

HACETTEPE RACING

Cost Explanation File



FORMULA STUDENT

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Silverstone, UK

Material Prices

- Alüminyum=24TL/kg=4.49 Euro/kg
- Steel AISI 1020=4TL/kg=0.75 Euro/kg
- Steel S460MC= 6.5TL/kg=1.226 Euro/kg
- Steel S355MC= 5.5TL/kg=1.03 Euro/kg
- Carbon fiber 3k 200g/m²=200TL/m²=37.42 Euro/ m²
- Epoxy resin= 100tl/kg=18.7 Euro/kg
- Wood(balsa)=85 TL/kg=15.89Euro/kg
- Wood=2.6 TL/kg=0.48Euro/kg
- Peel ply=33.04TL/m²=6.17Euro/m²
- Flow mesh=11.41TL/m²=2.13Euro/m²
- Release agent=181Euro/liter=33.847 Euro/liter
- Acetone=20TL/liter=3.74Euro/liter
- Phosphoric acid=30TL/liter=5.61Euro/liter
- Carbon fiber pipe 20x1mm=105TL/m=19.64Euro/m
- Carbon fiber pipe 20x1.5mm=235TL/m=44.13Euro/m

Machining Prices

- Laser cut is 6 tl/min= 1.12 E/min (Operator labour cost is included)
The laser machine cut rate= 4000mm²/min
Laser cut cost= 0.00028 Euro/mm²
- 5 axes laser cut is 15 tl/min= 2.8 E/min (Operator labour cost is included with CAM costs)
The laser machine cut rate= 2500mm/min
5 axes laser cut cost= 0.006 Euro/mm
For every piece CAM and setup cost is 10TL which is 1.87Euro/piece.
- CNC Router is 75TL/hour=14.03E/hour(Operator labour cost is included with CAM costs)
The CNC Router average cut rate= 6000mm³/min
CNC Router cost approximately= 0.000039 Euro/mm³ for steel
CNC Router cost approximately= 0.0000039 Euro/mm³ for wood (because of high cutting speeds and higher tool life)
For every piece CAM and setup cost is 10TL which is 1.87Euro/piece.
- CNC 5 axes milling machine is 175TL/hour=32.74Euro/hour(Operator labour cost is included without CAM costs)

The CNC milling cut rate= $8000\text{mm}^3/\text{min}$

5 axes CNC milling cost approximately = $0.000068 \text{ Euro}/\text{mm}^3$ for steel

5 axes CNC milling cost approximately= $0.000068 \text{ Euro}/\text{mm}^3$ for wood (because of high cutting speeds and higher tool life)

For every piece CAM and setup cost is 35TL which is 6.55Euro/piece.

- Turning is $25\text{TL}/\text{hour}=4.68\text{E}/\text{hour}$ (Operator labour cost is included)
Turning feed rate is approximately= $5000\text{mm}^3/\text{min}$
Turning cost is approximately= $0.0000156 \text{ Euro}/\text{mm}^3$
Setup and installing each piece costs 3TL which is 0.561Euro/piece.

- Milling is $30\text{TL}/\text{hour}=5.61\text{E}/\text{hour}$ (operator labour cost is included)
Milling feed rate is approximately= $5000\text{mm}^3/\text{min}$
Milling cost is approximately= $0.0000187 \text{ Euro}/\text{mm}^3$
Setup and installing each piece costs 3TL which is 0.561Euro/piece.

- Cut(hand tool)= $15\text{TL}/\text{m}=2.8\text{Euro}/\text{m}$
- Tube cut(diamond)= $5\text{TL}/\text{piece}=0.93\text{Euro}/\text{m}$
- Covering= $0.3\text{TL}/\text{piece}=0.055\text{Euro}/\text{m}$

The following prices are the retail process price taken from the actual industrial environment according to approximate works. Operator labour and setup costs are included.

- Bending operation is $3\text{TL}=0.56 \text{ Euro}$
- Roll bending is $10\text{TL}=1.865 \text{ Euro}$
- Drilling operation is $3\text{TL}=0.56 \text{ Euro}$
- Threading operation is $5\text{TL}=0.935 \text{ Euro}$
- Cut(manual)= $1\text{TL}= 0.187 \text{ Euro}$

