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# CONCEPTION AND REALISATION OF A BEANS UNWRAPPING MACHINE WITH AUTOMATIC SORTING

Specifications

In this part it is a question for us of presenting the context of our study and the problem, the objectives, the methods and materials necessary, the expected result and the plan of our work.

## Context of study and problematic.

This study is done for studying purposes and the main interest of this work is to obtain de-enveloped bean seeds from the raw material already dried in a way fast in quantity and quality. These unenveloped seeds can be used as raw material for the social or industrial community to prepare various food dishes or for others for its ability to take care of the human organism... It can also be noted that the seeds can be marketed directly after unwrapping. The project we want to carry out is of great importance both socially in our households and industrially in the food industry. Indeed, it allows the various operators to save time and quality of work at a lower cost. In addition, it will allow us to spare our physical efforts and to obtain a hygienic product without however degrading or cluttering the surrounding environment.

## 2 Objectives

To carry out our study, we set ourselves a general objective and specific objectives.

### 2.1 General purpose

To produce a bean unwrapping machine with automatic sorting.

### 2.2 Specific objectives

* Obtain a good yield of more than 70%;
* Save time;
* Guarantee health and safety conditions
* Facilitate after-sales maintenance.

## 3 Methods and materials needed

### 3.1 Methods

* Carry out field trips and list the problems encountered by structures that use beans;
* Browse books dealing with unwrapping techniques;
* Carry out the conceptual study of the machine
* Carry out the manufacturing analysis study;
* Build the machine.

* 1. Materials required

* Internet;
* Computer-aided design and word processing software;
* Books and projects in the field concerned;
* Raw material;
* Mechanical manufacturing workshop of ENSET Douala.

## Expected results

In order to find a solution to the problem of bean shelling machine, we have analysed the current methods and we have proposed to make modifications to the said methods in order to obtain better results. However, to achieve the objectives that we have set ourselves in these specifications, namely to quickly unwrap the bean in a quantitative, qualitative (without breaking the seeds), hygienic and secure manner.

## Provisional work plans

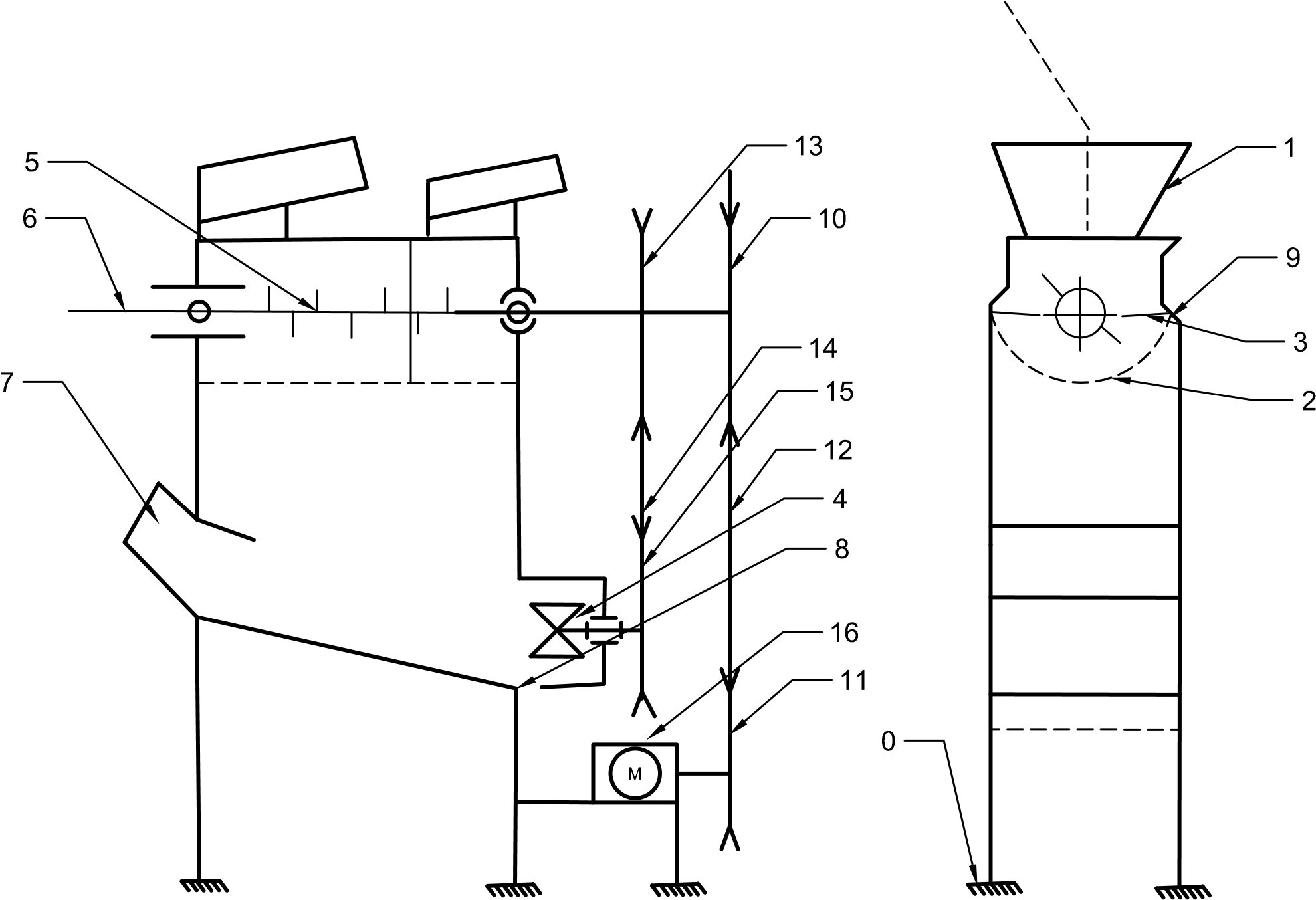
We propose the following work plan:

* Machine design study;
* Machine fabrication analysis;
* Cost estimate.

CHAPTER I: MACHINE DESIGN STUDY

## 1.PRESENTATION OF THE BEANS UNWRAPPING MACHINE

In this part, it is a question of presenting the optimal solution which has been adopted, the kinematic diagram of the beans unwrapping machine as well as its description and its functioning.

Kinematic diagram 

**Figure 1**:kinematic scheme of the beans unwrapping machine

• Legend

1. Hopper
2. Sieve
3. Fixed blade
4. Fan with blades
5. Movable blade
6. Main shaft
7. Pod outlet
8. Seed outlet
9. Cylinder
10. Receiver pulley
11. Drive pulley
12. Drive belt
13. Drive pulley
14. Drive belt
15. Drive pulley
16. Motor
17. bean seed receiving plat

• Description and functioning

The dried bean pods are introduced into the hopper **1**. When the motor **16** is activated, this transmits its movement to the main shaft **6** made up of blades **5.** Thanks to the belt pulley system (**10** + **11** + **12**). The beating of the pods between the moving blades **5** and the fixed blades **3** causes the unwrapping action. The sorting between the seeds and the pods is carried out by the fan with blades **4** thanks to the system (**13**+**14**+**15**). The grains are directed to exit **8** and the pods are directed to exit **7**.

* 1. CALCULATION NOTES

This part includes all the calculations for determining the dimensions of the key components of the machine. Thus, it was necessary to identify the unwrapping torque necessary to unwrap the dried beans, in order to make the choice of the motor. The chosen engine made it possible to dimension the elements of the transmission system before carrying out the static study which gave the forces making it possible to make the calculation of pulley - belt. The results found made it possible to dimension the receiving shaft and to make the choice of the key. The blades rotating around an axis receive the bean pods and drive them towards the fixed blades by creating forces to break the pods and release the beans. The force resulting from the action of unwrapping in a plane tangent to the seed, the pressing force makes it possible to maintain the seed between the mobile blade and the fixed blade.

* + 1. Determination of pressing force and tangential force to separate bean seeds from pods

.

