Cost & Manufacturing Event

Cost Explanation file

This document details the Cost Model of the Ecurie Piston Sport Auto (EPSA) team. It aims at clarifying the construction of the CBOM presented at the FSUK Cost Event. To do so, it explains the costing method used which means, the assumptions and calculations done.

Context and hypothesis

Company description

The simulated company is sized to be a prototyping center, able to manufacture and assemble most of the components for the frame and the body of a Formula Student car. Therefore, it will not have in-house specific expensive machineries used for a unique or only few parts of the Frame & Body System. For instance, 3 axis CNC Mills or CNC lathes will not be part of the investments. Nonetheless they will be considered as outsources expenses.

Of course, the company, its machinery and manpower, will not be dedicated all year long to build only one or few Formula Student frames. Thus, we assume that the remaining time, when the equipment is not allocated for the FS project, is used for other customers, to build other car frames, small/medium series of components, prototypes, ...

Therefore, the company is composed with :

- **Administrative Division:** This division gathers the services that run the business. As it is a really small company that is simulated, we suppose it is held by only one person that has the salary equivalent to the salary of a Technician in France.
- **Operational Division:** This division is directly related to the lifecycle of the products.
    - Research & Development
    - Manufacturing & Assembly Service

Hypothesis

In order to provide a better simulation of the expenses, the model is based on the following assumptions:

The general organisation:

- The company is French. That is why it follows the french labour laws.
- It is running 35 hours a week, 46 weeks per year.

The effectiveness of the company:

- During the opening time, machines are considered to have an Overall Production Effectiveness (OPE) reflecting downtime, preventive maintenance, lack of orders,...
- Manpower of the shop floor are considered to work 95% of the time

The workforce:

- Operators are considered to be skilled machinists. Thus, he could manage a CNC machine and program simple parts.
- D'autres hypothèses sur les autres postes

The expenses:

- Items are attributed a linear depreciation between 3 to 10 years regarding equipment type.
- Building expense (rent, security, insurance) are not included
- VAT for the purchased and sold products are not included
- Governmental taxes are not included
- Margin applied on sell products are not included

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Cost model division

The cost model has been divided in the following parts:

Overhead costs : This section includes all the expenses needed to run the company:

- Furniture
- Office consumables…

Manufacturing cost : This section includes all the expenses needed to the production:

- Manpower
- Machining cost
- Assembly cost

Bought parts :

- Materials
- Fasteners

Overall information

First, we need to introduce some data that will be necessary in many costs calculations:

General Data			
Category	**Description**	**Value**	**Explanation**
Administrative Workforce	Sales/Administratives	50 414,81 €	Cost per year
Operative Workforce	Welder	43 935,00 €	Cost per year
	Operator	36 901,56 €	
	Technician	50 414,81 €	
	Engineer	59 295,58 €	
Time	Hours/week	35	French labour law impose this minimal rate to earn the min wage
	Week/year	45	Total of week per year without, holiday, bank holiday…
	Base OPE	80%	It is a prototyping company, soit does not run nonstop. 6%: maintenance and cleaning of shop floor
	People efficiency	95%	People cannot be working nonstop.
Energies	Electricity Subscription	3 449,78 €	
	Electricity Rate /kWh	0,09 €	
	Water rate/m3	3,32 €	
Others	Euro to Dollar Rate	1,2076	The 13/05/2021 rate
	VAT	20%	French VAT

Moreover, the company owns several shop floor workstations :

- A laser tube cutting machine
- 2 CNC mills: one for wood milling, the other for metal milling
- A CNC laser table
- A sheet metal bender
- An assembly station
- A welding station
- Machines to produce body (air compressor, spray workstation, woodworkstation…)
- A conventional machining area with a mill and a lathe

- A metrological lab
- FAO workstations

Sources

The cost is built on reliable sources to ensure the quality of the model. Machine prices came from providers such as Baileigh industrial, Haas machining,... Informatic equipment comes from HP. Metrology equipment are sourced from Mitutoyo, Starrett and Orexad... This is also applicable to fasteners and materials. When we needed equipment and were not able to find a reliable source, we asked prices of these components to our partners and providers.

Overhead cost

The overhead cost includes all the equipment and expenses needed to run the company.
Therefore, it takes into account office furniture, items used for different workstations, administrative wages, manpower time used for maintenance purposes, energy cost for small machinery and offices, ...
This overhead is then distributed equally between each workstation production in order to annually compensate the overhead expense of the company.

