique for calculating the cost in these various elements (2). This will leave a model for which input needs to be gathered (3). The fourth step was testing the model, sensitivity analysis (4). The last step is constructing a basis for location selection of possible sites for the composite parts factory (5).

2.2 Theoretical frameworks in conjunction with the project steps

(1) The first step was determining the elements for the cost price model. Through a literature study it was learned that elements from cost estimation and cost accounting proved useful in the construction of a model.

(2) Techniques for calculating the cost of the model elements were derived as well from literature on cost estimation, cost accounting and through interviews with experts from Stork Fokker AESP.

(3) Input for the model was derived from previous research on the production of the composite parts and new information was added to incorporate changes in the production process.

Interviews with experts on the production process and cost estimation provided further input for the model.

(4) To test the response on varying the input values, a sensitivity analysis was done. Literature on sensitivity analysis was found in the field of operations management.

(5) The location study was added as a preliminary evaluation of some of the sites/countries pre-selected by Fokker as possible locations for the factory. A study on (re)locating businesses was used to establish factors/criteria for the selection of sites. These criteria were scored using a four point scale and weights were added using the swing weights technique.

It is chosen to elaborate on specific theoretical frameworks once a knowledge question arises throughout the report. Therefore none of the frameworks are discussed in detail in this section. Instead they are discussed where the actual framework was used.

2.3 Interviews

The purpose of interviewing employees of Fokker was to get information on how to break down the production process and supplemental information like quality control or specifics on the production. Information from projects with similar overhead costs (outsourcing a part of the GLARE production) was useful to use as a basis for the overhead cost of the composite parts factory. Interviewees were presented to the author through his contacts within the company, following a request for information when knowledge questions arose. Through discussion with the author's supervisor or other employees within Fokker the author was directed towards people within the organization that could be helpful. Because the interviews were done with people of varying expertise and on non related subjects not one standard interview form was constructed, but every interview was treated as open interviews. Wherever information was deduced from a interview a reference is made.

3 Overview cost price model

Before discussing the cost price model for the composite parts in more detail and the construction thereof, an overview of the model is given. This overview can be used by the reader to familiarize himself with the model and see the overall picture. No details or justification is discussed; these will all be covered in chapter four. A breakdown of the model is given and the input and output variables are addressed as well as the model elements.

3.1 Model breakdown

The model is represented in Excel sheets; these sheets form the practical components of the model (figure two). Naming of the model elements is based upon the terminology used by Fokker. The model elements themselves are discussed in more detail in chapter four, however they are based on the research by Layer (2003) whom describes the buildup of a model for cost estimation. His work was used because he describes cost estimation in the automotive sector. According to Fokker the composite parts factory should be modeled more along the lines of the automotive industry and therefore his work seemed appropriate to use. The main elements of the model are named:

- Cost of activities
- Non recurring cost
- Overhead cost

Because it was necessary to calculate certain demand for machines and personnel a separate sheet was used to organize these demands. This has taken form in the capacity and planning sheet.

- Capacity planning

The data in these Excel files is comprised into a yearly overview of cost. This overview gives a forecast for the upcoming eight years of production cost.

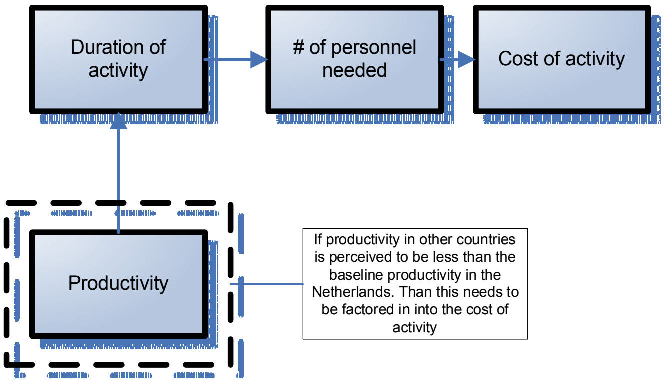
- Total yearly cost

3.2 Model elements

3.2.1 Overview cost of activities

The cost of activities has a number of input variables: duration of activities expressed in hours a worker is busy. The number of machines necessary to meet production demand or assist in keeping the production flowing (i.e. IT) and the materials that are used for production and the raw materials for the product. Output is generated in the form of a cost price per beam and per s/s of the composite part in cost of activity and cost of capital used.

These activity and capital cost are described in the 'overview cost of activities' Excel sheet. The production process consists out of twelve steps (A0 - A11 in model 3.2).



Model 3.1

These activities are analyzed on the basis of the elements in model 3.1. The number of machines needed is based on the 'capacity and planning' sheet in which the number of machines needed is calculated (which is explained in the next chapter). Together they form a basis (see input variables) for cost price of production activity for the composite parts. Also Quality Assurance and IT services are attributed to the cost of production activity because they are an integral part of that whole process.

3.2.2 Non recurring cost

The non recurring cost are typically expenditures that are needed to set up production lines, the input for non recurring cost were the average man hours needed for the ramp up and material qualifying period, energy cost during ramp up period and the material cost for testing (both for ramp up and material qualifying). Output is generated in the form of a cost price per beam and per s/s of the composite part in cost of activity and cost of capital used.
The non recurring costs occur only once and are amortized separately from recurring cost, because they are not dependant on production volumes. The non recurring costs for the beam factory are comprised out of material qualifying cost and ramp up cost.

3.2.3 Overhead cost

Input for overhead is comprised out of: yearly salary for staff members, cost for goods and services (varying from office supplies to transportation from raw materials and finished products) and the land purchasing cost and building cost. Output is generated in the form of a cost price per beam and per ship set (s/s) of the composite part in cost of activity and cost of capital used. A composite part ship set includes 53 parts.
Every organisation has cost for shared services and operational cost. These costs are normally allocated to the different products a company produces. They are indirect cost: cost not directly related to production, but necessary to keep the organization running. Because these cost do not have a direct relation with production, they are allocated in such a way that represents the demand that production carries on these overhead cost.

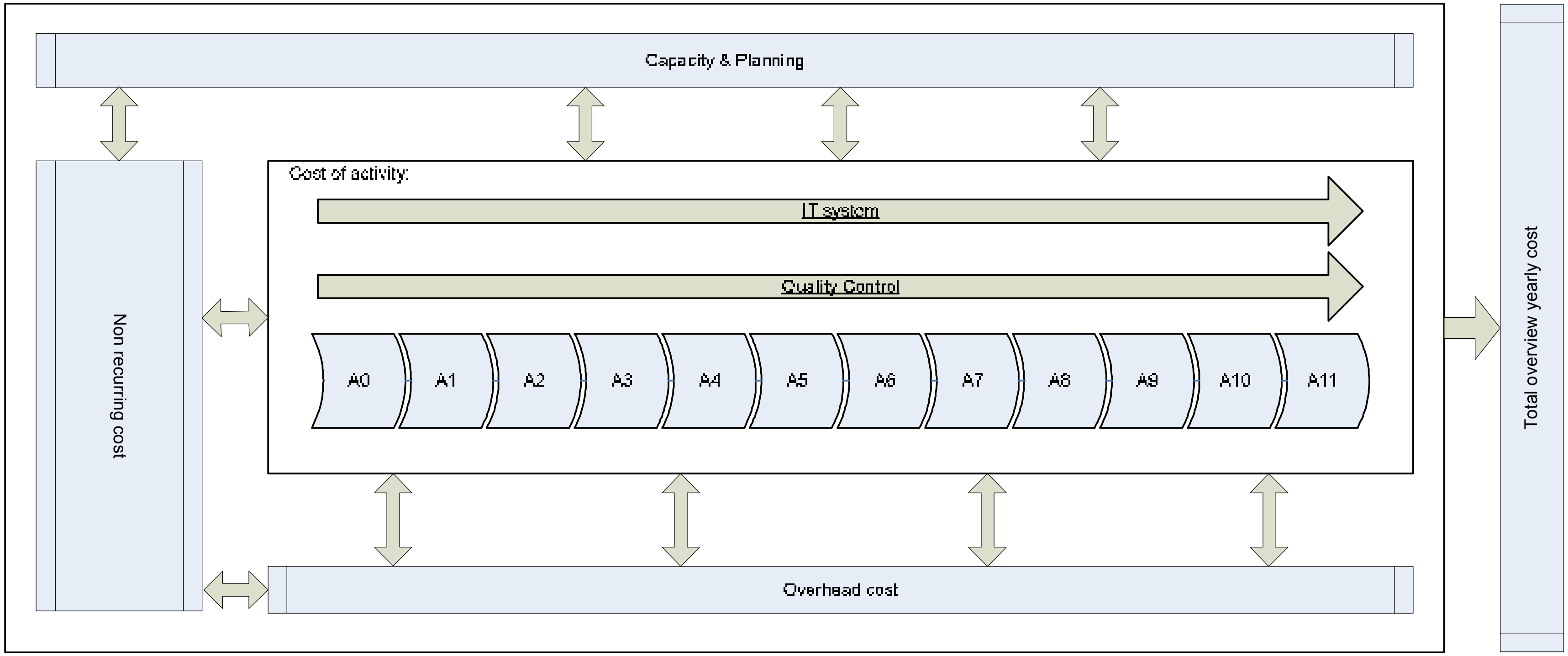
3.2.4 Capacity planning

As can be seen, this information serves as input for the cost of activity, the input for capacity planning sheet is: production hours needed for production, number of workable hours yearly for an operator, number of available machine hours, the demand for composite parts and the number of shifts the factory works in. The output of the capacity and planning sheet is the number of FTE and machines needed to meet production demand.
From the activity sheets the number of hours needed from operators is deduced in order to get an overview of the amount FTE needed. As well as the number of machines needed to meet production demand.

3.2.5 Total overview yearly cost

The inputs for the yearly overview are all the subtotals from the cost of activity, non recurring cost and overhead cost. The output is totalled per building block (overhead cost, non recurring etc.) and summed up in a yearly overview. The overview gives an eight year (minimum expected runtime for the program) forecast for the cost price of producing composite parts. Factored into that forecast are wage escalations and price escalations for raw materials, goods and services.