Labour rates

- TIG Welding is 100TL/hour=18.7 Euro/hour
Welding speed is 160mm/min=9600mm/h=9.6m/h(With preperation etc.)
Therefore welding= 1.947 Euro/m
- Assembling unqualified parts line on line is 2TL/piece=0.37Euro/piece
- Assembling qualified neccesarry parts(like bearing etc) line on line and attaching wire is 3.5TL/piece=0.65Euro/piece
- Fastener install is 15TL/hour=2.81Euro/hour
A fastener is approximately tighten 4 tour.
We can assume tighten a tour, a nut to a bolt with a washer takes 6 seconds.
For tighten the triple process(a nut+a bolt+a washer=3) 4 times takes 24 seconds.
A fastener install takes 8 seconds.
Therefore a fastener install is 0.033Euro/piece
- Grinding(with handtool) 40TL/hour=7.48Euro/hour
Grinding speed approximately 200mm/min=12m/h
Therefore grinding(with handtool)=0.623Euro/m
- Grinding (with hand) 40TL/hour. The speed is approximately 0.25m²/hour. 120TL/m²
=22.44Euro/m²

-Composite labour hour= 150TL/h=28.06Euro/h (For composite applications like; Resin application, Lamination, Vacuum form, Cure)

- Resin application = 10mins/m²
Therefore resin application cost=4.67Euro/m²
- Lamination, vacuum fabric lay down = 4 mins/m²
Therefore lamination cost=1.87Euro/m²
- Infusion molding= 3 hours/m²
Therefore infusion molding cost=84.18Euro/m²
- Labour can cure for 24 hours and can work while the material is curing. Therefore, cure= 50TL/hour(9.35Euro/hour) is for thermal curing, 30TL/hour(5.61Euro/hour) for room temperature.
- According to our time measure, a composite man can bond 0.1m² surface in 7 minutes so 0.857m²/hour labour cost. Also an approximate epoxy adhesive cost is: 110TL=20.57Euro

$$50\text{ml}=50000\text{mm}^3$$

$$\text{Adhesive layer}=0.1\text{mm}$$

$$500,000\text{mm}^2=0.5\text{m}^2$$

$$41.14\text{Euro}/\text{m}^2 \text{ adhesive cost}$$

$$\text{Therefore bonding cost}=73.88\text{Euro}/\text{m}^2$$

- For surface cleaning application with 4L/m² acetone is used. And cleaning time approximately 8m²/hour. Therefore surface cleaning cost 18.46Euro/m²
- For surface etching with 1L/m² phosphoric acid is used. Etching takes 6 minutes per part(and because of working with dangerous material it cost twice with special gloves etc. Therefore etching cost 5.61Euro/m² in addition to 2.8Euro/piece

Times

Resin application takes 10mins per m²

Lamination takes 4 mins per m²

Vacuum form takes 3 hours per m²

Carbon fiber curing takes approximately 8 hours at room temperature.

Notes:

In lengths or area of the tubes, pipes, sheet or blocks have taken to the account according to which process will accomplished.

In machining operations 4mm added to 2 dimensions.

In laser cut applications: 2mm added to 2 dimensions.

	M4	M5	M6	M8	M10	M12	M14
8	0,15	0,21	0,30				
10	0,13	0,14	0,20	0,51	2,50		
12	0,13	0,15	0,20	0,42	1,60		
16	0,15	0,17	0,22	0,43	0,84	1,65	
20	0,17	0,20	0,25	0,47	0,80	1,40	2,94
25	0,19	0,23	0,28	0,53	0,90	1,45	2,08
30	0,22	0,26	0,32	0,59	0,99	1,55	2,28
35	0,28	0,29	0,36	0,65	1,09	1,60	2,47
40	0,31	0,33	0,39	0,71	1,18	1,73	2,67
45	0,34	0,35	0,43	0,77	1,28	1,87	2,87
50	0,37	0,38	0,47	0,83	1,37	2,01	3,06
55	0,44	0,46	0,51	0,89	1,47	2,15	3,26
60	0,48	0,50	0,54	0,95	1,56	2,25	3,46
65		0,53	0,59	1,01	1,66	2,43	3,65
70		0,57	0,67	1,07	1,75	2,57	3,85
75		0,90	0,72	1,15	1,85	2,71	4,05
80		1,37	0,76	1,21	1,94	2,85	4,25
85			1,20	1,60	3,10	3,75	6,50
90			0,85	1,33	2,13	3,12	4,65
100			1,01	1,55	2,32	3,40	5,05
110			1,35	2,06	2,93	4,20	7,18
120			1,62	2,22	3,19	4,56	7,70
130			1,70	2,38	3,42	4,86	8,37
140			1,95	2,54	3,64	5,28	8,90
150			2,30	2,93	4,18	6,06	10,04
160				6,21	5,30	7,70	11,04
170				6,83	5,83	8,47	12,15
180				6,90	5,88	8,52	13,36
190				7,59	6,47	9,37	14,70
200				7,60	6,47	9,35	16,17
225				9,45	14,85	22,95	
250				10,80	18,90	27,90	