Overheads cost				
Category	**Description**	**Cost (incl tax)**	**Depreciation time (year)**	**Cost/year**
Manwork	Administrative/sales people	50 414,81 €	1	50 414,81 €
	50% engineer	29 647,79 €	1	29 647,79 €
	5% of manwork OPE on shopfloor	9 538,36 €	1	9 538,36 €
	Maintenance manwork	4 990,86 €	1	4 990,86 €
Energy Consumption	Electricity subscription	3 449,78 €	1	3 449,78 €
	Electricity consumption for office and small components (avg 16kW)	2 373,05 €	1	2 373,05 €
	Water (6om^3)	199,44 €	1	199,44 €
IT&Office	Softwares	911,12 €	1	911,12 €
	Printer	269,90 €	3	89,97 €
	Printer consumable (4000 A4pages B&W, 1600 A4pages Colors, A4x5000, A3x2000)	392,57 €	1	392,57 €
	Computers and accessories	14 911,80 €	3	4 970,60 €
	Internet/phone access	1 468,80 €	1	1 468,80 €
	Phone/mobile phone	1 598,40 €	3	532,80 €
	Office furniture	200,00 €	1	200,00 €
	Worktable & office storage	16 747,20 €	10	1 674,72 €
Manufacturing	Manufacturing tools (Band Saw, Drill, Metal bender, belt and disc grinder, Vise, forklift...)	22 917,65 €	10	2 291,76 €
	Consumables (saw blades, drill bits, taps, abrasives, ...)	3 000,00 €	1	3 000,00 €
	Roller Cabinet (3 V3 and 3 V5)	10 266,00 €	10	1 026,60 €
	Other specific tools (scribing tool, eletrical pliers, simple measuring tools, ...)	5 133,00 €	10	513,30 €
	Shopfloor organisation equipement (locker, shelves, drawer...)	33 591,00 €	10	3 359,10 €
	Industrial Hoovers	2 580,00 €	10	258,00 €
Metrology	Micrometres	2 416,67 €	10	241,67 €
	Inside micrometers	1 915,00 €	10	191,50 €
	Indicators	998,33 €	10	99,83 €
	Profile projector	48 334,81 €	10	4 833,48 €
	Reference Block	3 343,33 €	10	334,33 €
	Depth gauges	513,33 €	10	51,33 €
	Measurement column	5 390,00 €	10	539,00 €

Overhead Summary		
Fixed Cost	Sum of fixed cost/year (+5% extra equipment integrated)	133 974,31 €
	Fixed cost/hour to charge on operation (machine/station/programing/metrology)	16,29 €
Manpower cost	Operator cost/hour	23,38 €
	Welder cost/hour	27,83 €
	Technician cost/hour	31,94 €
	Engineer cost/hour	37,56 €

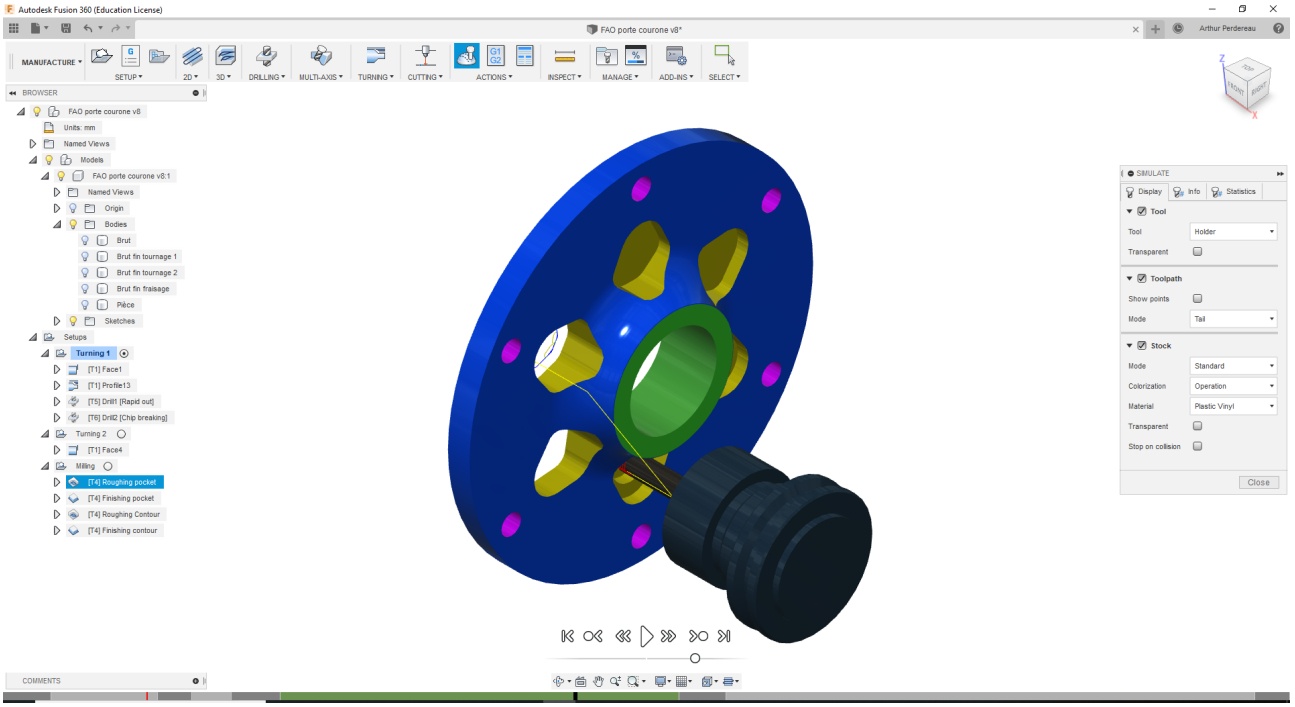
Manufacturing cost

For each equipment, a fixed cost is built around machine, tooling, fixture prices and maintenance cost dedicated to the workstation. It is depreciated as the overhead is. Then is added variable cost like electricity cutting fluid, filler and tools. A ratio is determined to link a machining data (volume, length) to execution time. Finally, it is possible to associate a cost on each operation.