Cost price model



Model 3.2

4 Cost price calculations

Chapter three gave an overall view of the cost price model (model 3.2), this chapter covers the construction of that model. The conditions for the model were set in the introduction of this thesis. Following those conditions the model was constructed, which resulted in the following distinctive parts:

- Cost of production activity (overview cost of activities.xls)
- Overhead cost (overhead cost.xls)
- Non recurring cost (non recurring.xls)h

These varying model elements and supplemental elements are covered in the following sections, starting with the activity cost and ending with the total cost of producing composite parts. At first an introduction is given on the basis of the cost price calculation.

4.1 Basis for cost price calculation

Cost price calculation needs an underlying cost system. From Fokker it was stipulated that activity based costing (ABC) was the preferred cost system. Other cost systems were not investigated.
Activity based costing implies that there should be a cause-and-effect relation between indirect costs and cost objects (Drury 2002). Drury (2002) further stipulates the breakup of cost in two distinct parts direct cost and indirect cost, the latter is used synonymously for overhead cost. Direct cost can be directly traced back to a specific cost object, for example a separately produced part, indirect cost however cannot (Blocher et al., 2002). Indirect cost are usually accumulated through one or more cost objects using cost allocation (Drury 2002, Blocher et al., 2002).

Incorporating this knowledge, the next step was to design the ABC system; four steps are involved with the ABC system (Drury 2002):

1. Identifying the major activities that take place in an organization;
2. Assigning cost to cost pools/cost centers for each activity;
3. Determining the cost driver for each major activity;
4. Assigning the cost of activities to products according to the product's demand for activities.

The identified activities were placed under the headers mentioned above (cost of activity, overhead cost and non recurring cost) as dictated in the outline. The steps were used in the construction of the model and they are referred to in the next sections.

4.2 Cost of production activity

According to the ABC steps the activities need to be identified, this was done for each aggregated part of the company. This section covers the production activity. Extra information was needed to identify all activities of the production process. As a basis the original production process was used as reported by Hans Wiersma[4]. This gave an overview of the whole production process. This was supplemented with information from the R&D department in Hoogeveen on the current status of the production process for composite parts.

4.2.1 Identifying the major activities

The authors next step was to break down the process into smaller steps. Layer (2003) describes a method called generative analytical model. Analytical approaches depict the relevant processes of product creation in detail and derive the costs incurred, aggregating them. The next step was determining those steps, Layer points out that jobs or machine operations are a good basis for these steps.

The author first determined these steps from the Wiersma report, extra feedback was given by mr. Alwin Daudey in an open interview. The author discussed with mr. Daudey the different production steps. From his experience in cost price calculation for the Glare factory mr. Daudey commented on the steps chosen by the author. His experience with the Glare production provided some extra insight into the consolidation phase of production and two additional steps were chosen (build up of mould & debag mould) that originally was one activity (Consolidation) in the Wiersma report. His motivation was that the consolidation process should be filled up to maximum efficiency and therefore calculated separately.
The twelve steps of the production process:

- Sorting Materials
- Pick and Place (NC lay-up)
- Pre-form Press
- Sawing Pre-forms
- Build up of mould
- Consolidation
- Debag mould
- Grid blasting + epi coat
- NDO inspection
- Revision + chip up
- Assembly
- End inspection

[4] F-ORC 04-028, Fabriekseoncept, issue 1

A brief explanation about these activities is given in the first sheet of 'overview cost of activities.xls'. Every activity has its own sheet and at the end of the excel file data sheets are included (with information of production demand, material cost etc.). The data sheets are discussed at the end of this section.

4.2.2 Example Sawing pre-forms:

All activity sheets follow the same principle: all actions to complete these activities are listed and duration for that action is given. These durations are partly estimated and partly calculated on the basis of the report of Hans Wiersma. In the Wiersma report only the production run duration was mentioned, the other 'overhead' times were determined on basis of a process also described by Layer(2003) called guesstimation by the author in cooperation with mr. Daudey. The guesstimation process can best be described as follows: on the basis of past experience (mr. Daudey's) an estimate is given on how long these activities will taken in a new factory. These duration times combined form the total time an activity needs to produce one composite part. Furthermore estimations are made for which action an operator is needed and following that estimation the total time in hours is calculated that an operator is busy.

Activity	Sawing pre-forms + buffer depot parts	Duration C-channel (in hours)	Duration upper cap (in hours)	Duration lower cap (in hours)	Input of operator required
Actions	Check beam type from production schedule	0,03	0,03	0,03	
	Check materials needed	0,02	0,02	0,02	
	Order disbursement of materials from previous station	0,01	0,01	0,01	
	Setting-up the machine	0,07	0,07	0,07	
	Production run	0,08	0,19	0,19	
	Registering finished product in system	0,03	0,03	0,03	
	Release product to KANBAN-buffer	0,03	0,03	0,03	
	Clean machine	0,05	0,05	0,05	
	Total time of operation	0,30	0,41	0,41	
	Time for error (2,5%)	0,01	0,01	0,01	
	Total time needed for 1 part per laminate	0,62	0,11	0,11	
	Total time for 1 part	0,83			

Table 4.1

4.2.3 Determining the cost driver

A Cost Driver is any activity that causes a cost to be incurred. On an aggregated level the composite parts can be seen as the cost drivers, when observed in more detail the cost drivers in production are duration drivers (labor time) and intensity drivers (cost of capital resources, Drury 2002). These drivers where translated into (labor) activity cost and cost of capital for the production of one composite part and for a complete s/s.

4.2.4 Assigning cost to cost pools

The next step in the ABC system is assigning cost to cost pools, in the authors model every activity is seen as a cost pool. These are split up in labor cost and capital cost. The time an operator is busy is multiplied with the hourly wage and the hourly wage can be found at the end of the Excel file on the 'Data' sheet. Table 4.1 describes the activity cost part of Sawing pre-forms.
Secondly the capital investment of Sawing pre-forms is calculated, this means that the cost for capital goods is established by looking at what capital goods are needed (including materials if needed) for that specific activity. These materials and machines were derived from the report by Hans Wiersma. Offers made by suppliers for machines were used as a basis for pricing machines, these offers were gathered during the previous year's Fokker was working on the composite parts case. Because these offers are all tailor made to the composite parts project and require extensive knowledge of the production process and were done in consultation with the suppliers and Fokker it sufficed to use these offers and corresponding prices for machinery. The number of machines needed is established in the 'capacity planning.xls' file, which is covered at the end of this chapter.

Trim unit: Autonational d.d. 14.11.2003	€	250.000,00
# machines needed		2
Total price	€	500.000,00
Kanban buffer (estimation Altran)	€	15.000,00
Total investment:	€	515.000,00
service cost 3%, yearly	€	15.450,00
over 8 years	€	123.600,00
Total cost	€	638.600,00

Table 4.2

Furthermore the service costs for keeping the machines working are set at three percent of the original purchase price per year. These service cost include scheduled and unscheduled repairs. This figure is derived from interviews with again mr. Daudey. He based these figures on the equipment used in the new GLARE factory and concluded that this would be a good indication

for such costs. The machines have an economical life span of eight years (based on write off periods established by the financial department from Stork N.V.).
In conclusion the cost of capital is the cost of capital investment for that activity divided by the number of beams that are produced within the economical lifespan of that capital investment.

For Sawing pre-forms the total cost of capital and activity are:

Total cost of activity:

Capital cost / part	€ 28,69
Activity cost / part	€ 25,85

Capital cost / ship set	€ 1.520,48
Activity cost / ship set	€ 1.369,96

Table 4.3

The cost of all activities are added in the 'data' sheet of the excel file, for some excel sheets a special calculation was needed. These calculations are explained in the Excel file. As mentioned in chapter 3 a composite part ship set includes 53 parts.

4.2.5 Additional cost drivers

Also covered in the activity cost are the cost for materials (AS4D/PEKK), IT, Quality Control and Investment Cost. These cost drivers are covered in the cost of activity Excel file but are a indirect part of the production activity.

Materials

The costs of materials are based on the price for AS4D/PEKK and other materials needed, in this case the composite part is the direct cost driver. These prices were indicated by Pui Chan[5]. In accordance with the Production Price Index[6] these material prices are increased with three percent per year. Although these prices were negotiated for this moment, they should be treated as an assumption. Future prices could still go up when prices for oil increase.

For the AS4D/PEKK the gross amount of material needed is taken as a basis for the price per beam of that material. Together with other materials needed (sealant, upilex foil etc.) an indication is given for the price of materials per beam and s/s for the next eight years. These other price indications were supplied by mr. John Teunissen from Fokker Hoogeveen. Mr. Teunissen is responsible for the technical creation of the first series of composite parts, concepts and test beams.

[5] Ms. Chan is one of the materials purchasers for Stork Fokker AESP. Her information can be considered a fact.
[6] PPI: Statistical database kept up to date by the CBS (Centraal Bureau voor Statistiek), Stork Fokker AESP has an subscription to that database.

IT

IT systems are needed for logistical support of the production process; Altran[7] has done some research for the composite parts factory and have come up with a recommendation for the systems needed. The financial department of Stork N.V. uses a write-off period of five years for IT systems worth fifty thousand Euros or more. Subsequently the cost for the IT system (intensity driver) is divided by the number of composite parts produced in five years according to current demand.

Quality control

According to mr. Jan Luijten[8] of the Quality control department of Fokker a fair assumption for the number of hours needed for quality inspection can be calculated on the basis of a percentage of the total production hours needed (duration driver). In the beginning a higher demand of quality control can be expected because workers are still not fully efficient. Under normal working conditions Fokker finds that with recurring inspection eight percent of the total production time is needed for quality control. This amounts to a total of 2006 hours of work. The author has decided (on the basis of the available workable hours per year) this can be handled by one full time quality control inspector and one part time quality control inspector, the latter fulfills a dual role and can be available when the full time quality control inspector is indisposed.