Assumptions: The contact between the steel and the pod is assimilated to the steel-polyethylene contact and has an adhesion factor f=tanφ= 0.8 [1]

Figure 1.2 presents the kinematic scheme of the experiment

Tray

Pod

Mass

Seed

workbench

0

,25kg

1

kg

F

P



F

t

F

**Figure 1. 2:**experience on pressure force

The experiment presented in figure 1.2 uses well-dried bean pods which are placed on a workbench then, above this one places a tray in order to put the striking mass to determine the pressing force (Fp). We see that the least resistant pod begins to crack from a load of 1250g. relation (1) is used to calculate the pressing force

Fp – mg ( 1 )

Note :1,25×10=12,5N => Fp= 12.5N

Relation 1.2 is used to calculate the tangential force:

Ft= F tanφ ( 1.2 ) AN: Ft= 12.5×0,8 => Ft= 10N

* + 1. Torque to unwrap

Data:

* The distance between the axis of the main shaft and the tip of the blade is: d1 = 0.165m
* The tangential unwrapping force is Ft - 10N
* The machine will unwrap at least 10 bean pods at the same time

Note: Cr1= 10(1× 0,082) = 8.2N.m (1.3)

* + 1. Power to unwrap

Assuming, the main shaft 6 rotates at a rotational speed N = 1000 rpm the power to unwrap is given by the relation

Pr= Cr1.W Pr= (1.4) AN : Pr => Pr= 0.85 Kw

After having calculated the power to unwrap the bean pods, the next step is to calculate the power of the blower needed to separate the seeds of pods to determine the characteristics of the prototype's electric motor.

* + 1. Power of the blower

✓ Speed of rotation of the blades Condition of entrainment of the envelopes and non-entrainment of the pods

* Assumptions:

V: air velocity;

S: projected area;

P: air density: 1.22 kg/m³;

Cx: drag factor: 0.35;

F: force exerted on a seed or on an envelope by the air exerted by the blower

After unwrapping, an envelope is fragmented into pieces, the largest of which is 1/7 of the entire envelope.

✓ Envelope fragment entrainment condition

P ' the weight of an envelope fragment

We have: F > P '

Or, F=1/2 CxΡ S3V2 and P ' = 1 / 7 Meg [2]

So, 1/2 CxΡ S3V2 1/7 Meg

S’ is the area of an envelope fragment and is given by the relation (1.5)

L (1.5)

Note: S’= = 45, 4408.10-5

S’=45, 4408.10-5m2

The speed of rotation of the blades is given by the relationship (1.6)

V (3.6)

AN: V= 1,27

V1,27m/s

✓ Seed entrainment condition

Let P be the weight of a bean grain

We have: F < P, or F= 1/2 CxΡ S3V2 and P = Meg [2]

Hence

S: bean grain section ( d²) is given by the relation (1.7)

S=4πr2 (1.7)

Note: S= 4x3,14(6,75)2= 572,55x10-6m2

S=572,55x10-6m2

The speed of rotation is given by the relationship (1.8)

V (1.8)

V6,55m/s

We then have 1,25m/s6,55m/s

Then we will take V = 4m / s

### 1-1-4 Calculation of the speed of the extreme points of the blades of the blower

Figure 1.3 represents a diagram of a blower with blades

**Figure1.3**: fan with blades.

VL: linear speed of an extreme point of the blade;

V: speed of the air moved by the blade;

Va: sliding speed between the air and the blades;

B: angle between V and VL;

With B = 30°

The linear speed is given by the relation (1.9)

We have cos β = (1.9)

Nb: VL== 4,618

VL= 4,618m/s

✓ Let's determine the speed of the blower shaft Ns

The speed of the blower shaft is given by the relation (1.10)

Ns= d’où Ns = (1.10)

Ns: rotational speed of the blower shaft;

VL: linear speed of the extreme point of the blade;

Dp: mean diameter of the blade;

We will take Dp = 150mm

Nb : Ns= =587,98

Ns=587,98tr/min, we will take Ns =600 tr/min

* Resultant force due to wind Fv=nF

Fv: resultant force due to wind

N: number of envelopes that can be driven

The resultant force due to the wind is given by the relation (1.11)

Hence Fv= (3.11) Nb: Fv =21084×0,35×1,22×45,440.10-5×8=32,72

Fv=32,72N

* Blower torque

The blower torque is given by the relation (1.12)

Cs= Fv  (3.12)

Nb: Cs=32,72=2,454

Cs=2,454N/m

* Blower Power

Ps= CsWs Ps= Cs  (1.13)

AN: Ps=2,454=154,18

Ps=154,18W

Already having the power to unwrap as well as the power of the blower, the characteristics of the motor will be determined.

## **1-2 Choice of motor**

Assumptions and data

* The performance of the transmission by the trapezoidale pulley system is ɳ1=0,96[5]
* The efficiency of the transmission in the rolling blades is ɳ2=0,98[2];
* The power of the blower is P=154.18w;
* The motor power is Pm;
* The overall efficiency is ɳ;
* The power to unwrap is P = 858.70w.
* Overall efficiency

the Overall efficiency will be given by the relationship (1.14)

ɳ= ɳ 1×ɳ2 (1.14)

AN: ɳ = 0,960,98

* The power of the motor

The power of the motor is given by the relation (1.15)

Pm= (1.15)

AN: Pm== 912,73w

Pm=912,73

From the above, the proper motor for unwrapping will need to develop a power of about 912.73w. however, low speed motors are quite rare on the Cameroonian market. Choosing a higher speed motor is appropriate. Thus, the choice of the motor is that of a closed asynchronous motor LS90L of Pm = 1.1 kw and speed of rotation Nm = 1500rpm [ 4].

## **1-3Choice of pulley and belt systems**

in this section, it is a question of determining all the elements intervening in the power transmission of the machine.The transmission here is achieved by the pulley-belt system consisting of two pulleys connected via a V-belt.

Figure 1.4 presents the kinematic diagram of the transmission by the pulley system belt

**Figure1. 4:** modeling of pulleys and belts

Entraxe

e

t

1

T

1

### **1-3-1 Transmission between motor’s shaft and the main shaft**

The aim is to determine the characteristics of the transmission between the pulleys (**11**-**10**) and the belt **12**.

Data:

- P1: driving power required to unwrap (0.912KW);

- Nm: engine rotation speed (1500rpm);

- N₁: rotational speed of the unwrapping shaft (1000 rpm);

- d: diameter of the driving pulley (100mm);

The catalog used is TEXROPE.

### **1-3-2 Calculation of the service power: Ps**

Given that the machine operates 8 hours per day, the service factor will be: Ks = 1.12 (annex 2)

The service power is given by the relationship (1.16)

Ps= P1KsPs= 0,9891,12=1,10KW (1.16)

**Ps=1,02KW**

**Ps=1,02KW** and Nm= 1500tr/min hence the belt chosen are of type **spz (annexe 5).**

### **1-3-3 Calculation of the belt diameter**

From the formula of the transmission ratio on relation (1.17)

=d’où D=100 (1.17)

D=150mm (normalised diameter: annexe 5)

### **1-3-4 Calculation of the Linear Speed of the belt V₁**

The linear speed of the V₁ belt is given by the relation (1.18)

V1= (1.18)

AN: V1= =>V1=7,85m/s

V₁ < 40m / s (Limit speed of trapezoidal belts)

### **1-3-5 Choice of theoretical center distance: Eth**

The value of the theoretical center distance is given by the relationship (1.1)

Soit 1 d’où d+Eth (1.19)

NB: 100+Eth

For space reasons Eth = 600mm

### **1-3-6 Calculation of the belt pitch length: Li**

The value of the pitch length is given by the relation (1.20)

L1=2 (1.20)

AN: 2600+ (100+150) +

The list of reference lengths for narrow SPZ belts (see annex 5) allows you to choose Ln= 1600mm

**Ln = 1600mm**

### **1-3-7 Calculation of the actual center distance: Er**

The value of the actual center distance is given by the relationship (1.21)

Er= (1.21)

AN: Er= 600+= 603,23

**Er= 603,23mm**

### **1-3-8 Calculation of the admissible power: Pa**

The value of the admissible power is given by the relationship (1.22)

Pa=P0CLa[50] (1.22)

CL: facteur de longueur

a : facteur d’arc

* **Calculation of arc factor: a**

**=** d’après TEXROPE a=0,99 (annexe 6)

* **Calculation of the length factor: CL**

The factor of the length is given by the relation (1.23)

CL= (1.23)

AN :

CL=1,6

* Calculation of the power transmissible by the belt

the admissible power is given by the relationship (1.24)

P0 (1.24)

Nb : P0= = 1,5, d’apres TEXROPE P0=1,7 (annexe 5)

where Pa= P0 CLa

Nb: Pa= 1,71,60,99= 2,69

where Pa= 2,69

### **1-3-9 Calculation of the number of belts:n**

The number of belts is given by the relationship (1.25)

n = (1.25)

Nb: n=

n = 1belt

### 

### **1-3-10 Calculation of the winding angle of the primary belt on the driving pulley:**

The Value of the wrap angle is given by the relation (1.26)

=180°-2Sin-1(D-d) [51] (1.26)

Nb: =180°-2Sin-1(150-100) = 175,24

**= 175,24° = 3.05 rad**

**Summary of characteristics:**

* Diameter of the receiving pulley: D = 150mm;
* Type and number of belt: 01 trapezoidal belt spz 1600;
* Pitch length of the primary belt: Ln = 1600mm;
* Actual center distance: Er - 603.23mm.