Milling and turning

Turning was quite particular. Indeed as there are really few parts to turn in the system Frame&Body that we studied, we considered that the company owned a conventional lathe and its price was added to the fixed cost of the overall company. This is why, when it comes to turning, only the fixed costs and the cost of manpower are considered.

For metal milling, a machine has been selected from Haas catalogue to fulfil most of the production need for the FSAE prototype.A Y axis lathe with live tooling has been preferred to a classic CNC lathe as it allows more versatile machining like sprocket machining and reduce the number of setups. The wood milling machine was chosen thanks to the partner that helps us to do the Bodywork. The company expects to keep its equipment in a proper condition. Therefore, 5 min of operator preventive maintenance (OPM) is included for each job.
The removal rate and programming time has been determined through a CAM analysis of one of our parts with Fusion 360. It includes machine non-cutting time in the estimation of volume removed per minute.



Programming and metrology operations are added separately to the process in order to show the allocation in the part cost. It is also indexed on volume removed.
The machine is considered to be managed by an operator. During a first part run in the machine, the operator ensures the program does not have any issue. Coefficients are used for multiple parts as the programming is not needed anymore, and the program is validated through the first run.
The programming of the part could be allocated to an operator, a technician or an engineer regarding part complexity. In this case, the metrology of the part is allocated to the same employee.
For conventional machining, the measurements are included in the machining process.

Manufacturing cost: Machinery performances	
Operating performances of the Machine	**Spec**
Milling	
Power consumption (kW)	22,40
OPE	80%
OPM per job (Cleaning in min)	5
Removal rate (for Aluminium) (min/mm^3)	1,00E-04
Programming time and supply order (min/ mm^3) (50% of machining time)	5,00E-05
Measuring and deflash time (min/ mm^3) (40% of machining time)	4,00E-05
Setup time per job (fixture and tools) (min)	20

Conventionnal machining	
Power consumption (kW)	6
OPE	44%
OPM per job (Cleaning in min)	5
Removal rate (for aluminium) (include measuring) (min/mm^3)	3,00E-04
Setup time (fixture and tools) (min)	10

Manufacturing cost : Equipement Costs					
Description	**Variable**	**Way of costing**	**Cost**	**Depreciation time (year)**	**Cost/year**
Milling					
3 Axis CNC Mill Direct	No		95 994,00 €	10	9 599,40 €
Milling tool holders	No		4 800,00 €	5	800,00 €
Fixtures	No		2 500,00 €	5	500,00 €
Maintenance	No	5 % of initial cost each year	4 799,70 €	1	4 799,70 €
Cutting fluid	No	200L/year	2 116,00 €	1	2 116,00 €
Electricity	Yes	€/hour	1,68 €		
Cutting tools	Yes	€/hour	20,00 €		

Conventionnal					
Conventionnal milling machine	No		18 000,00 €	10	1 800,00 €
Conventionnal turning machine	No		12 000,00 €	10	1 200,00 €
Tool holders and fixtures	No		28 073,50 €	5	5 614,70 €
Maintenance	No	3 % of initial cost /year	900,00 €	1	900,00 €
Electricity	Yes	€/hour	0,25 €		
Cutting tools	Yes	€/hour	10,00 €		

Laser cutting

Laser cutting removal rate has been chosen from the manufacturer spec sheet of the laser cutter.
As this kind of machine is really efficient, it is difficult to index a programming time on the cut length. Therefore, we assume a constant programming time of 2 min per part. It is also applicable for measuring operations that consist of measuring basic part dimensions like holes diameter.
The setup time is related to a full metal sheet with coefficient as it is more realistic.
For 3D laser cutting, all the performances were discussed with the partner that welds the frame tubes with us. Especially for the programming and operation times.