Both inspectors should be trained to be Nondestructive Inspectors, it is recognized that these inspectors have extra skills and they have a higher hourly wage (as can be seen in the 'data' sheet).

Next to these quality inspectors an EN9100 certification is needed, the cost for such a certification is twofold: an initial fee (€ 25.000,-) and a yearly fee (€ 5.500). These figures are from BVQi, a certification bureau that Fokker uses. The yearly fee is assigned on the basis of yearly production of composite parts and the initial fee is spread over the first eight years of production.

The above mentioned figures were used to be able to construct the quality control cost. Because no real measurements could be done for the new production facility it was chosen to work with figures Fokker has experience with. Because it is fair to assume that Fokker is able to keep up the same quality control record in the new facility. Improvements could also be made and the new production facility could also be used as a test case for a new quality control system. It is the author's recommendation to Fokker to take the opportunity to use this new facility as a proving ground for quality control in conjunction with the current Lean Enterprise Fokker (LEF) project.

[7] Altran is a consultant Stork Fokker AESP hired to examine the logistical process of the composite parts factory

[8] Mr. Luyten is a Quality Control Manager in Stork Fokker AESP Papendrecht.

Investment cost
Investment cost = interest, therefore the amount of investment in machines, land en building is totaled in the 'Total investment' sheet: The initial debt is € 8.706.610,- in 2008 at the start of production. Each year the debt is reduced with the income production generates.

Warehouse	€ 37.310,00
Sorting Materials	€ 6.600,00
P&P machine	€ 2.240.000,00
Pre.Press	€ 598.800,00
Sawing Preforms	€ 515.000,00
Build mould	€ 1.054.000,00
Consolidation	€ 1.026.000,00
Debag mould	€ -
Grid blasting	€ 660.000,00
NDO inspection	€ 150.000,00
Revision	€ 766.400,00
Assembly	€ -
End inspection	€ -
Storage	€ 75.000,00
Total production (machine + tooling)	€ 7.054.110,00
Building	€ 1.600.000,00
Land	€ 52.500,00
Total capital investment	€ 8.706.610,00

Table 4.4

For example: Table 4.5 shows the forecast from the marketing intelligence database from Stork Fokker for the expected production rate of the airplane. The debt is reduced in 2008 with: 14 * € 3.934,52 (building + land) + 14 * € 24.911,08 (Capital cost) = € 403.838,40
Based on discussions with ing W. Beelaerts[9] the author decided that an interest rate of eight percent for the capital investment is conform the risk profile for the composite parts factory.

Therefore the first year an interest of € 664.221,72 is due, divided over 14 s/s.
This cycle repeats itself each year until the debt is paid in 2013.

2008	2009	2010	2011	2012	2013	2014	2015	2016
14	38	43	50	63	58	58	48	48

Table 4.5

[9] Mr. Beelaerts is a professor at the University of Delft, *Coordination for BSc Minor Exploitation & Operations and MSc Aerospace Management & Operations*

4.3 Overhead cost

The overhead cost for the composite parts factory are based on three main pillars: building and land, operational cost and staff. These are all categorized as intensity drivers on a basis of beams and s/s produced.

4.3.1 Building & land

In order to establish prices for building and land, additional information was needed on possible production locations. Fokker made it clear they were interested in the following countries for production:

- The Netherlands
- The United States & Canada
- India & China

Selection of these locations was not a part of the graduation project, although the possible locations are discussed in more detail in chapter six.
For the Netherlands the data is taken from Stork Fokker's earlier cost price calculations by Mr. Baan, China is based on figures from Stork Fokker ELMO in Lang Fang, India, Canada and the US were derived from studies by the development offices from their respective countries. These figures incorporate the mean value of land price and the cost of building for their regions per square meter.
It was established in early studies[10] that the factory needs a minimum of 3500 square meters land and the minimum factory surface is approximately 2000 square meters. Using these figures a total price for land and building per country can be calculated. Subsequently these totals were divided by the number of beams to be built in eight years, the time minimum period the program will run.

4.3.2 Operational cost

Operational cost in overhead are all cost that are needed to keep the organization running, examples of these cost are simple hand tools needed throughout the factory and cost to keep the office running. Because no direct information was available to base these cost on additional sources were sought. These were found with Mr. Scheeren, who is now business developer of the NH90 project at Fokker, he has done cost price calculations on a factory for the outsourcing of part of the Glare production process. His assumptions were used as basis for the operational cost, because that factory in size would be similar to the composite parts factory. In our interview he agreed that large portions of the generic overhead cost should be similar to the composite parts factory and so these were used as a basis for the author's calculations.

[4F] - ŒRC0 F8ŒF12, - abriekseconcept, issue 4

An example is one of the biggest contributions to these costs: the transportation cost for getting the raw material to the factory and the finished product to the customer. Information on transportation was sought within Fokker, as they already have enough experience with transporting parts and products throughout the world. According to Mr. Kortbeek a maximum of three s/s can be transported per container at a price of € 1500,- per container. Because of a lack of better information, the basis for transporting raw materials to the factory is kept the same.
It was then necessary to know on what scale the price of these goods and services would escalate each year. The most commonly used source is the Production Price Index[11]. Once the cost estimates were established the cost were multiplied by the escalation factors corresponding to that type of service or good. This gives an overview of the expected cost for the upcoming eight years, which are then divided by the average number of build beams for that year to get a price per beam and per s/s.
These overhead costs should be evaluated more closely if Fokker continues with the composite parts project. No direct theoretical frameworks were available to establish these cost and therefore mr. Scheeren was consulted. However, these figures should be regarded as indicative.

4.3.3 Staff

Together with Mr. Kortbeek the function for staff members were discussed and outlined. These functions were combined into a list of physical staff members, whom could have more than one function. Staff members are a part of the overhead cost. A driver for these cost are again intensity drivers. Because the factory only produces composite parts, the amount of composite parts are a basis over which the cost can be averaged, to get a price per beam and s/s these cost are also increased by the yearly wage escalation.

[11] These indices are kept by institutions like the Bureau of Labor Statistics or by specific branch organizations. The author used the PPI kept by Stork Fokker AESP.

4.4 Non recurring

The phrase non recurring is in itself a straightforward term, in the author's model it is comprised out of ramp-up cost and qualifying cost. In the context of ABC these cost can be seen as intensity drivers, although they are performed only once and before production starts. Therefore the cost driver is again the composite parts produced over a period of eight years. After that period these cost are written off.

4.4.1 Ramp-up cost

Before production can start, it is necessary to test the whole production process. Together with Mr. Kortbeek it was decided that this ramp-up period should take an approximate six months and a total of five s/s need to be build. During this ramp-up period the machines will be tested and the operators need to be trained.
Simple calculations will show that when a company starts with no personnel and ends up with the maximum needed personnel after six months. That on average the company will have fifty percent of the total workforce on his payroll. Next to wages the workers need to build 5 s/s of composite parts, the materials for these composite parts of course need to be paid. The machines also need to operate as does the whole factory, energy cost are therefore incurred for the total of six months. It is therefore concluded that the ramp-up period shall consist of the following elements:

- Wages for fifty percent of total workforce
- Cost of needed materials
- Cost of energy for approximately 6 months

Cost of land, building & machines will be incurred when production becomes operational. For the ramp-up to the first article inspection it is determined by Mr. Kortbeek that five s/s or 265 beams are sufficient. This will determine the cost for materials needed. These ramp-up costs are written off over the first 420 s/s, produced in eight years.

4.4.2 Qualifying cost

If Stork Fokker Aerospace wants to produce Thermoplastic Composite parts for the Integrators company they need to pass a material qualification process[12]. When Stork Fokker passes that process, they can produce any type of product from that specific kind of material. In 2006 Fokker also completed an qualification process for this Integrator. Cost for that project were used to establish a estimate for the Thermoplastic qualification process, these qualifying cost shall be written off over the first 420 s/s, produced in eight years.

[12] This is a policy which is dictated by the Integrator, information for this project came from Marc Koetsier whom was in charge of a qualifying process.

4.6 Capacity and planning

In order to establish the number of personnel needed and the number of machines that are necessary to meet production demand, a capacity planning is needed. For the available personnel hours a year cycle is established on the basis of Fokker' year cycle.
The total workable hours per year are 1730 hours. The deduction of available working hours is self explanatory and can be found in 'capacity and planning.xls'.

4.6.1 Man hours and FTE

For the total number of operators working in the factory the needed man hours per production activity are divided by 1730, for example:
Sawing pre-forms needs 0,83 per beam of man hours. An average of 2809 beams are produced each year[13]. This results in a total of 2809*0,83 = 2320 man hours needed for Sawing pre-forms. Working in one shift 2320/1730 = 1,34 FTE are needed to meet demand. At the moment it is not yet clear if it would be possible to share operators between different activities. There it is chosen that when for example 0,34 FTE is needed, a full FTE is hired. The consequence is that cost for personnel will initially be higher, but demand can be met and redundancy in operators is assured. When the employees get more trained at their job it might be possible to shave of some time and a few FTE can be reduced. There it is recommended to hire a portion of the employees on a temporary basis.

4.6.2 Number of machines

The basis for the number of machines needed is the number of machine hours that are needed divided by the number of hours a machine can be operated per year. The number of machine hours that are available yearly is made dependant on the number of man hours that are available yearly. In effect this means that every machine can work for 1730 hours a year.
An example for the Sawing pre-forms: again 2320 hours are needed and working with one shift: 1730 man hours are available. 2320/1730 = 1,34. Because it is not possible to buy 0,34 machines and the work cannot be spread to other similar workstations. Two trim units are needed (as can be read in table 2).

4.7 Total overview yearly cost

The total overview of the expected yearly production cost for the composite parts factory is in itself straightforward. For every cost pool mentioned above (production activity, overhead cost and non recurring), the summaries are totaled and a total price per beam is calculated for the years 2008 through 2016.