### **1-3-11 Transmission between the motor shaft and the secondary shaft**

The aim is to determine the characteristics of the transmission between the pulleys (**13**-**15**) and the belt **14**

Data:

✓ P - 0.912KW necessary driving power of the blower;

✓ Nm 1500rpm Engine rotation speed;

✓N - 600rpm: Blower rotation speed;

✓d = Diameter of the driving pulley (100mm).

* Calculation of the service power: P,

given that the machine operates 8 hours per day, the service factor will be Ks= 1.12 and the service power will be given by the relationship (1.27)

Ps= Pc. KsPs= 0,9121,12= 1.02Kw (1.27)

**Ps=1.02Kw**

**Ps**= 0,183KW and Nm=1500trs/min, where the chosen belts are of type **spz** (annexe 4)

### **1-3-12 Calculation of pulley diameters**.

According to the formula of transmission ratios, the diameter of the pulleys is given by the relation (1.28)

K**=**= d’ou  (1.28)

Nb: =250mm

250mm

D₂ = 250mm (standard diameter of the blower) (annex 5)

* **Calculation of the linear speed of the belt:**

The linear velocity will be given by the relation (1.29)

V2= (1.29)

Nb: V2== 13,08m/s

V2=13,08m/s

V2 < 40m/s (V-belt limit speed)

* **Choice of theoretical center distance: Eth1**

The theoretical center distance is given by the relationship (1.30)

= , 1 where d+Eth13( (1.30)

Nb: 100+3(275 Eth11050

275

For security reasons **Eth1=400mm**

* **Calculation of the pitch length of the belt: L2**

The pitch length of the belt is given by the relation (1.31)

L2=2 Eth1+(+[38] (1.31)

Nb: L2=2+(+= 1254,06mm

The list of reference lengths for narrow SPZ belts (see annex 5) allows you to choose

Ln = 1387mm

**Ln = 1387mm**

* **Calculation of the real center distance: Er2**

The real center distance will be given by the relation (1.32)

Er2= Eth1+ [53] (1.32)

Nb: Er2= 400+= 466,47

**Er2=466,47mm**

* **Calculation of the admissible power: Pa**

The admissible power will be given by the relation (1.33)

Pa= P0CLa (see annexe 3) (1.33)

Po: power transmissible by belt

CL: length factor

a: arc factor

* **Calculation of arc factor: a**

The value of the arc factor is given by the relationship (1.34)

= = 0,32 from TEXROPE **a=0,95** (annexe 5) (1.34)

* **Calculation of length factor:** **CL**

The length factor is given by the relationship (1.35)

CL=(annexe 5) (1.35)

Nb : CL== 1,387

where **CL=1,387**

* **Calculation of the power transmitted by the belt**

The power transmitted is given by the relation (1.36)

P0= ; P0== 2,5 from TEXROPE P0=2,5 d’où Pa = P0CLa (1.36)

AN: Pa= 2,51,387= 3,29

**Pa=3,29**

* **Calculation of the number of belts: n**

The number of belts is given by the relation (1.37)

n = (1.37)

Nb : n = so n=1belt

* **Calculation of the winding angle of the primary belt on the driven pulley: 0₂**

The winding angle will be given by the relation (1.38)

=180°-2sin-1 (1.38)

Nb:=180°-2sin-1=159,01°

**159,01°**

**Summary of characteristics of the driven pulley**:

* Diameter of the driven pulley: **D₂ - 250mm**
* Type and number of belt: **01 V-belt spz 1387**
* Pitch length of the primary belt **Ln = 1387**
* Real center distance: **Er2=72mm**

## **1.4 -** **Sizing of shafts, keys and choice of bearings**

### **1.4.1- Sizing of belt tensions**

* T and t tensions

A dynamic study must be carried out on the driving pulley in order to bring out the different tensions

**Hypothesis**

✓ Friction forces assumed to be uniform over the entire length of the winding arc

✓ The effects of centrifugal force will be neglected on the belt

✓T tension of the taut strands (in N);

✓ t slack side tension (in N);

✓ ϴ1 winding angle around the drive pulley ϴ1 = 3.05rad;

✓ Radius of the bigger pulley R1= 50mm, and for the smaller pulley R=25mm

✓ Motor torque Cm in N

1. Slack side tension and taut side tension

The tensions will be given by the relations (1.39) and (1.40)

(1.39 ;1.40)

1. Installation tension

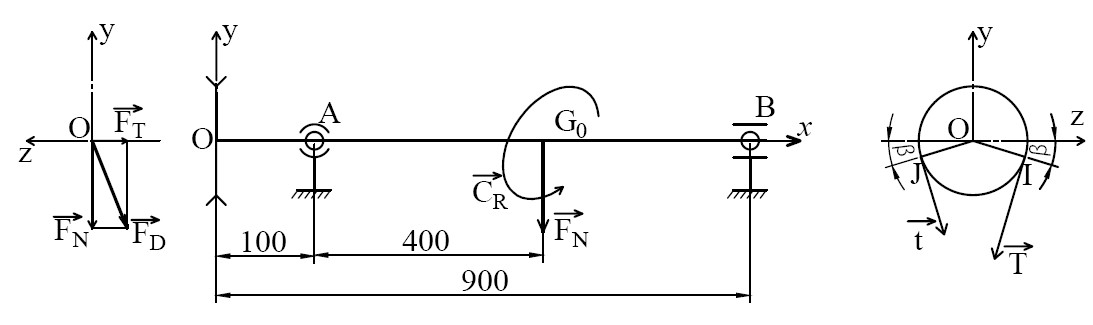
The installation is given by the relation (3.41)

T0= (1.41)

Nb :

### **Static study of the receiving shaft**

Figure 3.4 represents a model of our shaft of transmission



**Figure 1.5**:Modeling of the receiver shaft.

* hypotheses and data

✓ The tree is homogeneous and isotropic;

✓ The links are assumed to be perfect;

✓ The weight of the shaft is neglected;

✓ The space is related to the reference (0, x, y, z);

✓ Θ2 angle of inclination Θ2=10.45

**Assessment of the torsors** (here C=G (the center of the shaft)

● torsor at point O

= avec =

= +=

**=**

* Torsor at point A:

=

* Torsor at point B:

=

* Torsor at point C:

=

* Reduction of the torsor at point A :

= with

**=**

= with =

**=**

* =

**=A**

From the fondamental principle of dynamics

=

+ +=

The expressions of the torsors in the reference (O, x, y, z) are:

**=**

**=**

**=**

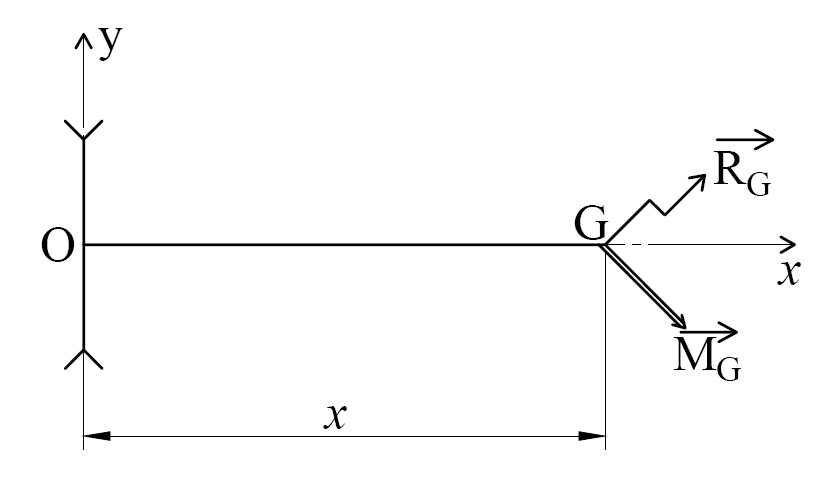
**=**

### **1.4-3** **Torsor of the forces of cohesion along the shaft**

It is a question of determining the forces of internal cohesion in order to check the conditions of resistance of the shaft; for this, a study will be carried out on a series of cuts along the shaft.

