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Budget - Economic analysis

TREBALL DE FI DE GRAU



“DESIGN AND CONSTRUCTION OF AN AUTOMATIC SYSTEM FOR WATER MAINTENANCE OF DOMESTIC POOL”

TFG presentat per obtenir el títol de GRAU en
ENGINYERIA ELECTRÒNICA INDUSTRIAL I
AUTOMÀTICA

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CHAPTER 1: PROTOTYPE COST

In this volume the cost involved the implementation of this project is detailed.

1.1 Engineering costs

The cost includes the detailed engineering cost of all tasks performed throughout the project. To emulate a real price of course have different prices depending on the tasks performed. It has set a average price of 20 €/h it will be reduced if less complex tasks are performed.

Performed tasks	Time spent	Price/hour	Total price
Viability of the TFG	80 h	20 €/h	1.600,00 €
Hardware design	5 h	20 €/h	100,00 €
PCB board design	40 h	20 €/h	800,00 €
Mounting hardware	20 h	20 €/h	400,00 €
Hardware verification and correction	20 h	20 €/h	400,00 €
Design software	250 h	20 €/h	5.000,00 €
Debugging software	100 h	20 €/h	2.000,00 €
Functionality tests	40 h	20 €/h	800,00 €
Preparation of documentation	140 h	20 €/h	2.800,00 €
TOTAL	695 h	-	13.900,00 €

Table 1 Engineering costs

1.2 Material costs

This section is detailed the costing used in the material of each system developed during the project. The price of each component has been chosen based on the prices specified on the website of RS Componentes and Ondaradio.

The next table is focused on the electronic devices needed to build one board (Main board):

Family	Quantity	Reference	Value	Unitary price
Resistors	16	R1-R4, R9, R11, R13, R15, R17, R19, R21, R23, R25, R27, R29, R31,RR	10K	0,02 €
	17	R5-R8, R10, R12, R14, R16, R18, R20, R22, R24, R26, R28, R30, R32, R37	220	0,02 €
	2	R35, R36	4,7K	0,02 €
	1	RV1	4,7K	1,50 €
			Potentiometer	
Capacitors	2	C1,C2	15pF	0,26 €
Integrated circuits	1	U1	PIC18f4550	1,38 €
	1	U4	DS3232	2,04 €
	3	U5-U7	L293D	1,99 €
	2	U8,U9	HEF4051	1,05 €
Diode	1	D1	LED Green	0,12 €
Miscellaneous	1	B1	3V Battery	3,00 €
	1	LCD	LM044L	17,40 €
	1	X1	Crystal 4MHz	0,48 €
	1	Relay module	5VDC relay module	5,45 €
	1	Power supply	5VDC	12,32 €
	1	Power supply	12VDC	14,48 €
Connectors	2	J1, J3	SIL-100-03	0,14 €
	1	J2	SIL-156-03	0,24 €
	14	J4- J17	SIL-100-02	0,12 €
PCB	1	PCB board	Double positive side	14,76 €
	1	Layout of the PCB		10,00 €

TOTAL

94,42 €

Table 2 *Materials cost, electronic board*

The next table is for the mechanical components of the system, the price of the 3D printed parts are based on the printing time (for the electrical costs) and plastic consumption:

Family	Quantity	Reference	Value	Unitary price
Electronics box	1	Waterproof socket	BASE IP44 IK07	3,25 €
	1	Electronics covert	3D Printed	1,25 €
	1	Power switch	2A 125V/250V Switch	1,12 €
	3	Push buttons	0.5A 125V/250V Switch	0,54 €
Mechanic box	4	T connexions	95HP 70KW	0,80 €
	1	Flexible latex tube	20 meters	16,28 €
Peristaltic pump	1	Bottom part pump	3D Printed	1,22 €
	1	Rotor half 1	3D Printed	0,98 €
	1	Rotor half 2	3D Printed	0,98 €
	4	Bearings	Radial bearing 608ZZ	1,05 €
	2	Bushing	Selfoil 4-8-12	0,50 €
	1	Top part pump	3D Printed	0,80 €
	1	Geared motor	Mabuchi 12VDC 15RPM	10,89
	1	Motor gear	3D Printed	0,12 €
	1	Transmission gear	3D Printed	0,22 €
	1	Main gear	3D Printed	0,22 €