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[13] See chapter 7 for specifics on input data

5 Sensitivity Analysis of Cost Price Model

A sensitivity analysis was conducted for the cost price model. The purpose of that analysis is to learn what the tolerances for the model are: what are the effects of an increase or decrease in demand, what effects do price changes of raw materials have and what effect labor cost changes have. This was done according to literature from Goodwin[14] and Winston[15].

Goodwin and Winston describe the sensitivity analysis as follows: changing various variables of a model to see their effects on the model outcome. Because the labor cost, demand and raw materials are the biggest influences on the cost price, it was chosen to do a sensitivity analysis with those variables only. They carry the biggest weight in the production process and are susceptible to possible variances during the production process. Although capital costs represent a large portion of the cost price, these cost change automatically when there is a change in demand, it was therefore chosen not to include them in this sensitivity analysis separately.

5.1 Labor cost

To see what effect the lowering or raising of the labor cost has on the outcome of the cost price it was chosen to see what outcomes were produced when labor cost was increased by the following percentages: -90%,-50%, -25%, -20%, -15%, -10%, -5%, 5%, 10%, 15%, 20%, 25%, 50% and 90%. The -/+ 90 percentage was chosen to see what effect extreme changes would have, the rest of the percentage change was chose to see what effect would occur within a bandwidth of -/+ 50 percent. The results are shown in table 5.1.

[14] Decision analysis for management judgment, P. Goodwin, G. Wright
[15] Operations Research, W. L. Winston

		hourly wage:		effect cost price per part in 2008		relative change
	original	€	25,04	€	3.758,15	0%
percentage increase:	-90%	€	2,50	€	3.367,94	-10%
	-50%	€	12,52	€	3.541,44	-6%
	-25%	€	18,78	€	3.649,83	-3%
	-20%	€	20,03	€	3.671,48	-2%
	-15%	€	21,28	€	3.693,12	-2%
	-10%	€	22,53	€	3.714,77	-1%
	-5%	€	23,78	€	3.736,41	-1%
	5%	€	26,29	€	3.779,87	1%
	10%	€	27,54	€	3.801,52	1%
	15%	€	28,79	€	3.823,16	2%
	20%	€	30,04	€	3.844,80	2%
	25%	€	31,29	€	3.866,45	3%
	50%	€	37,55	€	3.974,84	6%
	90%	€	47,57	€	4.146,61	10%

Table 5.1

These de- and increases of the hourly wage show that their effect on the total cost price is minimal. This knowledge can be used in evaluating different possible locations and their respective labor costs. If however it is chosen that the production process is not automated but done by hand, these figures will change dramatically.

5.2 Demand

Similar to the hourly wages, the demand for s/s of composite parts is de- and increased to see what effect it has on the cost price. It could be expected that there exists an optimum for the demand for which the cost price is acceptable and when increased more capital investments are needed that result in a higher cost price.

Demand for composite part s/s': -90%,-50%, -40%, -30%, -20%, -10%, -5%, 5%, 10%, 20%, 30%, 40%, 50%,100% and 200%.

		Yearly demand in s/s	effect cost price per part in 2008		relative change
	original	52,50	€	3.758,15	0%
increase:	-90%	5,25	€	9.351,28	149%
	-50%	26,25	€	3.799,60	1%
	-40%	31,50	€	4.041,48	8%
	-30%	36,75	€	3.931,60	5%
	-20%	42,00	€	3.918,97	4%
	-10%	47,25	€	3.782,19	1%
	-5%	49,88	€	3.729,68	-1%
	5%	55,13	€	3.812,56	1%
	10%	57,75	€	3.771,13	0%
	20%	63,00	€	3.312,39	-12%
	30%	68,25	€	3.528,75	-6%
	40%	73,50	€	3.490,06	-7%
	50%	78,75	€	3.497,65	-7%
	100%	105,00	€	3.395,29	-10%
	200%	157,50	€	3.357,45	-11%

Table 5.2

Table 2 shows the effects of in- and decreasing the demand for the composite parts. From this information the following stands out: decreases of 90%, 50% and 40% and increases of 20%, 100% and 200%. The author has analyzed these effects and the possible explanation could be as follows.

The decreases of 50% and 40% show that there seems to be a turning point in cost for machinery: with a 50% decrease less machinery seems to be necessary to meet demand. The cost for producing 50% less is only 1% higher, while producing 40% less the cost are 8% higher. The capacity and planning sheets corroborate this assumption, as is shows that with a 50% decrease only 1 machine is needed of every type, while with a 40% decrease some stations require 2 machines to meet demand. The following question could be: why do the costs increase? The answer to that is quite simple and straightforward: the amount of composite parts decreases, so the cost can be attributed to less composite parts. This is all on the basis that machines are only purchased when they are really needed. Capacity and demand should be calculated correctly before buying any capital assets that cannot be sold easily.

The changes with increased demand show the same effects, albeit here it generates the opposite outcome. Cost decrease because the amount of composite parts to which these cost can be attributed increase. Optimum points of increased demand arise where that demand is met with the least amount of machines, this can be done by working in shifts. The small increase of hourly wage for shift benefits seems to outweigh the extra cost of machinery.

5.3 Raw material (AS4D/PEKK)

The cost of AS4D/PEKK, the base material of the composite part, is already the highest cost driver for the cost price of the composite part. The price of AS4D/PEKK is analyzed in the same way as the labor cost and demand was. It was was increased by the following percentages: -90%,-50%, -25%, -20%, -15%, -10%, -5%, 5%, 10%, 15%, 20%, 25%, 50% and 90%. The -/+ 90 percentage was chosen to see what effect extreme changes would have, the rest of the percentage change was chose to see what effect would occur within a bandwidth of -/+ 50 percent . The results are shown in table 5.3.

		Price of AS4D/PEKK per pound	effect cost price per part in 2008	relative change
	original	39,88	€ 3.758,15	0%
increase:	-90%	3,99	€ 2.653,42	-29%
	-50%	19,94	€ 3.144,38	-16%
	-25%	29,91	€ 3.451,26	-8%
	-20%	31,90	€ 3.512,52	-7%
	-15%	33,90	€ 3.574,08	-5%
	-10%	35,89	€ 3.635,33	-3%
	-5%	37,89	€ 3.696,89	-2%
	5%	41,87	€ 3.819,40	2%
	10%	43,87	€ 3.880,96	3%
	15%	45,86	€ 3.942,22	5%
	20%	47,86	€ 4.003,78	7%
	25%	49,85	€ 4.065,03	8%
	50%	59,82	€ 4.371,91	16%
	90%	75,77	€ 4.862,87	29%

Table 5.3

With this analysis it becomes obvious that the cost for AS4D/PEKK is the single most important cost driver for the cost price of the composite part. For every percent the price of AS4D/PEKK in- or decreases, the cost price for composite part changes 0,33 percent.

In conclusion this analysis shows that the model behaves as would be expected: the changes in the model output were all explained. It also gives an insight into the effects of lower wages and product demand. Wages will not affect the cost price very much, but an optimum between demand and production capacity needs to be sought. Furthermore it gives weight to the assumption that the cost for raw material is very important for the total cost price. Fokker should make sure they receive the most competitive price for AS4D/PEKK, one way to achieve this is using dual sources for the raw materials.

6 Site locations

Fokker intends that the composite parts factory will be a new production facility, for which no direct ties are needed to the existing facilities that Fokker operates out of today. Therefore there is no restriction to produce the composite parts in the Netherlands from a production point of view. There even are incentives for producing the composite parts in other countries; this part of the thesis will address some potential sites for production and their possible incentives. Although a detailed study into site selection is needed once Fokker decides to build the factory, it gives an indication into which sites seem lucrative.

Information about the sites was gathered during multiple interviews with Larry de Vaal[16] and based on information provided by his research. To obtain information mr. de Vaal contacted development offices in the state of Alabama (United States) and India as well as the Stork Fokker ELMO facility in Lang Fang China.

The author himself did research on locations in the Greater Vancouver Area. The Canadian development office[17] provided information for this research as well did the utilities company of British Columbia. Studies done in Hoogeveen by Fokker for production just over the border in Germany were also used. All locations were pre-selected by Fokker, looking for another suitable location was not part of the assignment.

6.1 Setting up criteria

Before the data could be analyzed, criteria were needed for evaluating different locations. These criteria could then be used to score each different location Fokker already selected. This resulted in a ranking of the locations according to the criteria. Pen (2002) describes push, pull and keepfactors the latter are factors that keep businesses at their present location. The first two are factors that either pull businesses to a new location or push them out of their current. For Fokker the pull factors are the most interesting, because the factory is not build yet and it was already decided that there is no room at the current production facilities. However pull and push factors can be the same for example parking space, as a pull factor it is the availability of parking space and as push factor it the lack thereof.

B&A Group (1997) categorized these factors according to business areas; industry, trade, transportation and services.

[16] Mr. De Vaal is sales director at Stork Fokker AESP and was part of the composite parts project team
[17] www.investincanada.com June 2006

For industry these factors are:

1. Reachable over the road
2. Loading and offloading
3. Parking space
4. Availability of personnel
5. Building
6. Telecommunication facilities
7. Land/lease price
8. Expansion opportunities
9. Representative surroundings
10. Availability of public transportation

The different locations pre-selected by Fokker are now discussed in light of the criteria mentioned above, specific points are discussed. At the end of each location discussion that location is scored. The author has rewarded points on every criteria for every location on a scale of 1 to 5, 1 being the worst and 5 the best.

To reflect the respective importance of all factors to the decision maker, weights are added to each of these attributes. Because these weights need to be in proportion with the range over which the factors are assessed, the swing weights method is best suited for allocation purposes (Goodwin, 1991). The swing weights work as follows:

1. First all factors are hypothetically set at their lowest score, then the decision maker (in this case the author, but in the future Fokker should repeat these steps) is asked what factor is preferred the most to be given the highest score. So the decision maker is asked which criteria he or she prefers to have the highest score.

2. When that change has been made, the next factor is ranked the same way but for the next most important criteria, this process is repeated until all factors are ranked.