*a) section 1:*

For the first cut represented below



**Figure1.6:** Modelling of the cut section [OA [.

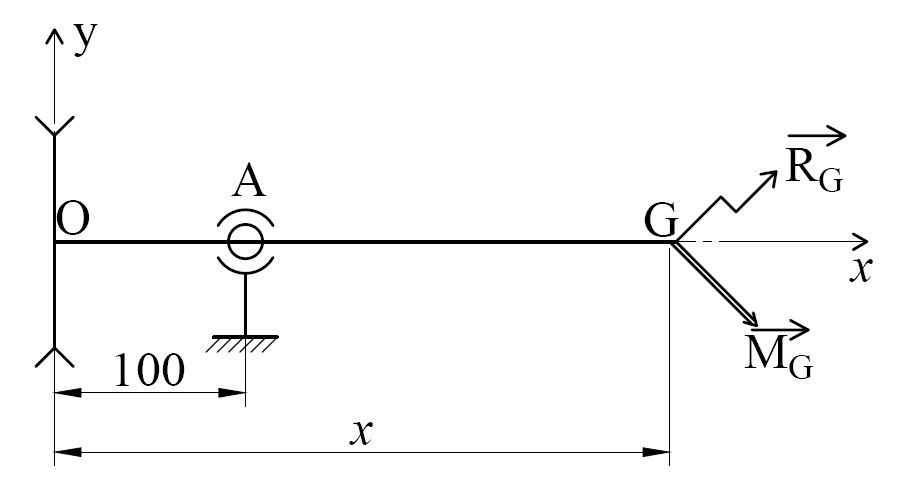
* Torsor of the mechanical action of cohesion at point G
* Extreme values

Table I.1: Summary of extreme values on the section *[OA [*

|  |  |  |
| --- | --- | --- |
|  | **0** | **100** |
|  | 0 | 0 |
|  |  |  |
|  |  |  |
|  | -3726.25 | -3726.25 |
|  | 0 | -1687 |
|  | 0 | -14657 |

**Table 1. 1:** Summary of extreme values on the section [OA [.

1. *section 2:* **here C=G (the center of the shaft)**



**Figure1.7:** Schematization of the imaginary cut of the section [AG [.

From the FPS

+

+

=

=

* Extreme values

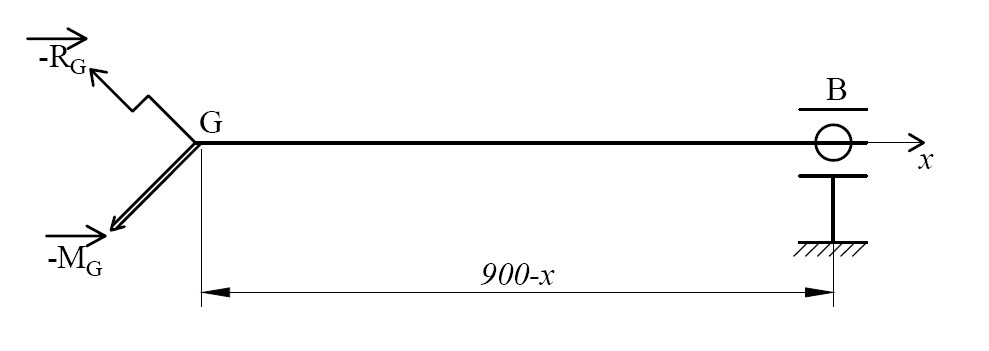
Table I.2: Summary of extreme values on the section *[AG [*

|  |  |  |
| --- | --- | --- |
|  | 100 | **500** |
|  | 0 | 0 |
|  |  |  |
|  |  |  |
|  |  |  |
|  | -1687 | -2835 |
|  | -14657 | -139229.3 |

**Table 1. 2:** Summary of extreme values on the section [AG [.

c)Section 3 ***:***

figure I.10 presents the schematization of the imaginary on section [G0 B [.



**Figure1.8**: Schematization of the imaginary on section [G0 B [.

G=

* Extreme values

Table I.2: Summary of extreme values on the section *[BG [*

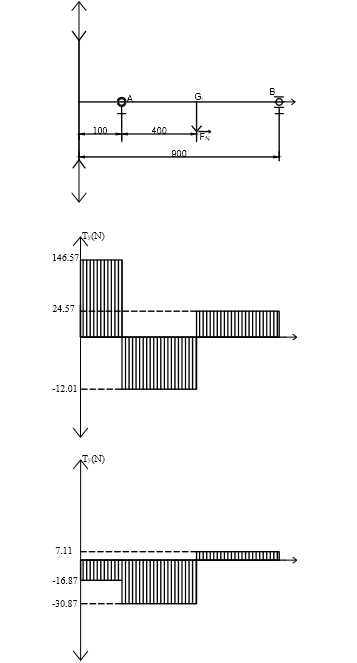
|  |  |  |
| --- | --- | --- |
|  | 500 | **900** |
|  | 0 | 0 |
|  |  |  |
|  |  |  |
|  |  |  |
|  | -2835 | 0 |
|  | -139229.3 | 0 |

**Table 1. 3:** Summary of extreme values on the section [AG [.

### **1.4-4 Effort diagram**

a) diagrams of cohesion efforts

figure I.11 presents the diagrams of cohesion efforts.



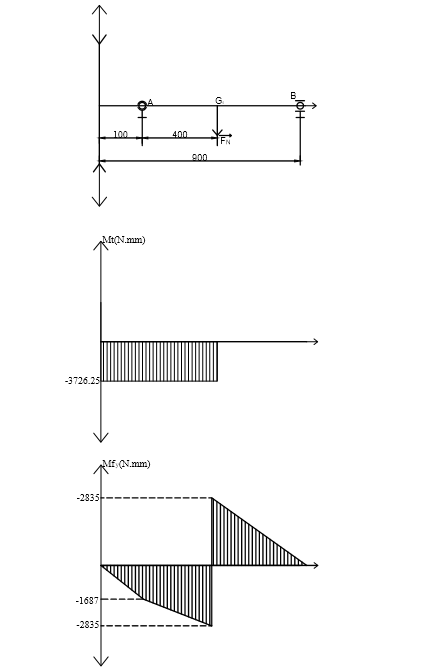
**Figure1. 9**: diagrams of cohesion efforts.

### **1.4-5 moment diagram**

a) diagrams for moments of cohesion

figure I.11 presents the diagrams for moments of cohesion.

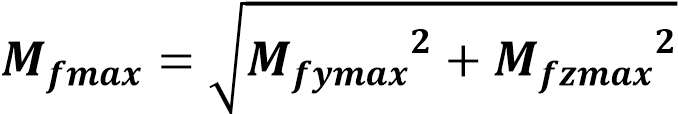
**Figure1.10:** diagrams for moments of cohesion



*.*

According to the diagrams of the forces and the moments presented one can deduce that the most requested section is in Go and in this point, one has the maximum values

* Tymax =146.57
* Tzmax =30.87
* Mtmax =3726.25
* Mfymax =2835
* Mfzmax =139229.3

****

Mfmax =139258.16 N.mm

## **Static and dimensional study of the blower shaft**

In this part, the mechanical actions on the shaft of the blower will be determined, and to do so the following assumptions will be accepted on the study of the system:

* The biddings are assumed to be perfect
* ϴ2 winding angle around the drive pulley ;
* Radius of the small pulley R2
* Friction forces assumed to be uniform over the entire length of the winding arc:
* The effects of centrifugal force will be neglected on the belt;
* T tension of the taut strands (in N);
* t slack strand tension (in N);

1. **Static modelling**

r

**Figure1.11:**Static modelling of the blower shaft

The shaft is subject to simple torsion; thus, we have two couples of opposite moments with respect to the mean line

1. **Cohesion torsors**

The cohesion torsor has the section (s) of surface center G is defined by; (T-t) R= Cm

### **1.5.1 Determination of the diameter of the principal shaft**

* **Calculation of the ideal moment of torsion**

Mit= (3.44)

Nb: Mit=139337.99Nm

* **Calculation of the ideal bending moment**

Mif =

Mif =139325.53Nm

* **Resistance condition for bending and torsion**
* Bending study (normal stress)

According to the VON MISES criterion, we have the relation (1.45)

(1.45)

d≥ 22,78mm

* Torsion study

Remember that: Mit=139337.99Nm

According to the TRESCA criterion in this case we have:

with

Then the value of the minimum diameter is given by the relation (1.46):

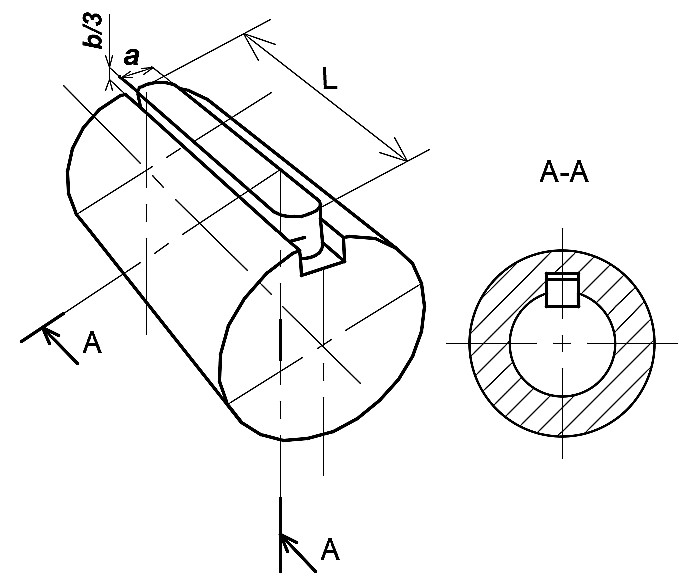
d3 (1.46) d

According to the torsion and bending resistance characterization study, the minimum diameter deduced is: d2 19.94mm.