Manufacturing cost: Machinery performances	
Operating performances of the Machine	**Spec**
2D Laser Cutting	
Power consumption (kW)	7,5
OPE	70%
OPM per job (Cleaning in min)	5
Removal rate (for steel) (min/mm²)	1,37E-04
Programmation time (min)	2
Measuring time (min)	1
Cost of Oxygen (€/mm²)	0,0000334 €
Setup time (min)	8

3D Laser Cutting	
Power consumption (kW)	6
OPE	80%
OPM per job (Cleaning in min)	5
Programmation time and supply order (min/tube)	10
Time of operation per tube (s/tube) if raw < 6m (setup + cutting)	613
Time of operation per tube (s/tube) if raw > 6m (setup + cutting)	373

Manufacturing cost : Equipment Costs					
Description	**Variable**	**Way of costing**	**Cost**	**Depreciation time (year)**	**Cost/year**
2D Laser Cutting					
2D Laser cut	No		120 726,40 €	10	12 072,64 €
Maintenance	No	5 % of initial cost each year	6 036,32 €	1	6 036,32 €
Electricity	Yes	Cost/hour	0,49 €		

3D Laser Cutting					
Laser cutter tube fiber	No		1 000 000,00 €	7	142 857,14 €
Maintenance	No	estimated by our partner	10 000,00 €	1	10 000,00 €
Consumables	No		1 500,00 €	1	1 500,00 €
Water draining	No		1 500,00 €	1	1 500,00 €
Electricity	Yes	€/hour	0,45 €		

Welding

The welding rate was estimated thanks to a precise timing of the different steps necessary to weld the exhaust system and all the aluminium parts that the team used to do before when it was doing thermic combustion cars. The welding rate includes the time of putting in position the parts to be welded, the time of tack welding, the time of welding of course but also the time of metrology.
All the cost of the welding manufacturing machines were found at professional suppliers (Orexad, promeca).

Manufacturing cost: Machinery performances	
Operating performances of the Machine	**Spec**
Welding	
Power consumption (kW)	4,96
OPE	80%
OPM per job (Cleaning in min)	2
Welding speed (min/m)	1,40E+02
Setup time (min)	2

Manufacturing cost : Equipment Costs					
Description	**Variable**	**Way of costing**	**Cost**	**Depreciation time (year)**	**Cost/year**
Welding					
TIG Welder & Chiller	No		7 129,69 €	10	712,97 €
Fume extractor	No		3 546,58 €	10	354,66 €
Welding table	No		5 220,00 €	10	522,00 €
Specific welding tools	No		1 815,60 €	5	363,12 €
EPI (Welmet, gloves,...)	No		298,12 €	5	59,62 €
Maintenance	No	5 % of initial cost each year	533,81 €	1	533,81 €
Electricity	Yes	€/hour	0,47 €		
Filler (35CrMo4)	Yes	€/m	4,89 €		
Gaz	Yes	€/m	14,35 €		

Processes cost

Thanks to the cost model, a cost / hour for each employee, fixing cost included, was determined.

Manpower	Hourly Wage (€/h/employee)
Operator - Grade 4	23,38 €
Operator - Grade 9 Welder	27,83 €
Technician - Grade 23	31,94 €
Engineer - Grade II	37,56 €

In order to determine the rest of the process's cost, the different time for each process were methodically timed during previous vehicle integration. All the details of the process's cost can be found in the summary.

Fasteners cost

All the fasteners cost used are the one of the team suppliers (TDI visserie, k-Nut, Oreca, ...). The price indicated by the unit is always the one with taxes (TTC). The one calculated in the column Price when a quantity is entered is without taxes (HT). All the details of the fasteners cost can be found on the summary.

Materials cost

Concerning the materials cost, prices between suppliers have been compared to obtain a right price. Concerning the raw materials, a study was realised to see the influence of the dimensions on the price by mm^3. As the differences of price observed for the dimensions of materials used for Engine & Powertrain were very low, it was decided to keep a unique price (€/mm^3) for each material. Same conclusions for the metal sheet materials.

Materials	Steel S235	Steel S355	Steel S700	Steel 25CD4	Alu 2017A	Alu 7075 T6
Chemical composition	S235	S355	S700	24CrMo 5	AlCu4MgSi	AlZn6MgCu
Tensile Strength: Yield (MPa)	235	355	700	350	120	480

All the details of the materials cost can be found on the summary.

Summary

Manufacturing Summary			
Comments		**Costs**	
Milling			
Prices calculated for aluminium		Cost of the Machinery	
Corrective factor if material = steel	250%	Yearly fixed cost of machine	17815
Corrective factor if material = Delrin	50%	Fixed cost of machine / hour	3,04E+01
		Total cost of machine/hour (+ variable costs)	**5,21E+01**
		Cost of the Process	
x = volume (mm^3) removed from the piece c1 = x* cost of the machining part c2 =x * (cost of programming + measuring) c3 = fixed cost of setup + cleaning Cost of the piece = c1 +c2+c3		Cost of machining part (€/mm^3)	1,26E-04
		Manpower part of machining cost	31%
		Other costs	
		Cost of programing part Operator (€/mm^3)	3,31E-05
		Cost of programing part Technician(€/mm^3)	4,61E-05
		Cost of programing part Engineer (€/mm^3)	5,45E-05
		Cost of measuring part Operator (€/mm^3)	2,64E-05
		Cost of measuring part Technician(€/mm^3)	3,69E-05
		Cost of measuring part Engineer (€/mm^3)	4,36E-05
		Cost of Setup + cleaning	2,24E+01
3D Laser Cutting			
Prices calculated for steel		Cost of the Machinery	
Corrective factor if material = aluminium	50%	Yearly fixed cost of machine	155 857,14 €
Corrective factor if material = Delrin	25%	Fixed cost of machine / hour	1,40E+02
		Total cost of machine/hour (+ variable costs)	**1,40E+02**
		Cost of the Process	
x =nb of tubes c1 = x* cost of the machining part c2 =x * cost of programming c3 = fixed cost of cleaning Cost of the piece = c1 +c2+c3		Cost of machining part if raw < 6m (€/tube)	2,78E+01
		Cost of machining part if raw > 6m (€/tube)	1,69E+01
		Manpower part of machining cost (average)	14%
		Other costs	
		Cost of programing part Operator (€/tube)	6,61E+00
		Cost of programing part Technician(€/tube)	8,04E+00
		Cost of programing part Engineer (€/tube)	8,98E+00
		Cost Cleaning (setup included in operation time)	1,36E+01
2D Laser Cutting			
Prices calculated for steel		Cost of the Machinery	
Corrective factor if material = aluminium	42%	Yearly fixed cost of machine	18 108,96 €
		Fixed cost of machine / hour	3,27E+01
		Total cost of machine/hour (+ variable costs)	**3,32E+01**