Figure 1-Stainless Steel DIN 933 8.8 Grade Price List(Turkish Liras per piece)

	M3	M4	M5	M6	M8	M10	M12	M14
4	0,23							
5	0,12	0,20						
6	0,08	0,12	0,25	0,45				
8	0,08	0,12	0,19	0,37				
10	0,08	0,12	0,15	0,24	0,78			
12	0,09	0,13	0,17	0,25	0,45	1,25		
16	0,10	0,15	0,18	0,26	0,49	0,95	2,10	
20	0,11	0,16	0,21	0,29	0,55	0,91	1,35	
25	0,13	0,18	0,25	0,34	0,61	1,01	1,49	3,85
30	0,16	0,22	0,29	0,37	0,69	1,11	1,68	2,66
35	0,18	0,26	0,33	0,47	0,77	1,21	1,79	2,91
40	0,21	0,28	0,38	0,52	0,87	1,31	1,94	3,16
45	0,29	0,35	0,43	0,57	0,95	1,50	2,09	3,55
50	0,35	0,37	0,44	0,62	1,04	1,64	2,27	3,67
55		0,42	0,60	0,90	1,30	2,10	3,00	5,50
60		0,45	0,57	0,77	1,20	1,90	2,65	4,38
65		0,80	0,70	1,20	1,70	2,40	3,50	6,40
70		1,50	0,66	0,88	1,37	2,17	2,99	5,01
75			1,20	1,40	2,10	2,85	4,50	7,25
80			2,27	1,00	1,47	2,32	3,18	5,63
90			2,46	1,08	1,78	2,69	3,64	6,26
100			2,85	1,18	2,12	3,11	4,64	7,24
110				2,51	2,59	3,81	5,02	8,68
120				2,72	2,75	4,12	6,22	9,41
130				2,93	3,28	4,84	6,81	10,13
140				3,38	3,51	5,18	7,30	10,85
150				3,90	4,50	6,28	8,83	17,37
160				5,25	7,00	9,50	17,00	23,60
170					9,50	13,00	21,00	27,60
180					12,00	16,00	24,00	32,50
200					17,00	21,00	35,00	39,00

Figure 2-Stainless Steel DIN 912 8.8 Grade Price List(Turkish Liras per piece)









								
	DIN 934	DIN 985	DIN 1587	DIN 315	DIN 125	DIN 127	DIN 6798A	DIN 9021
M2	0,08				0,02	0,02	0,02	
M2.5	0,09				0,02	0,02	0,02	
M3	0,04	0,09	0,21	0,39	0,02	0,02	0,03	0,02
M4	0,05	0,09	0,16	0,42	0,03	0,03	0,03	0,04
M5	0,06	0,10	0,17	0,46	0,04	0,03	0,04	0,06
M6	0,11	0,12	0,27	0,54	0,06	0,04	0,05	0,10
M8	0,19	0,24	0,50	0,79	0,07	0,06	0,07	0,21
M10	0,43	0,51	0,95	1,51	0,12	0,10	0,10	0,43
M12	0,64	0,76	1,42	3,61	0,24	0,14	0,12	0,75
M14	0,96	1,30	3,45	9,83	0,33	0,24	0,16	1,05

Figure 3- Nut and Washers Price List(Turkish Liras per piece)

What labor rates have you used and where have these come from?

According to these data which are very strict. Minimum wage of 1 person per month is 292,9 € and overhead cost can calculate with the ratio of 1.25 which includes taxes, breaks and holidays etc.

Reference: <https://turkishlaborlaw.com/news/legal-news/567-2018-minimum-wage-announced>

How many hours do you need to recover for Facilities/Machines & Labour?

Facilities and machines are already arranged by our industry engineers it took 10 days to set up all these machines. On the other hand we needed 4 month and 19 people for creating prototype.

What facilities, machinery, tools and equipment do you need to buy?

Turning, milling, drilling machines, power tools, welding machines, technical tool kits, dynamometer etc...

How are these cost going to be recovered?

We are supported by Hacettepe University Technocity and also we had lots of sponsors such as CNC works or welding works etc...

What about cost funding any loans to buy equipment?

We loan from Hacettepe University itself to find equipment then we create a project report for our expenses about prototype.

What about all the other overheads of running a business?

We don't have other overheads because of the policy of the Turkish government. We are neglected from some expenses such as taxes or facility prices.