3. Then the highest ranking factor is given a weight of 100 points, all following factors are then compared to the highest ranking factor, i.e. if expansion opportunities is ranked highest and availability of personnel is second. The swing between the worst availability of personnel to the best is compared to expansion opportunities; where it could be determined by the decision makers that this is worth 80 points (Goodwin, 1991). This process is then repeated until all criteria are given a weight.

With this chapter the author gives an impression of what is possible with site selection methods. This procedure should be carried out by Fokker in much more detail for future use, for compliance with their own perceived importance of criteria and interpretation of the data. Also due to the fact that information on India and China was difficult to double check and the information given by the development offices could be represented in such a way that it glorifies their respective countries. Therefore they should contact these bureaus again once the specific demands for the factory are established and hard verifiable facts can be obtained and checked. In that phase SFA can get specific information on what is possible and for which incentive SFA can apply. This information should then be used to evaluate the prospected locations again.

6.2 Evaluating locations

USA:

The USA is attractive for a multitude of reasons: the dollar, closeness to customer, skilled personnel and logistic advantages. These reasons are discussed below. At the end of this section all locations are compared on criteria discussed above.

In the airline industry it is a customary to sell your products in dollars, for European companies this presents extra volatility when the dollar fluctuates against the euro. This volatility is represented in form of hedging cost. To avoid this extra cost it can be seen as an advantage to produce the composite parts in a dollar currency country.

For production in the US it is possible to produce in the vicinity of the Integrator or subcontractor, which produces the largest sections of the new airplane. This subcontractor is located in North Carolina which borders with Alabama. The research from mr. de Vaal was done on Alabama, which has a high concentration of skilled aerospace workers and a multitude of state incentives for companies to start their business there. Some state incentives are listed below:

- Alabama Industrial Development Training (AIDT): financial aid in recruiting and training of new workers.
- Enhanced Growth Credit (EGC): Economic development incentive for rebates in cost of energy.
- Income Tax Capital Credit: Deduction in taxable income
- Tax abatements: State & City tax savings on building materials, machinery, building labour and land.

In the northern part of Alabama there is a lot of aerospace industry as well as in the Seattle area. According to the state development office the schools in Alabama provide good education towards the industry, contracting qualified workers should therefore be no problem. Fokker also have their own engineering office in Seattle and from that office extra assistance can be provided.

The US is close to the Integrator and their new program. From their special cargo plane will make trips to all suppliers around the world. The composite parts could be carried around the world with their cargo freighter. Production near subcontractors has logistic advantages to the extent that they could be the largest 'customer' and that the cargo freighter also makes trips to these subcontractors. The composite parts could then also be transported around the world with the LCF.

Some disadvantages for the US are:

- Wages in the US will be higher than in developing countries
- Far away from Fokker experts back in the Netherlands.
- Higher ramp up cost, coincides with being far away from Fokker in the Netherlands. Extra expenses are made to get Fokker experts to the site and supervise the production and train personnel.

United States	Score	weighted score
Reachable over the road	5	7
Loading and offloading	5	5
Parking space	4	4
Availability of personnel	5	7
Building	4	4
Telecommunication facilities	4	3
Land/lease price	3	3
Expansion opportunities	3	4
Representative surroundings	4	2
Availability of public transportation	2	1
Total	39	40

Canada

Canada and particular British Columbia has the same kind of advantages as Seattle has: good workforce, closeness to the customer and supplier and logistical advantages. Furthermore it provides some financial advantages:

- Provincial Sales Tax Exemptions
- Provincial and Local Property Tax Exemptions
- Small discount on energy cost.

Some disadvantages for Canada are:

- Wages in the Canada will be higher than in developing countries
- Far away from Fokker experts back in the Netherlands.
- Higher ramp up cost, coincides with being far away from Fokker in the Netherlands. Extra expenses are made to get Fokker experts to the site and supervise the production and train personnel.

Canada	Score	weighted score
Reachable over the road	5	7
Loading and offloading	5	5
Parking space	4	4
Availability of personnel	5	7
Building	4	4
Telecommunication facilities	4	3
Land/lease price	3	3
Expansion opportunities	2	2
Representative surroundings	4	2
Availability of public transportation	2	1
Total	38	39

China

China has two mayor advantages: low wages and off-set generation. Next to these advantages it also has a highly motivated and young workforce[18].

From information obtained from Fokker ELMO in Lang Fang it becomes evident that there are two mayor factors for taking advantage of the low wages in China: total ownership

[18] Manufacturing employment and compensation in China, J. Banister for the Bureau of Labor Statistics (www.bls.gov, June 2006)

and organizational model. These two factors are strongly related: once Fokker is the total owner of the company it can introduce its own organizational model. The organizational should be similar to the Dutch mother company in order to achieve higher productivity then under Chinese governance. The Chinese model uses more workers to achieve the same results, they use a lot more supervisors and those supervisors also need close supervision. Fokker ELMO has learned that when given the same kind of responsibilities as Dutch workers, they can produce at around 70% of a similar western factory. This way a lot fewer people are needed and the advantages from the low wages can truly be experienced.

The Integrators are pressured by the Chinese government into off-set generation in their country. When suppliers like Fokker AESP produce their parts in China, they can also be calculated as off-set generation. But it is uncertain if China will accept these off-set generating activities for future programs once the factory is build in China. It could be a order winner for a first program.

With long running programs like commercial aircrafts it is wise to consider the future development of the workforces. In China there still is a highly motivated and young workforce in contrast to Europe and the US.

Some disadvantages for this location are:

- Far away from Fokker experts back in the Netherlands.
- Higher ramp up cost, coincides with being far away from Fokker in the Netherlands. Extra expenses are made to get Fokker experts to the site and supervise the production and train personnel.
- Geopolitical situation, the Chinese government has bigger influence in how business is conducted. This can be an uncertainty.
- Logistics, China is not close to any of the bigger assembly factories of the aircraft. Higher cost for logistics can be expected.
- Efficiency of the workforce is less than in Western economies
- Social turbulence

China	Score	weighted score
Reachable over the road	5	7
Loading and offloading	5	5
Parking space	4	4
Availability of personnel	4	5
Building	3	3
Telecommunication facilities	4	3
Land/lease price	5	5
Expansion opportunities	5	6
Representative surroundings	3	2
Availability of public transportation	3	2
Total	41	43

India

India is comparable to China with its wages, according to a study done by the Boston Consulting Group[19] it also has some additional distinct advantages. Furthermore there are some financial incentives.

A total comparison on cost is done below, it can be said that India also has low wages similar to China. Information on productivity is not widespread available and thus can only be estimated.

The Boston Consultancy Group has done an analysis on India's economy. Some of the important points were the following: stable political situation, well developed capital markets and a track record of satisfied western companies.

The stable political situation has caused long and stable development of the economy over the past 50 years due to consistent growth of policies across different political regimes. This had led to a number of multi-national companies investing heavily in India, also because of the highly educated, young and motivated workforce that is available.

According to the Think India development office, India also provides the following financial incentives:

- Capital subsidy (cash in hand)
- 33% subsidy on electric first four years
- 50% reimbursement of expenses on patent registration

[19] National Conference: Business process outscourcing trends and insights – Advantage India, Boston Consulting Group

- Full reimbursement of sales tax/ value added tax paid on purchase of components in India
- Exemption from customs duty to be paid on imported raw materials/ components

As well as in China, these Integrators are both pressured by the Indian government into off-set generation in their country. When suppliers like Fokker AESP produce their parts in India, they can also be calculated as off-set generation.

Some disadvantages for India are:

- Far away from Fokker experts back in the Netherlands.
- Higher ramp up cost, coincides with being far away from Fokker in the Netherlands. Extra expenses are made to get Fokker experts to the site and supervise the production and train personnel.
- Geopolitical situation, the Indian government has bigger influence in how business is conducted. This can be an uncertainty.
- Logistics, China is not close to any of the bigger assembly factories of the aircraft. Higher cost for logistics can be expected.

India	Score	weighted score
Reachable over the road	4	6
Loading and offloading	3	3
Parking space	3	3
Availability of personnel	4	5
Building	3	3
Telecommunication facilities	3	2
Land/lease price	5	5
Expansion opportunities	5	6
Representative surroundings	3	2
Availability of public transportation	2	1
Total	35	37

Hoogeveen/ Duitsland

Fokker also has a production facility in Hoogeveen, on site there is no possibility for expansion, however there are some sites nearby and there is a location over the border with Germany.

These locations both have the same kind of advantages: close to the knowledge base of Fokker and highly skilled workforce. Also the Northern provinces give subsidies to companies that promote the employment of local workers.

Furthermore it can give Fokker a better control over the production because is it close to the mother company. This can also be an advantage for the qualification of Fokker as a supplier of Thermoplastic components to the Integrator because this way resource can be shared: laboratory and quality inspection.

Some disadvantages for Hoogeveen are:

- Higher cost for employees.
- Logistics, Hoogeveen is not close to any of the bigger assembly factories of the aircraft. Higher cost for logistics can be expected.