x =nb of mm to cut y = nb of mm² to cut = x*thickeness c1 = y* cost of the machining part c2 =y * cost of oxygen c3 = y* prog and measuring part c4 = fixed cost of cleaning **Cost of the piece** **= c1 +c2 c3+ c4**	**Cost of the Process**	
	Cost of machining part (€/mm)	1,29E-04
	Cost of oxygen (€/mm)	0,0000334 €
	Manpower part of machining cost (average)	41%
	Other costs	
	Cost of programing and measuring part Operator (€)	1,32E+00
	Cost of programing and measuring part Technician(€)	1,61E+00
	Cost of programing and measuring part Engineer (€)	1,80E+00
	Cost Cleaning (setup included in operation time)	12,15 €
Tube Welding		
c1 = lenght to weld * welding speed* cost of the machine c2 =lenght to weld * cost of filler gas and metal c3 = hours of welder work * welder hourly salary * nb of welders **C = c1+c2 + c3**	**Yearly fixed cost of machine**	2 546,18 €
	Fixed cost of machine / hour	1,83E+01
	Total cost of machine/hour (+ variable costs)	1,88E+01
	Cost of the Process	
	Cost of filler metal (€/m)	4,89 €
	Cost of filler gas (€/m)	14,35 €
	Total Manpower cost for welding the frame (discussion with our partner)	6 680,01 €
Bracket Welding		
x =nb of m to weld/ t1 = time of wood coding design / t2 = time of wood coding manufacturing / t3 = time for positioning the bracket c1 = x* cost of the machining part c2 =x * cost of material c3 = fixed cost of cleaning c4 = t1*cost of engineer + t2 * cost of technician+ t3 * cost of welder **Cost of the piece** **= c1 +c2 c3+ c4**	**Yearly fixed cost of machine**	2 546,18 €
	Fixed cost of machine / hour	1,83E+01
	Total cost of machine/hour (+ variable costs)	1,88E+01
	Cost of the Process	
	Cost of filler metal and gas (€/m)	19,25 €
	Cost of machining part (€/m)	174,23 €
	Manpower part of machining cost (average)	75%
	Other costs for wood coding parts	
	Cost of wood coding conception by an Engineer (€/h of conception)	37,56 €
	Cost of wood coding manufacturing by a Technician (€/min)	0,53 €
	Cost of positioning the brackets by Welder (€/min)	0,46 €
Conventionnal Machining		
x = volume (mm^3) removed from the piece c1 = x* cost of the machining part c2 = fixed cost of setup + cleaning **Cost of the piece = c1 +c2**	**Yearly fixed cost of machine**	9 514,70 €
	Fixed cost of machine / hour	3,00E+01
	Cost of machine/hour running	4,02E+01
	Cost of the Process	
	Cost of machining part (€/mm^3)	1,98E-04
	Cost of Setup + cleaning	8,89E+00
Body Manufacturing		
	Yearly fixed cost of machine	52 088,34 €

c1 = cost of manpower & machining
c2 =Cost of material

Cost of the piece = c1 +c2

Fixed cost of machine / hour	8,96E+01
Total cost of machine/hour (+ variable costs)	9,06E+01
Cost estimations	
Cost of master manufacturing	980,05 €
Cost of Technician (€/hour)	31,94 €
Cost of material (€/m²)	95,53 €