Taking into account the different section variations along the shaft, the stress concentrations that the shaft could undergo during the various operations (keying, etc.); the choice of diameter is: d = 25mm This diameter will be used on the secondary shaft (blower); the main shaft being more stressed we will take a diameter of d=60mm.

### **3.6.8- The shaft’s key choice**

The goal here is to make the choice of the key with respect to the diameter of the shaft. therefore, the figure below represents the modeling of the key mounted on the hub



**Figure 1.12:**modeling of the key a×b×l

For the determination of the minimum length of the key, certain assumptions will be admitted Assumptions:

* Choice of the key: parallel key of form A in mild steel S185;
* The diameter of the receiving shaft D = 30mm;
* Section key S = 10x8 with a = 10mm and b - 8mm;
* PmL value limit mounting pressure 70Mpa;
* Pa: pressure at the hub key contact;
* F: Resultants of mechanical actions on the side of the key;

a) Calculation of the force

The force will be given by the relation ( 1.47 )

=FrF= (1.47)

NB : F=124.20N

b) Determination of the length of the key

In the application of unmounting conditions, the following relations are obtained:

Pa PmL (1.48)

Pa= avec

L (3.51)

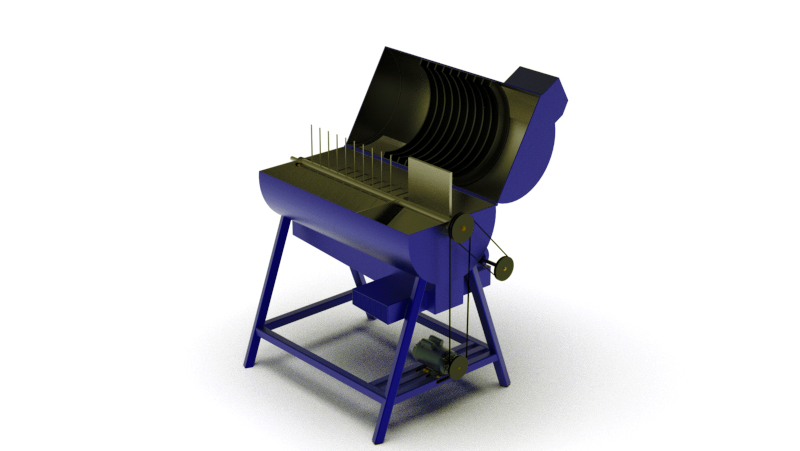
AN: L0.44mm

The selected key will be, a **type A parallel key of dimensions 6 x 6 x 35 ( appendix 6 )** .

# **CHAPTER II: GRAPHIC STUDY**

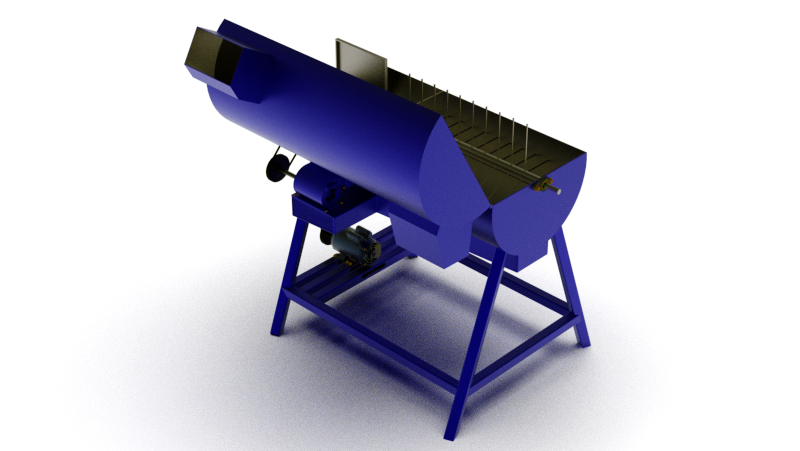
Here we will present to you the 3D drawing of the BEAN UNWRAPPING MACHINE and 3D drawing of certain parts, as well as the definition drawings of certain parts of the machine. To this presentation is added the calculation of several operating conditions.

## **II.1 3D DRAWING OF THE BEAN UNWRAPPING MACHINE AND 3D DRAWINGS OF CERTAIN PARTS**

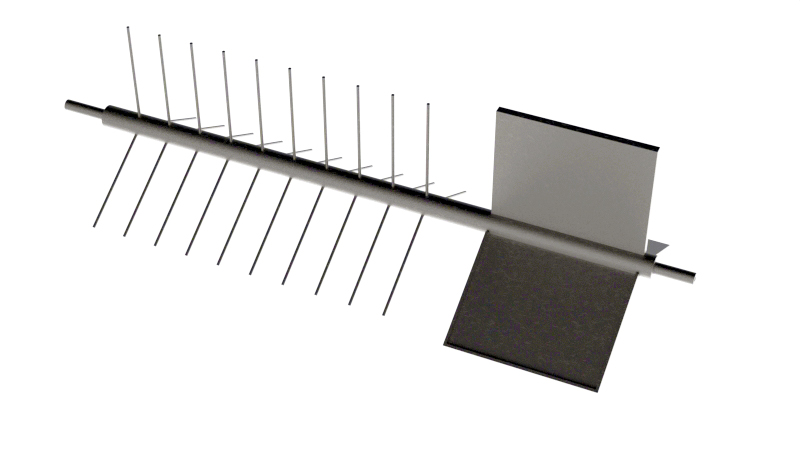


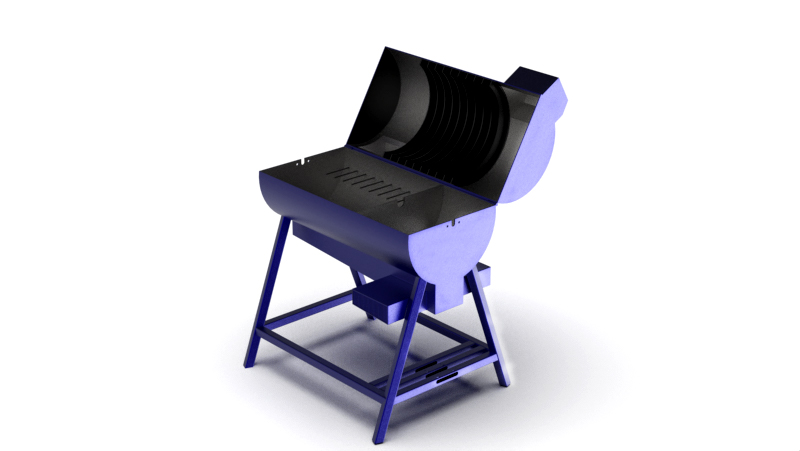
## 

## Here we will present the overall appearance of the bean unwrapping machine in space, as well as that of some parts that we have deemed useful to show.



**Figure 2.1:** Beans unwrapping machine





1. *b)*

**Figure 2.2:** Frame and the shaft

**2.1 Functional dimensioning**

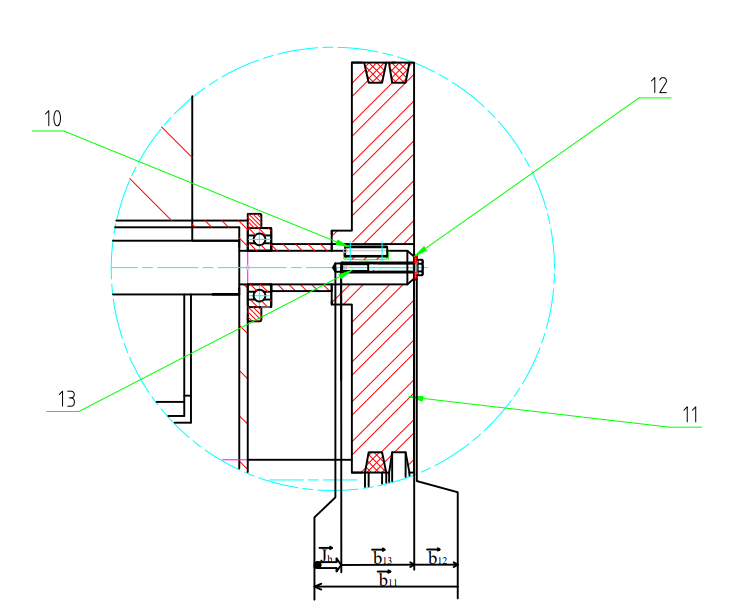
We highlight in this part, for each gap that we judged important for the proper functioning of the beans unwrapping machine, the rib chain followed by the calculation of the gap relating to this chain.