Hoogeveen	Score	weighted score
Reachable over the road	5	7
Loading and offloading	5	5
Parking space	3	3
Availability of personnel	5	7
Building	3	3
Telecommunication facilities	4	3
Land/lease price	3	3
Expansion opportunities	2	2
Representative surroundings	3	2
Availability of public transportation	4	2
Total	37	38

6.3 Financial comparison:

	China	per	India	per	USA (Al.)	per	Can.(Vac)	per	NL	per
Land	€ 20,00	m2	€ 25,50	m2	$141	m2	$186	m2	€ 15,00	m2
Building	€ 41,50	m2	€ 63,73	m2	$193	m2	$538	m2	€ 800,00	m2
Furnishing	€ 38,00	m2	€ 38,00	m2	$1.052	m2	$1.153	m2		m2
Labour:										
Skilled	€ 1,00	u	€ 1,83	u	$16,55	u	$19,91	u	€ 28,00	u
Unskilled	€ 0,65	u	€ 0,61	u	$11,35	u	$13,96	u		u
Manager	€ 3,50	u	€ 5,56	u	$33,33	u	$30,41	u		u
Power	€ 0,07	kWh	€ 0,09	kWh	$0,06	kWh	$0,06	kWh	€ 0,06	kWh
	€		€		US$		C$			

Wage escalation per year	5 a 10 %		10%		2 a 3 %		1,5 - 2 %		2 a 3 %	
			unskilled 4%							

skilled	€ 1,00	u	€ 1,83	u	$12,88	u	$15,50	u	€ 28,00	u

1€ :	
Usd	$ 1,285
Cad	$ 1,435

6.4 Conclusion

On the basis of all mentioned above the author believes that a choice for a production locations is not as clear cut as would be expected. At this moment the level of expertise in the Netherlands, US and Canada is higher than in India and China. However Fokker ELMO has demonstrated that it is possible to conduct business in a similar and efficient manner to western companies. It could take more time than in the Netherlands or US and Canada. But for a production unit that should produce for the upcoming twenty years or more, these short-term cost should not be weighted too heavily.

For the long-term cost the tax incentives in the Netherlands, US and Canada could pose less lucrative than the lower wages in China and India. Off-set generation also favors the Asian countries more than Western, although the real effect could be disputed.

It is the author's recommendation to conduct more research in the field of logistics cost for production in China and to explore possible collaboration with Fokker ELMO. If the research proves to be economical the author believes that China with its lower wages and high motivated workforce will prove the better production location for Fokker in the long run.

7 Conclusion and recommendations

As can be seen the calculation of the composite parts cost price holds many variables, some of more importance than others. It was chosen to use a pick and place machine, therefore the number of operators is kept small. Because of that choice the influence of wages on the overall cost price is lower than with manual picking and placing. It is unclear what effect changing to all manual production would be.

Also in looking for alternative production locations the way the composite parts are produced is of importance. At first glance one would think that in this day and age production can always be done cheaper in China or India. In a highly automated production process this seems not that clear. Therefore the first indication, when comparing the sites, does not favor one particular country.

Material costs are clearly the most important factor in the cost price of the composite part, especially the ASD4/PEKK material that accounts for one third of the total price. Further reductions in materials needed for the production of composite parts would drive down the prices and weight of the composite part. Both of these could result in an ever better business case.

The price of the base material of the composite part is paid in dollars. Because that represents roughly thirty three percent of the cost price, it could be that producing outside a dollar country is less of a problem than first expected. Fokker receives a lower price for the composite part, but it also pays less for the base material.

Recommendations

- The main ingredient for the composite parts, ASD4/PEKK, should not come from one single source. This should be done to become less dependent on one supplier, which leads to better pricing conditions.
- If Fokker wants a fair comparison on manual production over an automated process, which in low wage countries could be more economical, it should conduct a more detailed study in the cost of such a way of production. Keeping in mind that such a manner could result in lower quality and the subsequent need of more quality control.
- An alternative location, besides the Netherlands, should be conducted in a more thorough way before a clear decision can be made. It is recommended that in the light of outsourcing to a low wage country further study is needed. Also in combination with the current dollar vs. euro rates. Which, as stated above, could be less of a problem than previously thought. That study should also not be limited to the composite parts factory but should also incorporate the future strategy of Fokker for possible outsourcing to other countries.

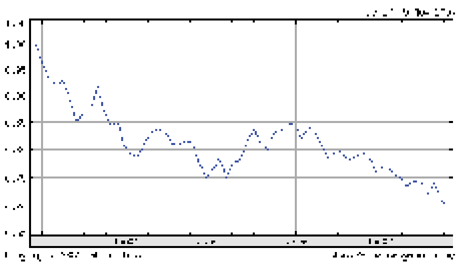
8 Reflection

Doing research for the graduation thesis at Stork Fokker AESP has been a good learning experience. Because of circumstances at the beginning of the project, it was not exactly clear what the end result of the thesis needed to be. Therefore the starting off point has been suboptimal, which resulted in a thesis which may not be as thorough as the author would have wanted. This said the author does feel that he has learned a lot in his period at the Stork Fokker AESP offices and would like to thank all people who have pointed him in the right direction.

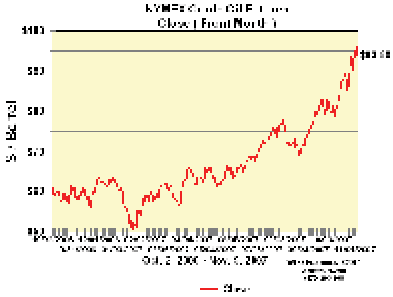
This has resulted in a cost price calculation and first hint at what production location could be useful for the production of composite parts. This cost price calculation in exact Euro's should be taken as an indication for a possible cost price of composite parts produced in a separate factory. The author feels that in order for Stork Fokker AESP to successfully start producing and selling composite parts. That a separate factory with a independent financial structure is paramount for it's success. Because the production of high volumes cannot be incorporated into the current facilities Stork Fokker AESP utilizes, size and technical limitations prohibits it at this moment. The independent financial structure ensures that existing overhead from Stork Fokker AESP will not be attributed to the program and the cost price can be competitive.

It is also shown that production in China is not automatically the best choice and that a further case study should be done into possible locations once it is decided that Stork Fokker Beams becomes a reality and more details for production are known.

This business case analysis is based upon a fixed dollar-euro exchange rate. The dollar market is very volatile as is the oil market. These factors and other escalation factors are a relatively big part of the cost price and could have positive as well as a negative effect. The site location decision could have a big influence on these factors, but were not examined enough to give a good indication at the moment.



Dollar / Euro exchange rate last 5 years



$ / barrel crude oil okt-07

References

Blocher et al., 2002 Blocher, E.J., Chen, K.H., and Lin, T.W. (2002). Cost management: A strategic emphasis, McGraw-Hill, Boston.

Case-based Cost Estimation: A Building Block for Product Cost Management and Design-for-X. Ph.D.Thesis A. Layer 2003.

Drury, 2000 Drury, C. (2000). Management and cost accounting, Thomson Learning, London.

C.J. Pen, 2002, Wat beweegt bedrijven, Grafisch Centrum, Rijks Universiteit Groningen.

Wayne L. Winston, 1994, Operations Research, third edition, Duxbury Press Indiana.

P. Goodwin, G. Wright, 1991, Decision Analysis for Management Judgement, Wiley, New York.

Aaron E. Cobet and Gregory A. Wilson, 2002, Comparing 50 years of labor productivity in U.S. and foreign manufacturing, Monthly Labor Review (Bureau of Labor Statistics, www.bls.gov)

Judith Banister, 2005, Manufacturing Employmen and comparison in China, U.S. Department of Labor, Bureau of Labor Statistics.

Dollar vs Euro exchange rate last five years:
http://finance.yahoo.com/q/bc?s=USDEUR=X&t=5y&l=on&z=m&q=l&c=

Oil price $ / barrel last month (Oktober 2007)
http://www.wtrg.com/daily/crudeoilprice.html

Appendix A: Input data

In this appendix a description is given of where all input data for the model came from. The source of the data is given and where this source can be contacted or consulted. This overview is given for future use/reference of the model. The data is given according to the model elements for ease of searching through the information.

Cost of activity

Production activity

- Production runtimes: F-ORC 04-028, Fabrieksconcept, issue 1 (PDF)
- Marketing forecast: 06-OF178-0028 - Program Forecasts - Lucas Clercx – 060517 (Excel file)
- Indexation of prices:
    - PPI index from Stork Fokker AESP (Excel file)
    - Bureau of Labor Statistics (www.bls.gov)

Quality control

- Percentages derived from interview with Jan Luijten (section 4.2.5).
- Figures from BVQi offer (Hard copy shown by Quality department SFA).

Materials

- 06-OF178-0031 - Stand Cytec Material prices - PEKK AS4D Tape – 060518 (confirmed by Pui Chang, procurement department Stork Fokker AESP Papendrecht) (E-mail).

IT cost

- 06-OF178-0022 - Altran - Fabrieksconcept vloerbalken final – 060516 (Excel file)

Capital goods

- 06-OF178-0034 - WP3 - Industrialisatie - Onderbouwing Estimates – 060519 (Excel file)
- Offer: Polypal Intraprofiel , d.d. 28-9-2007, offer number: O.6543-01/HM (hard copy)

Overhead cost

Cost of staff

- Interview with Erik Scheeren, established what would be a reasonable wage for Staff members.

Cost of miscellaneous goods and services

- Interview with Erik Scheeren
- Exploitatie nieuw concept investeringen (Excel file)

Non-recurring cost

Qualifying and Ramp-up

- Based up on figures provided by Marc Koetsier (Hard copy shown by mr. Koetsier). Combined with estimation of mr. Kortbeek on duration of ramp-up period. Subsequently figures were used that are established in activity cost, wages and materials.

Capacity and planning

Machine capacity and man hours

- Stork Fokker AESP year cycle for workable hours. (Excel file; copied into Capacity planning.xls)
- Calculated man hours needed in Cost of activity (Excel file: overview cost of activities.xls)

Appendix B: Datasheets

Appendix B holds the Excel datasheets that represent the model for the cost price calculations.