Manufacturing summary

Complementary processes cost summary

Type	Description	Time	Unity	By who ?	Price (€/unity)	Quantity (by unity)	Price (€)
Assemble by hand	Assembly of one y of exhaust system or muffler	6 min		Operator			2,45 €
Assemble by hand	Assembled together with bolts		nbr of bolts	Operator	0,10 €		- €
Assemble by hand	Assembled together with clamps		nbr of clamps	Operator	0,20 €		- €
Assemble by hand	Engine, remove older shifter axis and put new one	15 min		Operator			6,12 €
Assemble by hand	Engine, Put the Wet slipper clutch	10 min		Operator			4,08 €
Assemble by hand	Engine, pan with sealing	15 min		Operator			6,12 €
Assemble by hand	Engine (oil pan), Draining, modif. oil strainer, new pan	30 min		Operator			12,24 €
Assemble by hand	Engine, Oil filter	5 min		Operator			2,04 €
Assemble by hand	Drivetrain, Socket carrier on differential	5 min		Operator			2,04 €
Assemble by hand	Drivetrain, adjustment length chain	10 min		Operator			4,08 €
Assemble by hand	Drivetrain, Installation chain	10 min		Operator			4,08 €
Assemble by hand	Drivetrain, tripods on shafts	1 min		Operator			0,41 €
Assemble by hand	Drivetrain, excentric on differential	1 min		Operator			0,41 €
Assemble by hand	Drivetrain, axle boots on shaft	5 min		Operator			2,04 €
Assemble by hand	Cans on frame, Hose mounting on cans	5 min		Operator			2,04 €
Assemble (>10kg)	Engine, into the frame	2 operators 10 min		Operator			8,16 €
Fastener install	Every	15 sec	nbr of fasteners	Operator	0,10 €		- €
Fastener install	Boot clamp, ligarex strap with buckle	30 sec	nbr of ligarex	Operator	0,20 €		- €
Fill with liquids, grease, ...	Cooling line	5 min		Operator			2,04 €
Fill with liquids, grease, ...	Differential	10 min		Operator			4,08 €
Fill with liquids, grease, ...	Engine oil	5 min		Operator			2,04 €
Fill with liquids, grease, ...	Fuel line	5 min		Operator			2,04 €
Fill with liquids, grease, ...	Tripods	1 min	nbr of tripods	Operator	0,41 €		- €
Install Tie wrap (zip tie, Cable clamp)		15 sec	nbr of tie wrap	Operator	0,10 €		- €
Liquid Applicator gun	For fuel tank, thermal protection	2 min					0,82 €
Press operations	To flatten a tube	1 min	nbr of flat	Operator	0,41 €		- €
Press operations	To mount bearings	5 min	nbr of bearings	Operator	2,04 €		- €
Threadlock application		30 sec	nbr of application	Operator	0,20 €		- €
Tighten bolts (Ratchet, Wrench, Screwdriver, ...)		30 sec	nbr of bolts	Operator	0,20 €		- €
Untighten bolts (Ratchet, Wrench, Screwdriver, ...)		30 sec	nbr of bolts	Operator	0,20 €		- €

Assembly cost summary

Type	Time	Description	By who ?	Cost (€)
Assemble (fittings on hoses)	10 min	For fuel lines	Operator	4,08 €
Cut metallic hosses (grinder)	10 min	For fuel lines	Operator	4,08 €

Hoses assembly cost summary

Type	Description	Unity	By who ?	Price (€/unity)	Quantity (by unity)	Price (€)
Aerosol apply	Chain oil	Nbr of application	Operator	0,82 €		- €
Grinding		Nbr of grinding	Operator	0,20 €		- €
Painting, aerosol apply	Cleaning + painting	cm^2	Operator	0,0204		- €
Surface cleaning, by hand		cm^2	Operator	0,003		- €

Surface processes cost summary

Fasteners cost summary

Type	Grade	Size	Lenght	Price (TTC, for 100)	Number (to calculate)	Price (HT)
Socket Head Cap Screw	12.9	M6	16	4,31 €		- €
Socket Head Cap Screw	12.9	M6	20	4,46 €		- €
Socket Head Cap Screw	12.9	M6	25	4,60 €		- €
Socket Head Cap Screw	12.9	M6	30	5,16 €		- €
Socket Head Cap Screw	12.9	M6	35	5,41 €		- €
Socket Head Cap Screw	12.9	M6	40	5,79 €		- €
Socket Head Cap Screw	12.9	M6	45	6,58 €		- €
Socket Head Cap Screw	12.9	M6	50	7,35 €		- €
Socket Head Cap Screw	12.9	M6	55	7,76 €		- €
Hexagonal Head	12.9	M6	80	6,54 €		- €
Socket Head Cap Screw	12.9	M8	10	10,54 €		- €
Socket Head Cap Screw	12.9	M8	40	11,17 €		- €
Socket Head Cap Screw	12.9	M8	45	11,79 €		- €
Socket Head Cap Screw	8.8	M12	200	80,00 €		- €
Socket Head Cap Screw	8.8	M12	180	70,00 €		- €
Socket Head Cap Screw	8.8	M10	30	10,65 €		- €
Socket Head Cap Screw	8.8	M10	35	12,50 €		- €
Socket Head Cap Screw	8.8	M6	25	3,71 €		- €
Hexagonal Head	8.8	M4	20	2,06 €		- €
Hexagonal Head	8.8	M5	20	2,41 €		- €
Hexagonal Head	8.8	M8	30	6,21 €		- €
Socket Head Cap Screw	8.8	M6	20	2,65 €		- €
Socket Head Cap Screw	8.8	M6	25	3,00 €		- €
Socket Head Cap Screw	8.8	M6	30	3,20 €		- €
Socket Head Cap Screw	8.8	M6	40	4,66 €		- €
Socket Head Cap Screw	8.8	M6	50	5,07 €		- €
Hexagonal Head	8.8	M6	20	2,25 €		- €
Hexagonal Head	8.8	M6	30	2,45 €		- €
Hexagonal Head	8.8	M6	40	2,82 €		- €
Hexagonal Head	8.8	M6	50	3,01 €		- €
Hexagonal Head	8.8	M6	60	3,21 €		- €
Hexagonal Head	8.8	M8	20	3,50 €		- €
Hexagonal Head	8.8	M8	30	5,08 €		- €
Hexagonal Head	8.8	M8	40	5,40 €		- €
Hexagonal Head	8.8	M8	50	5,55 €		- €
Hexagonal Head	8.8	M8	60	6,10 €		- €
Socket Head Cap Screw	8.8	M8	20	5,07 €		- €
Socket Head Cap Screw	8.8	M8	25	6,55 €		- €
Socket Head Cap Screw	8.8	M8	30	5,42 €		- €
Socket Head Cap Screw	8.8	M8	40	5,75 €		- €
Socket Head Cap Screw	8.8	M8	50	6,02 €		- €
Socket Head Cap Screw	8.8	M8	60	7,05 €		- €