## **II.2.4.1 Calculation of the clearance *Jb***

This is the functional clearance between the washer **12** and the bolt **10** which ensures the blocking of the bicycle to permit it to stay on top of the ground**.**

* Cotation chain:the drawing in Figure II.3shows the layout of the cotation relative to*Jb.*

**Figure 2.3:** cotation relative to Jb



Role: Space which permits the fitting of the shaft **5** with the poulie **11**

Data

Jb =  , b12 =  , b13 =  , b11 =?

* Calculation of Jb

b = 12+ 13+11

* Functioning condition

bmin = 12max+ 13max )+11min

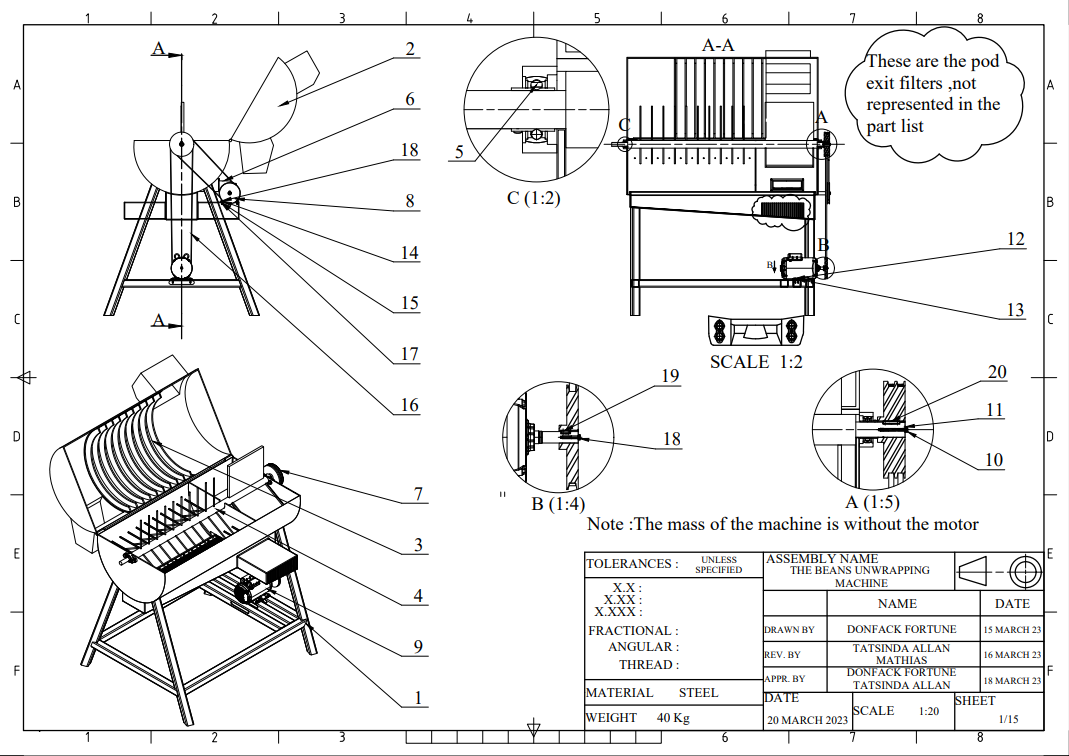
11min= 12max+ 13max +amin

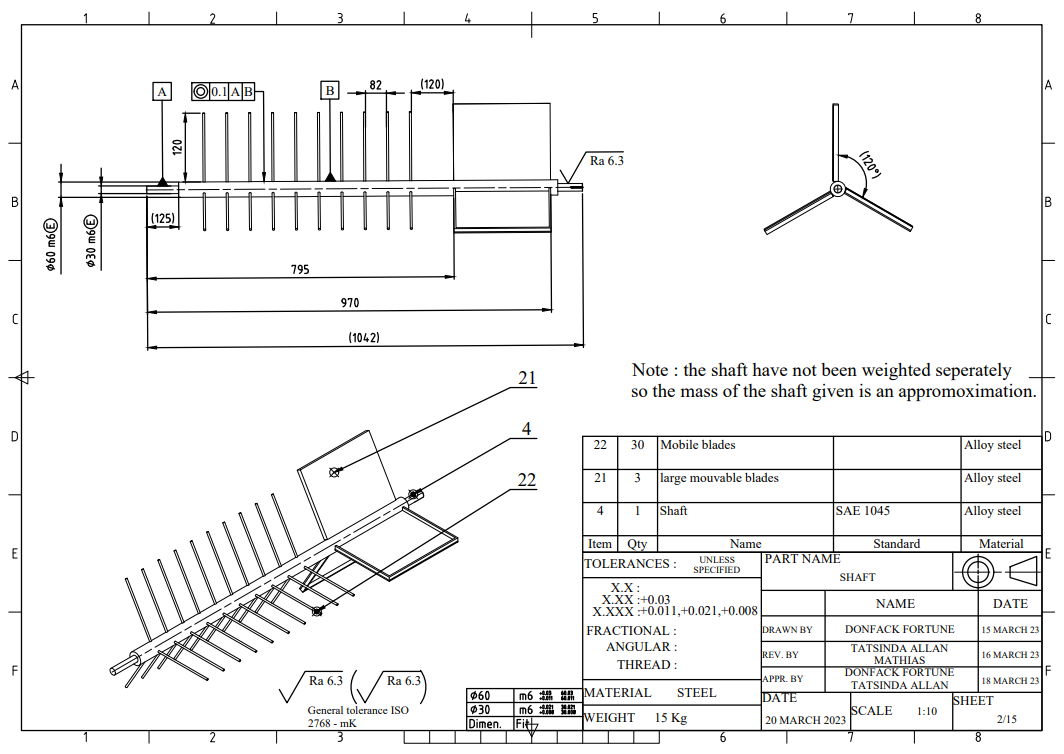
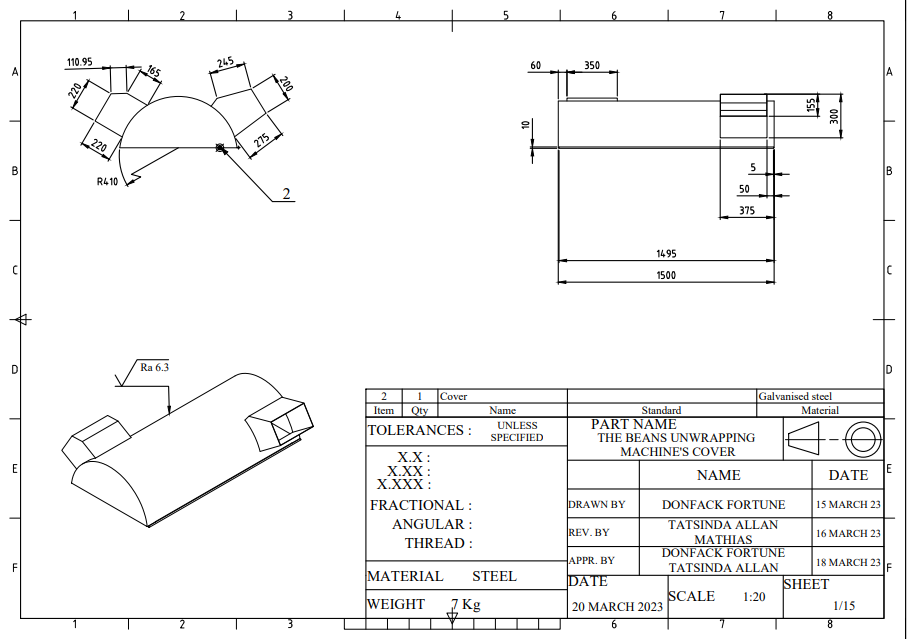
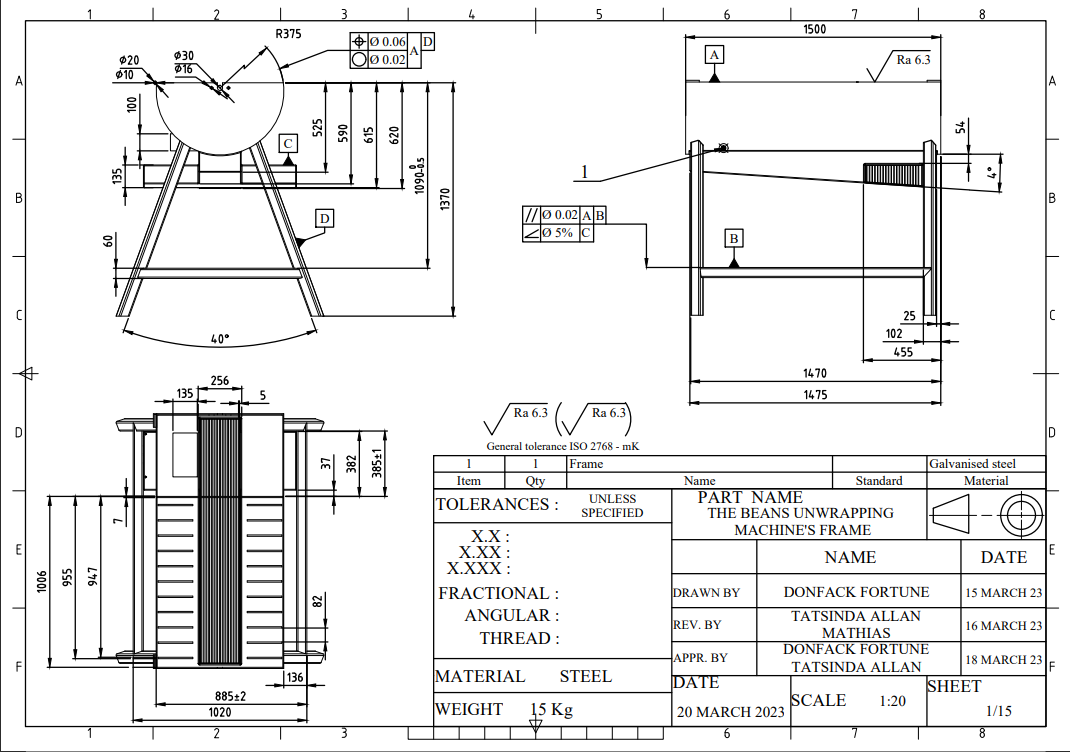
11min = 24.2