	1	Endstop spacer	3D Printed	0,09 €
	1	Endstop	0.5A 125V/250V Micro Switch	0,28 €
	1	Endstop contact	3D Printed	0,7 €
Press valve	4	Valve base	3D Printed	1,05 €
	4	Motor gear	3D Printed	0,12 €
	4	Geared motor	Mabuchi 12VDC 3.5RPM	11,66 €
	4	Main gear	3D Printed	0,22 €
	4	Press gear slave	3D Printed	0,23 €
	4	Press anvil	3D Printed	0,11 €
	8	Bushings	Selfoil 8-10-6	0,50 €
	8	Endstops	0.5A 125V/ 250V Micro Switch	0,28 €
Enclosure	1	Electronics box	EX-231	9,03 €
	1	Mechanic box	EX-322	27,72 €
Screws	90	Screws		20,00€
TOTAL				164,97 €

Table 3 Materials cost, mechanic parts

The total cost of the prototype is $94,42 + 164,97 = \mathbf{239,39€}$

1.3 Indirect costs

Indirect costs are those that influence the development of prototypes but cannot be assigned to a single product without using any allocation criteria.

Description	Price
Digital oscilloscope Hantek 6052BE	158,59 €
3D printer BCN3D+ (and modifications)	1.300,00 €
Tools, broken parts and electricity	600,00 €
Swimming pool	1.150,00 €
Precision digital pH meter PH-035	46,00 €
TOTAL	3.254,60 €

Table 4 Indirect costs

1.4 Totals Costs

For the total cost of this project the previous detailed cost have to be compute together. All the material cost and the tools and instruments of the indirect cost have been paid by the author of the project.

Description	Total price
Engineering costs	13.900,00 €
Total material costs	239,39 €
Indirect costs	3.254,60 €
TOTAL	17.393,99 €

Table 5 Totals costs

The Value added tax (IVA) is not taken into account the total cost of the prototypes because the cost of each section already contains the corresponding taxes. This tax will be taken into account in the final selling price of the products.

CHAPTER 2: COST OF A SERIAL PRODUCTION

In this section the cost of the system is calculated if a certain number of these are produced. For this calculation will take in consideration other factors that affect the final product cost.

The difference between a manual verification production of PCB and automatic verification is performed.

It has been decided that production will be 500 sets of each type and has applied a 20% discount on the cost of components and which is a percentage that these dealers usually do when large quantities are purchased. The amortization of the system is determined by the following equation (1).

$$\text{Amortization} = \frac{\text{Prototype cost}}{\text{Number of units produced}} + \text{Production costs} \quad (1)$$

2.1 Verification costs

This section presents the economic advantages of performing a test of automatic verification against a test of manual verification. It has been considered that the salary of the operator performing the verification of the system is 10 €/h.

Description	Time per board	Total time	Price/hour	Total price
Manual verification	3,0 min/board	25,0 h	10€/h	250,00 €
Automatic verification	0,5 min/board	4,2 h	10€/h	42,00 €

Table 6 Verification costs

As we can see the benefit is remarkable, considering that for each board is used manually time 6 minutes while using automatic verification are used only 30 seconds.

The manual verification is achieved by a technician testing some specific points of the board one by one, but the automatic verification is an adaptable device with test all the part at once.

2.2 Total costs

In this section, the total costs of the system depending on the type of verification is. Packaging costs of each system are also evaluated. When a company build the material in huge quantities it get a discount, in that that case the most expensive components like the LCD the motor or the flexible tube it get a 20% discount when 500 units or more are build it at ones.

In this total cost is also include a 15% benefit in order to get paid for each system sold to a final user.

Description	Price
Costs of packaging	4,15 €/unit
Costs of material (-20%)	191,51 €/ unit
Costs of manual verification	0,50 €/unit
Costs of automatic verification	0,08 €/unit
Prototype	273,85 €/unit
Benefits (+15%)	45,95 €/unit
Total (Manual v.)	361,07 €/unit
Total(Automatic v.)	346,52 €/unit
IVA (Manual v.)	95,98 €/unit
IVA (Automatic v.)	72,77 €/unit
Total (Manual v. + IVA)	457,05 €/unit
Total (Automatic v. + IVA)	419,29 €/unit

Table 7 Total costs of the system

CHAPTER 3: CONCLUSIONS

The calculations have been done from the perspective of an final user. Each prototype costs have been very high because, mainly, of engineering costs and indirect costs. If you viewed from the perspective of a company, the amount of these costs would not be so increased because there are more projects that share the same resources. Also is important that there are companies that make a substantial discount in material and production costs based on the number of plates made. This would be a remarkable reduction of the final price of the system.

We note that the prices of each type of verification differ by approximately 37,76€. The final price does not mean a great reduction but, viewed in terms of production, it is a significant reduction: 18.880 € per 500 systems produced.

We conclude that, for good practice in terms of economic calculations, should count the number of projects that share resources and significantly influences the final cost of the product. The importance of automatic verification of products to optimize production time and minimizing costs is also highlighted.