Bolts cost summary (source : TDI)

Type	Grade	Size	Price (TTC, for 1 knut/ 100 nylstop)	Quantity	Price (HT)	Source
Self-locking nut, nylon	8.8	M3	3,67 €		- €	TDI
Self-locking nut, nylon	8.8	M4	3,42 €		- €	TDI
Self-locking nut, nylon	8.8	M6	2,69 €		- €	TDI
Self-locking nut, nylon	8.8	M8	3,70 €		- €	TDI
Self-locking nut, nylon	8.8	M10	6,68 €		- €	TDI
K-nuts, metallic self-locking nut	K-nuts	M6	0,54 €		- €	K-nut
K-nuts, metallic self-locking nut	K-nuts	M8	0,79 €		- €	K-nut
K-nuts, metallic self-locking nut	K-nuts	M10	1,33 €		- €	K-nut
K-nuts, metallic self-locking nut	K-nuts	M12	3,28 €		- €	K-nut

Nuts cost summary

Type	Size (mm)	Price (TTC, for 100)	Quantity	Price (HT)	Source
Copper	8	22,50 €		- €	Oreca
Copper	3/8 inch	22,50 €		- €	Oreca
Copper	10	45,00 €		- €	Oreca
Copper	11.5	45,00 €		- €	Oreca
Copper	12.5	45,00 €		- €	Oreca
Steel, stainless	M3	2,56 €		- €	TDI
Steel, stainless	M4	2,96 €		- €	TDI
Steel, stainless	M6	4,45 €		- €	TDI
Steel, stainless	M8	5,65 €		- €	TDI
Steel, stainless	M10	8,90 €		- €	TDI

Washers cost summary

Type	Size (mm)	Price (TTC, for 1)	Quantity	Price (HT)	Source
Adapter, L.P., Female Flare, Aluminum	Dash 6	13,40 €		- €	Oreca
Adapter, L.P., Male Flare, Aluminum	Dash 6	5,30 €		- €	Oreca
Adapter, L.P., union Tee, Male flare, Aluminium	Dash 6	15,23 €		- €	Oreca
Adapter, L.P., union Reducer, Female flare, Aluminium	Dash 6	3,50 €		- €	Oreca
Banjo fitting, straight, Aluminium	12mm, dash6	31,03 €		- €	Oreca
Fitting, L.P., 45°, aluminium	Dash 6	23,20 €		- €	Oreca
Fitting, L.P., 90°, aluminium	Dash 6	22,40 €		- €	Oreca
Fitting, L.P., straight, aluminium	Dash 6	9,44 €		- €	Oreca
Fitting, weld-in, male, aluminium	Dash 6	4,06 €		- €	Oreca
Fitting, L.P, female plug, aluminium	Dash 3	2,48 €		- €	Oreca
Fitting, L.P, female plug, aluminium	Dash 6	3,16 €		- €	Oreca
Fuel check valve, in-line, aluminium	Dash 6	40,00 €		- €	Oreca