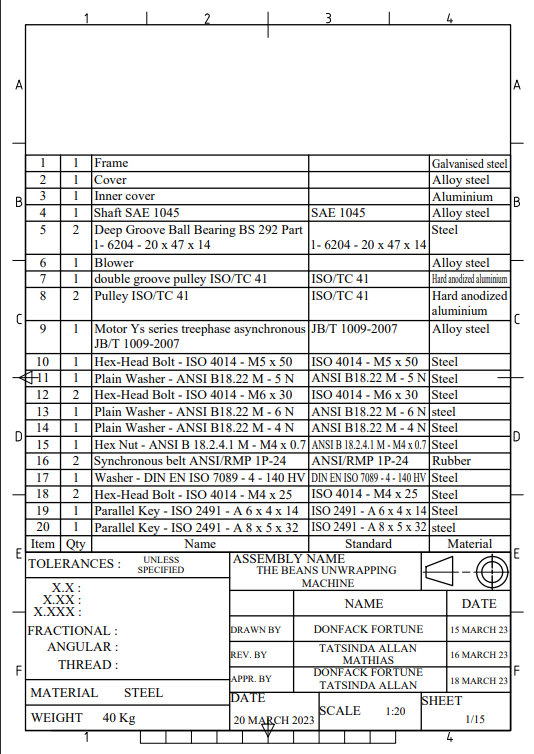
11max = 25.8

b

## **II.2.4.2) Definition drawings**





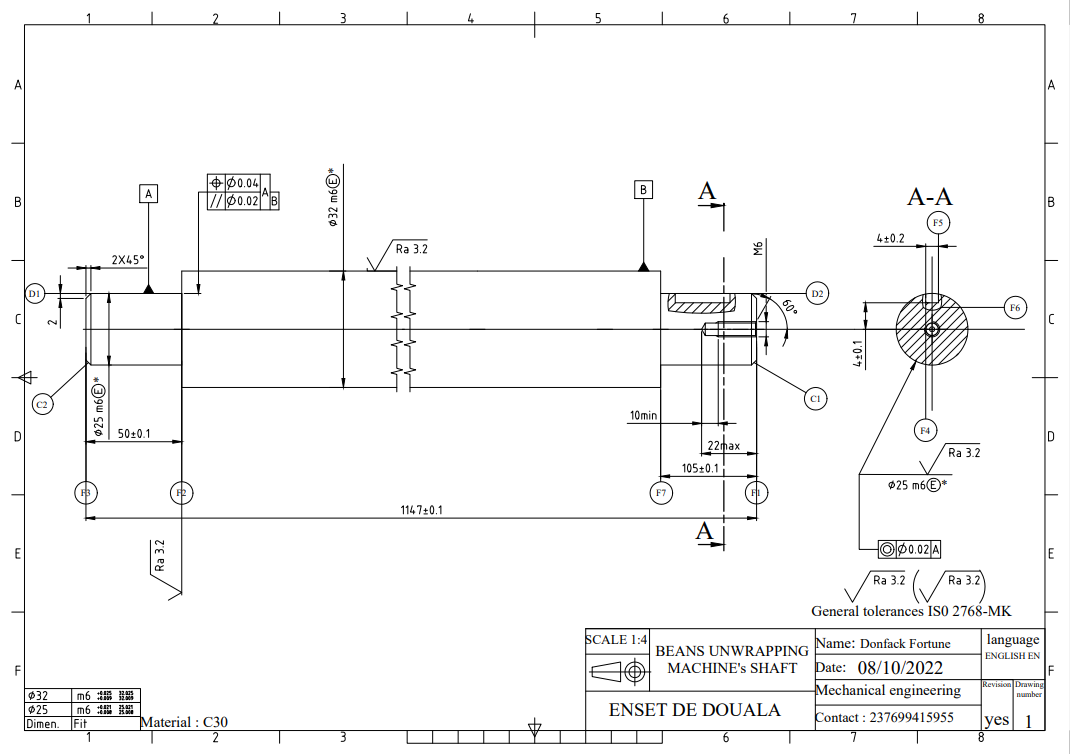


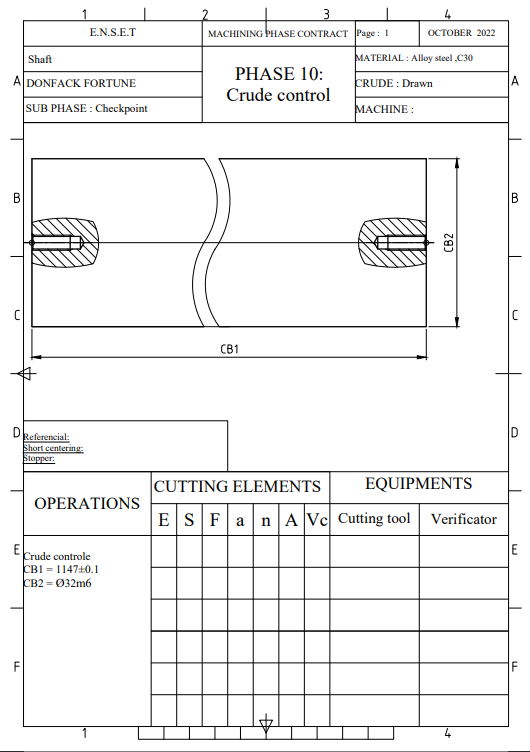
# **CHAPTER III: PRODUCTION STUDY**

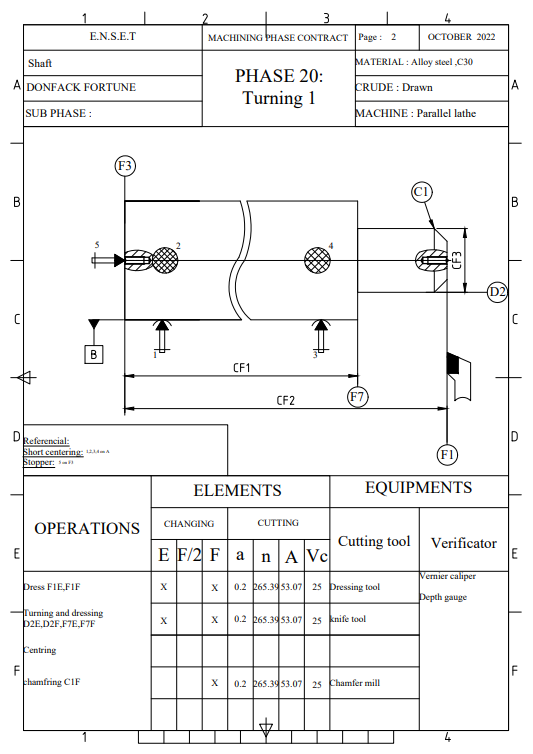
In this chapter it was a question of making the manufacturing analysis of the main shaft and of making the diagnosis in terms of the production of a prototype and of proposing a preventive maintenance schedule for the purpose of optimizing the duration of proper operation of the beans unwrapping machine. This is why the manufacturing analysis is presented first and the cost estimate second.