The following sheets are added:

1. Total overview yearly cost
2. Capacity and planning
3. Non recurring
4. Overhead cost

Total cost per s/s of composite part production:

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Building + Land	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52	€ 3.934,52
Operational cost	€ 6.183,49	€ 6.693,48	€ 7.055,46	€ 7.442,80	€ 7.857,64	€ 8.302,35	€ 8.779,46	€ 9.291,80	€ 9.842,42
Cost of Staff	€ 6.666,67	€ 6.866,67	€ 7.072,67	€ 7.284,85	€ 7.503,39	€ 7.728,49	€ 7.960,35	€ 8.199,16	€ 8.445,13
Overhead cost	**€ 16.784,68**	**€ 17.494,67**	**€ 18.062,65**	**€ 18.662,17**	**€ 19.295,56**	**€ 19.965,36**	**€ 20.674,34**	**€ 21.425,48**	**€ 22.222,08**
Qualifying cost	€ 6,74	€ 6,74	€ 6,74	€ 6,74	€ 6,74	€ 6,74	€ 6,74	€ 6,74	€ 6,74
Ramp-up cost	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64	€ 1.855,64
Non-recurring	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**	**€ 1.862,38**
Direct activity cost	€ 21.649,59	€ 22.299,08	€ 22.968,05	€ 23.657,10	€ 24.366,81	€ 25.097,81	€ 25.850,75	€ 26.626,27	€ 27.425,06
Capital cost	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08	€ 24.911,08
Material cost	€ 86.529,60	€ 88.692,84	€ 90.910,16	€ 93.182,91	€ 95.512,48	€ 97.900,29	€ 100.347,80	€ 102.856,50	€ 105.427,91
Recurring cost	**€ 133.090,27**	**€ 135.903,00**	**€ 138.789,29**	**€ 141.751,09**	**€ 144.790,37**	**€ 147.909,19**	**€ 151.109,63**	**€ 154.393,85**	**€ 157.764,05**
Finance	**€ 47.444,41**	**€ 15.171,87**	**€ 11.100,05**	**€ 7.238,40**	**€ 3.437,11**	**€ 1.425,76**	€ -	€ -	€ -
Total cost	**€ 199.181,73**	**€ 170.431,92**	**€ 169.814,37**	**€ 169.514,03**	**€ 169.385,42**	**€ 171.162,70**	**€ 173.646,35**	**€ 177.681,71**	**€ 181.848,50**

Total cost per part	**€ 3.758,15**	**€ 3.215,70**	**€ 3.204,04**	**€ 3.198,38**	**€ 3.195,95**	**€ 3.229,48**	**€ 3.276,35**	**€ 3.352,49**	**€ 3.431,10**

Capacity and planning:

Activities:		1 shift	2 shifts	3 shifts			
	Machine hours needed	Total of machines	Total of machines	Total of machines	Man hours needed	FTE	
Warehouse	-				176,67	0,10	1,00
A0*	-				599,84	0,35	1,00
A1	2907,32	2	1	1	2464,02	1,42	2,00
A2	2722,14	2	1	1	2722,135	1,57	2,00
A3	2320,18	2	1	1	2320,18	1,34	2,00
A4	-				2434,47	1,41	2,00
A5	3066,49	2	1	1	2639,29	1,53	2,00
A6	-				2327,374	1,35	2,00
A7	1725,78	1	1	1	1725,78	1,00	1,00
A8	2975,20	2	1	1	2975,20	1,72	2,00
A9	1732,33	2	1	1	1732,33	1,00	2,00
A10	-				959,7417	0,55	1,00
A11	-				791,7869	0,46	1,00
Storage	-				1199,68	0,69	1,00
Total					25068,48	14,49	22,00

**see 'Overview cost of activity.xls' for explanation on activities*

Production dat	s/s per year	s/s / month	s/s / week
	53	4,416667	1,10417
beams per ye	2809		
beams per m	234,0833333		
beams per w	58,52083333		

Workable hours per year for one factory employee:

Year cycle	days	hours
Calender days	**365**	**2920**
Weekends	105-	-840
Contract days	**260**	**2.080**
Holidays	5-	-40
Baseline:		
workable days	**255**	**2.040**
shorter working hours	13-	104-
vacation	25-	200-
planned days	**217**	**1.736**
overtime	-	-
ploegendnst corr.	-	-
sickness %	-4,5%	-4,5%
sick hours	0-	2-
short ommision (dentist appointments)	1-	4-
Aanw. - uren	**216**	**1.730**

The number of machinehours is determined by the available hours operators can work on them weekly:

	Available operators working (hours):		
	1 shift	**2 shifts**	**3 shifts**
yearly	1.730	3.460	5.191
monthly	144	288	433
weekly	33	67	100
daily	8	16	24

Non recurring:

If Stork Fokker Aerospace want to produce Thermoplastic Composite Parts for an Integrator they need to pass a material qualification process. Once passed Stork Fokker can produce any type of product from that specific kind of material. In 2006 also completed an qualification process for the Integrator. Cost for that project were used to establish a estimate for the Thermoplastic qualification process

Materials	€	25.000,00
Man hours	€	125.000,00
Total	€	150.000,00

These qualifying cost shall be written off over the first 420 s/s, produced in 8 years

Cost per s/s	€	357,14
Cost per part	€	6,74

Ramp-up cost:
Before production can start, it is necessary to test the whole production process. According to the experience from the past, this ramp up period will take an approximate six months. During this ramp up period the machines will be tested and the operators need to be trained.

Simpel calculations will show that when you start with no personnel and end up with the maximum needed personnel after six months. That on average you will have 50% of your total workforce on your payrole. It is therefore concluded that the ramp up period shall concist out of the following elements:

1) Wages for 50% of total workforce
2) Cost of needed materials
3) Cost of energy for approximately 6 months

Cost of land, building & machines starts when production becomes operational. Because these elements are already included in the calculations for production. For the ramp up to the first article inspection it is determined by Peter Kortbeek that 5 s/s or 265 parts are sufficient. This will determine the cost for materials needed.

Cost:

Wages	€	301.221,98
Materials	€	432.647,98
Energy	€	45.500,00
Total	€	779.369,96

These ramp up cost shall be written off over the first 420 s/s, produced in 8 years

Cost per s/s	€	1.855,64
Cost per part	€	35,01

Overhead cost:

Extra operational cost, based on calculations done by L. Sørensen

their factory concept was similar in size and had about the same amount of personnel

blank spots are to be determined in the future

		Escalation factor	2008	2009	2010	2011	2012	2013	2014	2015	2016
wervingskosten	€ -	103,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
verhuiskosten	€	103,00%	€	€	€	€	€	€	€	€	€
kosten woon-werk - eigen personeel	€ 10.800,00	103,00%	€ 10.800,00	€ 11.124,00	€ 11.457,72	€ 11.801,45	€ 12.155,50	€ 12.520,16	€ 12.895,76	€ 13.282,64	€ 13.681,12
kosten (koffie)automaten	€ 1.000,00	103,00%	€ 1.000,00	€ 1.030,00	€ 1.060,90	€ 1.092,73	€ 1.125,51	€ 1.159,27	€ 1.194,05	€ 1.229,87	€ 1.266,77
opleidingen	€ 1.000,00	103,00%	€ 1.000,00	€ 1.030,00	€ 1.060,90	€ 1.092,73	€ 1.125,51	€ 1.159,27	€ 1.194,05	€ 1.229,87	€ 1.266,77
geneeskundige med	€ 500,00	103,00%	€ 500,00	€ 515,00	€ 530,45	€ 546,36	€ 562,75	€ 579,64	€ 597,03	€ 614,94	€ 633,38
werkkleding	€ 1.000,00	103,00%	€ 1.000,00	€ 1.030,00	€ 1.060,90	€ 1.092,73	€ 1.125,51	€ 1.159,27	€ 1.194,05	€ 1.229,87	€ 1.266,77
congressen en seminars	€ 1.000,00	103,00%	€ 1.000,00	€ 1.030,00	€ 1.060,90	€ 1.092,73	€ 1.125,51	€ 1.159,27	€ 1.194,05	€ 1.229,87	€ 1.266,77
Personeelskosten Totaal	**€ 15.300,00**	**103,00%**	**€ 15.300,00**	**€ 15.759,00**	**€ 16.231,77**	**€ 16.718,72**	**€ 17.220,28**	**€ 17.736,89**	**€ 18.269,00**	**€ 18.817,07**	**€ 19.381,58**
ingeleend indirect personeel	€ 25.000,00	103,00%	€ 25.000,00	€ 25.750,00	€ 26.522,50	€ 27.318,18	€ 28.137,72	€ 28.981,85	€ 29.851,31	€ 30.746,85	€ 31.669,25
ingeleend direct personeel	€ -	103,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Ingeleend personeel Totaal	**€ 25.000,00**	**103,00%**	**€ 25.000,00**	**€ 25.750,00**	**€ 26.522,50**	**€ 27.318,18**	**€ 28.137,72**	**€ 28.981,85**	**€ 29.851,31**	**€ 30.746,85**	**€ 31.669,25**
kantoorbenodigdheden	€ 1.500,00	102,50%	€ 1.500,00	€ 1.537,50	€ 1.575,94	€ 1.615,34	€ 1.655,72	€ 1.697,11	€ 1.739,54	€ 1.783,03	€ 1.827,60
vaste telefoonkosten	€ 3.000,00	102,50%	€ 3.000,00	€ 3.075,00	€ 3.151,88	€ 3.230,67	€ 3.311,44	€ 3.394,22	€ 3.479,08	€ 3.566,06	€ 3.655,21
portokosten	€ 1.000,00	102,50%	€ 1.000,00	€ 1.025,00	€ 1.050,63	€ 1.076,89	€ 1.103,81	€ 1.131,41	€ 1.159,69	€ 1.188,69	€ 1.218,40
kosten inhoopoders	€ -	102,50%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
mobiele telefoonkosten	€ 5.000,00	102,50%	€ 5.000,00	€ 5.125,00	€ 5.253,13	€ 5.384,45	€ 5.519,06	€ 5.657,04	€ 5.798,47	€ 5.943,43	€ 6.092,01
kosten dataliinen	€ 500,00	102,50%	€ 500,00	€ 512,50	€ 525,31	€ 538,45	€ 551,91	€ 565,70	€ 579,85	€ 594,34	€ 609,20
abonnementen en donaties	€ 1.500,00	102,50%	€ 1.500,00	€ 1.537,50	€ 1.575,94	€ 1.615,34	€ 1.655,72	€ 1.697,11	€ 1.739,54	€ 1.783,03	€ 1.827,60
octrooi- en licentiekosten	€ -	102,50%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
accountants-kosten	€ 10.000,00	102,50%	€ 10.000,00	€ 10.250,00	€ 10.506,25	€ 10.768,91	€ 11.038,13	€ 11.314,08	€ 11.596,93	€ 11.886,85	€ 12.184,03
Bureaukosten Totaal	**€ 22.500,00**	**102,50%**	**€ 22.500,00**	**€ 23.062,50**	**€ 23.639,06**	**€ 24.230,04**	**€ 24.835,79**	**€ 25.456,68**	**€ 26.093,10**	**€ 26.745,43**	**€ 27.414,07**
relatiegeschenken	€ 1.000,00	102,50%	€ 1.000,00	€ 1.025,00	€ 1.050,63	€ 1.076,89	€ 1.103,81	€ 1.131,41	€ 1.159,69	€ 1.188,69	€ 1.218,40
reclamekosten	€ 1.000,00	102,50%	€ 1.000,00	€ 1.025,00	€ 1.050,63	€ 1.076,89	€ 1.103,81	€ 1.131,41	€ 1.159,69	€ 1.188,69	€ 1.218,40
tentoonstellingen	€ -	102,50%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
representatiekosten	€ 5.000,00	102,50%	€ 5.000,00	€ 5.125,00	€ 5.253,13	€ 5.384,45	€ 5.519,06	€ 5.657,04	€ 5.798,47	€ 5.943,43	€ 6.092,01
Verkoopkosten Totaal	**€ 7.000,00**	**102,50%**	**€ 7.000,00**	**€ 7.175,00**	**€ 7.354,38**	**€ 7.538,23**	**€ 7.726,69**	**€ 7.919,86**	**€ 8.117,85**	**€ 8.320,80**	**€ 8.528,82**
electriciteit	€ 91.000,00	110,00%	€ 91.000,00	€ 100.100,00	€ 110.110,00	€ 121.121,00	€ 133.233,10	€ 146.556,41	€ 161.212,05	€ 177.333,25	€ 195.066,58
gas	€ -	110,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
water	€ -	110,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
servicekosten	€ -	110,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -

Nuts voorzieningen Totaal	**€ 91.000,00**	**110,00%**	**€ 91.000,00**	**€ 100.100,00**	**€ 110.110,00**	**€ 121.121,00**	**€ 133.233,10**	**€ 146.556,41**	**€ 161.212,05**	**€ 177.333,26**	**€ 195.066,58**
afvalverwerking	€	104,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
transportkosten	€ 78.750,00	104,00%	€ 78.750,00	€ 81.900,00	€ 85.176,00	€ 88.583,04	€ 92.126,36	€ 95.811,42	€ 99.643,87	€ 103.629,63	€ 107.774,81
aanvoer transportkosten	€ 78.750,00	104,00%	€ 78.750,00	€ 81.900,00	€ 85.176,00	€ 88.583,04	€ 92.126,36	€ 95.811,42	€ 99.643,87	€ 103.629,63	€ 107.774,81
typerechten	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
div. hulpstoffen	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
emballage	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
materiaal verbruik (controle)	€	104,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
additionele ordercosten	€	104,00%	€	€	€	€	€	€	€	€	€
diensten van derden	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
interne verhuizingen	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
onderzoeken ad omgeving	€ -	104,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
overige bedrijfskosten	€	104,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Bedrijfskosten Totaal	**€ 157.500,00**	**104,00%**	**€ 157.500,00**	**€ 163.800,00**	**€ 170.352,00**	**€ 177.166,08**	**€ 184.252,72**	**€ 191.622,83**	**€ 199.287,75**	**€ 207.259,26**	**€ 215.549,63**
machines & toebehoren	€ 3.333,00	102,50%	€ 3.333,00	€ 3.416,33	€ 3.501,73	€ 3.589,28	€ 3.679,01	€ 3.770,98	€ 3.865,26	€ 3.961,89	€ 4.060,94
handgereedschap	€ 500,00	102,50%	€ 500,00	€ 512,50	€ 525,31	€ 538,45	€ 551,91	€ 565,70	€ 579,85	€ 594,34	€ 609,20
meetgereedschap	€ 1.000,00	102,50%	€ 1.000,00	€ 1.025,00	€ 1.050,63	€ 1.076,89	€ 1.103,81	€ 1.131,41	€ 1.159,69	€ 1.188,69	€ 1.218,40
werkplaatsuitrusting	€ 1.500,00	102,50%	€ 1.500,00	€ 1.537,50	€ 1.575,94	€ 1.615,34	€ 1.655,72	€ 1.697,11	€ 1.739,54	€ 1.783,03	€ 1.827,60
Kleine aanschaffingen Totaal	**€ 6.333,00**	**102,50%**	**€ 6.333,00**	**€ 6.491,33**	**€ 6.653,61**	**€ 6.819,95**	**€ 6.990,45**	**€ 7.165,21**	**€ 7.344,34**	**€ 7.527,95**	**€ 7.716,15**
schoonmaak werkzaamheden	€ 4.000,00	103,00%	€ 4.000,00	€ 4.120,00	€ 4.243,60	€ 4.370,91	€ 4.502,04	€ 4.637,10	€ 4.776,21	€ 4.919,50	€ 5.067,08
catering	€ 5.000,00	103,00%	€ 5.000,00	€ 5.150,00	€ 5.304,50	€ 5.463,64	€ 5.627,54	€ 5.796,37	€ 5.970,26	€ 6.149,37	€ 6.333,85
receptie	€ -	103,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
beveiliging	€ -	103,00%	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
tuinonderhoud	€ -	103,00%	€	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Diensten van derden Totaal	**€ 9.000,00**	**103,00%**	**€ 9.000,00**	**€ 9.270,00**	**€ 9.548,10**	**€ 9.834,54**	**€ 10.129,58**	**€ 10.433,47**	**€ 10.746,47**	**€ 11.068,86**	**€ 11.400,93**
Functionele kosten - Totaal	**€ 321.633,00**		**€ 321.633,00**	**€ 351.407,83**	**€ 370.411,42**	**€ 390.746,74**	**€ 412.526,33**	**€ 435.873,20**	**€ 460.921,87**	**€ 487.819,47**	**€ 516.727,00**

Operational cost are yearly, so these can be attributed to the price of the floorboarding on a basis of yearly production rates

Cost per sys	€ 6.183,45	€ 6.183,49	€ 6.693,48	€ 7.055,45	€ 7.442,80	€ 7.857,67	€ 8.302,35	€ 8.779,46	€ 9.291,80	€ 9.872,12
Cost per part	€ 118,07	€ 118,07	€ 120,28	€ 133,12	€ 140,43	€ 148,20	€ 158,05	€ 165,05	€ 175,52	€ 185,71

Cost for building & land:

	Landprice	m2	cost	Building cost	m2	cost	Total	Cost s/s	part
Netherlands	€ 15.00	3.500	€ 52.500.00	€ 800.00	2000	€ 1.600.000.00	€ 1.652.500.00	€ 3.934.52	€ 74.24
US	€ 112.60	3.500	€ 394.114,98	€ 154,28	2000	€ 308.555.49	€ 702.670.47	€ 1.673.02	€ 31.57
Canada	€ 122.06	3.500	€ 427.197,83	€ 353.06	2000	€ 706.112.50	€ 1.133.310.33	€ 2.698.36	€ 50,91
China	€ 20.00	3.500	€ 70.000.00	€ 41.50	2000	€ 83.000,00	€ 153.000.00	€ 364.29	€ 6.87
India	€ 25,50	3.500	€ 89.250,00	€ 63,73	2000	€ 127.460,00	€ 216.710,00	€ 515,98	€ 9,74

Function	Salary	Escalation factor	2008	2009	2010	2011	2012	2013	2014	2015	2016
General manager	€ 90.000,00	103%	€ 90.000,00	€ 92.700,00	€ 95.481,00	€ 98.345,43	€ 101.295,79	€ 104.334,67	€ 107.464,71	€ 110.688,65	€ 114.009,31
Quality and Environmental Assurance officer	€ 60.000,00	103%	€ 60.000,00	€ 61.800,00	€ 63.654,00	€ 65.563,62	€ 67.530,53	€ 69.556,44	€ 71.643,14	€ 73.792,43	€ 76.006,20
Work planning & purchaser + HRM	€ 55.000,00	103%	€ 55.000,00	€ 56.650,00	€ 58.349,50	€ 60.099,99	€ 61.902,98	€ 63.760,07	€ 65.672,88	€ 67.643,06	€ 69.672,35
Controller & IT manager	€ 55.000,00	103%	€ 55.000,00	€ 56.650,00	€ 58.349,50	€ 60.099,99	€ 61.902,98	€ 63.760,07	€ 65.672,88	€ 67.643,06	€ 69.672,35
Floor manager + innovation productions process	€ 55.000,00	103%	€ 55.000,00	€ 56.650,00	€ 58.349,50	€ 60.099,99	€ 61.902,98	€ 63.760,07	€ 65.672,88	€ 67.643,06	€ 69.672,35
Secretary	€ 35.000,00	103%	€ 35.000,00	€ 36.050,00	€ 37.131,50	€ 38.245,45	€ 39.392,81	€ 40.574,59	€ 41.791,83	€ 43.045,59	€ 44.336,95
Total	€ 350.000,00		€ 350.000,00	€ 360.500,00	€ 371.315,00	€ 382.454,45	€ 393.928,08	€ 405.745,93	€ 417.918,30	€ 430.455,85	€ 443.369,53

Staff cost are yearly, so these can be attributed to the price of the composite parts on a basis of yearly production rates

			2008	2009	2010	2011	2012	2013	2014	2015	2016
Cost per s/s	€ 6.666,67		€ 6.666,67	€ 6.866,67	€ 7.072,67	€ 7.284,85	€ 7.503,39	€ 7.728,49	€ 7.960,35	€ 8.199,16	€ 8.445,13
Cost per part	€ 125,79		€ 125,79	€ 129,56	€ 133,45	€ 137,46	€ 141,57	€ 145,82	€ 150,20	€ 154,70	€ 159,34