Plumbing fasteners cost summary

Type	Size	Unit	Price (TTC, by unit)	Quantity (to complete)	Price (HT)	Source
Boot clamp, ligarex strap with buckle	Medium (33cm)	for 1	0,90 €		- €	
Boot clamp, ligarex strap with buckle	Large (72 cm)	for 1	0,90 €		- €	
Hose clamps	5 - 10 mm (diameter)	for 1	0,50 €		- €	TDI
Hose clamps	12-18 mm (diameter)	for 1	0,56 €		- €	TDI
Hose clamps	25-32 mm (diameter)	for 1	0,63 €		- €	TDI
Hook and Loop, Hook & Loop Side (Velcro)	None	m	13,90 €		- €	Reverchon
Lock wire	0,62 mm	m	0,36 €		- €	
Mount, vibration damping, Sandwich	M6	for 1	3,50 €		- €	Solutions Elastomères
Quick link chain		for 1	5,23 €		- €	
Retaining ring, external, 30 mm	13 mm	for 100	2,20 €		- €	TDI
Retaining ring, external, 30 mm	30 mm	for 100	9,00 €		- €	TDI
Retaining ring, external, 30 mm	47 mm	for 100	17,50 €		- €	TDI
Spring, exhaust system	All	for 1	2,00 €		- €	echapmoto
Spring, intake system	All	for 1	1,50 €		- €	
Steel Loop Straps, Rubber-Cushioned	20 mm	for 1	2,08 €		- €	TDI
Tie wrap	Small	for 100	2,02 €		- €	Forch
Tie wrap	Medium	for 100	6,13 €		- €	Forch
Tie wrap	Large	for 100	20,04 €		- €	Forch
Tie straps, blower		for 1	2,35 €		- €	Reverchon

Miscellaneous fasteners cost summary

Materials cost summary

Fluid	Price (TTC, by Unity)	Unity	Quantity (unity)	Price (HT)	Source
Fluid, chain oil	0,20 €	by utilisation		- €	Maxxess (1 bottle = 40 utilisation)
Fluid, demineralized water	0,33 €	L		- €	
Fluid, limited slip differential oil 75W140	24,65 €	L		- €	Maxxess
Fluid, engine oil 10W40	16,56 €	L		- €	Maxxess
Fluide, gasoline 98RON	1,65 €	L		- €	
Glue, High temperature resistance	7,75 €	for fuel tank	None	7,75 €	RS components
Paint	0,0009 €	cm^2		- €	PSEP industrie
Threadlock, medium	0,48 €	by utilisation		- €	RS components
Tripod grease	139,09 €	kg		- €	Reverchon

Fluid materials cost summary

Type	Size	Unity	Price (HT, by unity)	Quantity (unity)	Price (HT)	Source
Hose, FEP	Φ ext. 8 mm	m	9,09 €		- €	Reverchon
Hose, rubber, flexible	Φ ext. 6 mm	m	0,50 €		- €	Reverchon
Hose, rubber, reinforced	Φ int. 35 mm	m	23,33 €		- €	Reverchon
Hose, Silicone	Φ ext. 6 mm	m	9,00 €		- €	Reverchon
Hose, Silicone	Φ ext. 25 mm	m	15,00 €		- €	Reverchon
Hose, Silicone, 45°	Φ ext. 25 mm	for 1	8,25 €		- €	Reverchon
Hose, Silicone, 135°	Φ ext. 25 mm	for 1	7,50 €		- €	Reverchon
Hose, Stainless	Φ ext. 12 mm	m	12,00 €		- €	Reverchon
Hose, Stainless	Φ ext. 26 mm	m	21,00 €		- €	Reverchon
Hose, Stainless Steel Braided Outer, L.P	Dash 6	m	30,30 €		- €	Reverchon

Hoses cost summary

Type	Unity	Price (HT, by unity)	Quantity (unity)	Price (€, HT)
Engine Sealant Paste	mL	0,09 €		- €
Fiberglass Insulation	for fuel tank	12,29	None	12,29 €
Sealing paper	m^2	70,63 €		- €
Seal, O-ring, Elastomer, 25mm	by O-ring	0,56 €		- €
Seal, O-ring, Copper	by O-ring	1,48 €		- €

Miscellaneous cost summary

Material	Price (HT, €/mm^3)	Length (mm)	Width (mm)	Thickness (mm)	Price (€, HT)
Aluminium, 2017A	3,48E-05				- €
Aluminium, 7075 T6	2,24E-05				- €
Plastic, Delrin	1,65E-05				- €
Steel, 25CD4	1,49E-05				- €

Raw materials cost summary

Material	Thickness (mm)	Price (HT, €/m^2)	Surface (m^2)	Price (€, HT)
Aluminium, 2017A	1,5	72,90 €		- €
Aluminium, 2017A	2	97,20 €		- €
Aluminium, 2017A	2,5	121,50 €		- €
Steel, S235	1,5	12,8205		- €
Steel, S355	3	58,275		- €
Steel, S700	4	77,7		- €

Sheet materials cost summary

Type	Size	Price (HT, by m)	Quantity (m)	Price (€, HT)
Tubing, Aluminum, 2017A	Φ 6 * 5 mm	1,85 €		- €
Tubing, Aluminum, 2017A	Φ 10 * 9 mm	3,19 €		- €
Tubing, Aluminum, 2017A	Φ 12 * 11 mm	3,86 €		- €
Tubing, Aluminum, 2017A	Φ 38 * 35 mm	26,25 €		- €

Tubing materials cost summary