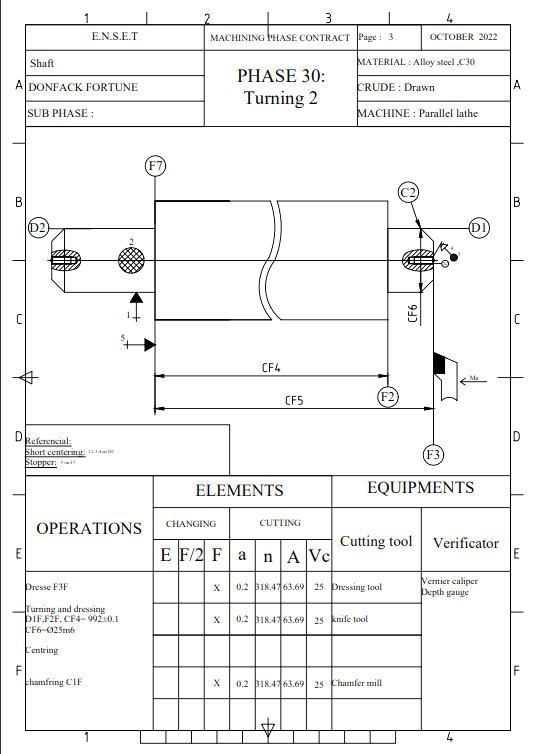
## **III.1 MANUFACTURING ANALYSIS**

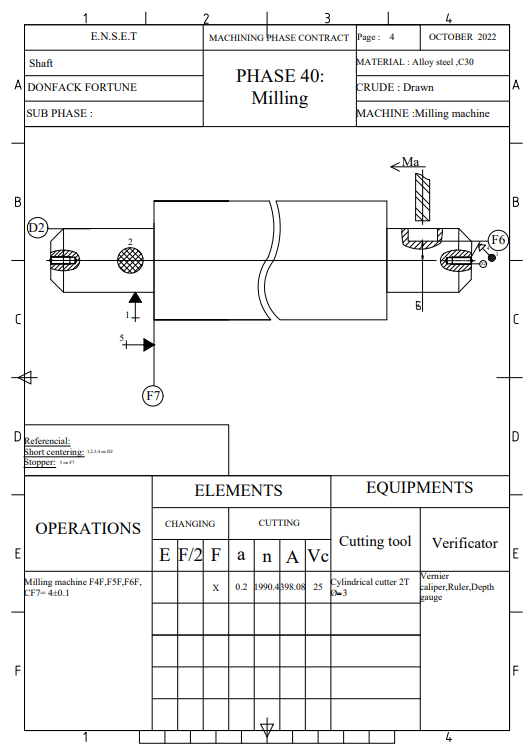
The manufacturing analysis of the main shaft is given by the following;

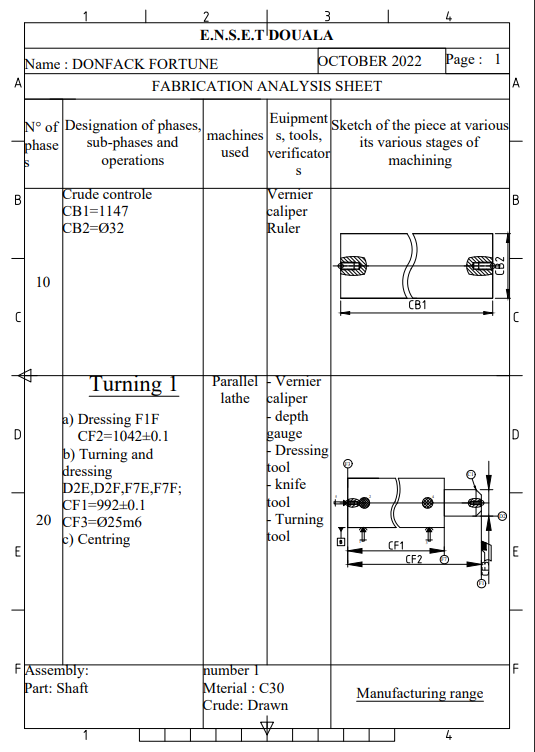


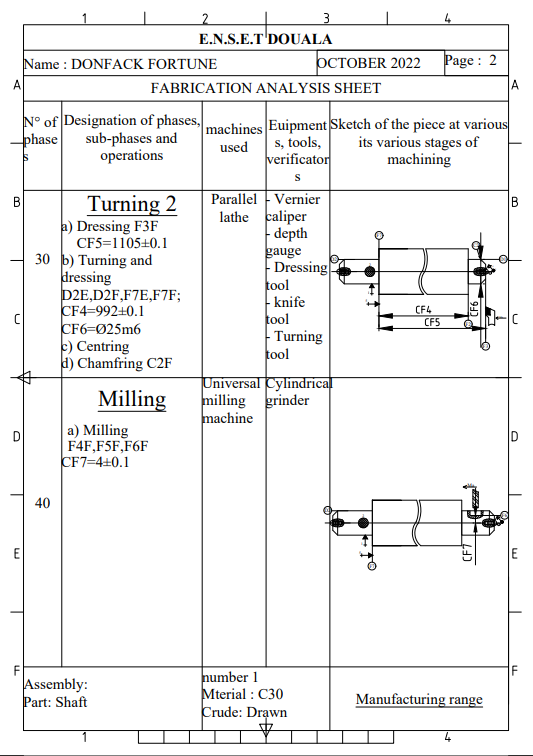












## 

## **III.2 COST ESTIMATES**

In this part, it was a question of presenting a prototype of the beans unwrapping machine, presenting the difficulties encountered during the realization of the prototype, evaluating the cost of the realization and of giving the user manual of the machine.

### **III.2.1 Presentation of the prototype**

The design and construction of the bean unwrapping machine with automatic sorting requires knowledge of mechanical construction and mechanical manufacturing, precision machining and considerable financial resources. Figure II.2 is a 3D drawing of the beans unwrapping machine prototype after completion.

### **III.2.2 Manufacturing difficulties**

During the realization of the prototype of the beans unwrapping machine, we encountered practical difficulties. Here are listed a few:

* Find the bean;

## **III.2.3 Evaluation of the cost of the realization**

This is to highlight all the expenses that we had to make during the realization of the prototype of the beans unwrapping machine.

### **III.2.3.1 Estimation of the cost of the work material**

In this part it is a question for us to list all the materials purchased for the realization of this prototype and to highlight the total cost. Table III.1 presents the estimate of the materials for the work.

**Table 3.1**: Estimated cost of materials.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ENSET OF DOUALA | | | |  |
| WORK: BEANS UNWRAPPING MACHINE | | | | |
| CLIENT: EVERYBODY | | | |  |
| WRITTEN BY : DONFACK FORTUNE | | | | |
| N° | DESIGNATION | QTE | UNIT PRICE | TOTAL  PRICE |
| 1 | Bean | 1 | 15000 | 15000 |
| 2 | Aluminum drive pulley 100 | 1 | 7000 | 7000 |
| 3 | Aluminum receiving pulley 150 | 1 | 9000 | 9000 |
| 4 | Aluminum secondary pulley 250 | 1 | 12000 | 12000 |
| 5 | Grinding disc | 10 | 1200 | 12000 |
| 6 | Cutting disc | 8 | 500 | 4000 |
| 7 | Regular chopsticks (Paquet) | 2 | 30000 | 60000 |
| 8 | Paint + brush + diluent |  | 10000 | 10000 |
| 9 | Screw HM8 | 8 | 500 | 4000 |
| 10 | Nut HM8 | 8 | 500 | 4000 |
| 11 | V-belt | 2 | 2500 | 5000 |
| 12 | Bearings | 2 | 35000 | 70000 |
| 13 | Galvanized steel drum | 1 | 50000 | 50000 |
| 14 | Square tube 40×40×2,6 | 3 | 8000 | 24000 |
| 15 | Basic chopsticks (package) | 1 | 25000 | 25000 |
| 16 | Black sheet | 1 | 12000 | 12000 |
| 17 | steel sheet 20/10e | 2 | 45000 | 90000 |
| 18 | Iron of 5 | 2 | 3500 | 7000 |
| 19 | Engine (leased) | 1 | 50000 | 50000 |
| Total 1 : T1=cost of material | | | | 470000 |
| Stopped the present sum of: four hundred and seventy thousand CFA francs | | | | |

III.2.3.2 Estimating the cost of production

This estimate consists of presenting the cost of the various manufacturing operations, namely the machining operations and the finishing operations. Table IV.2 presents the cost estimate for the manufacturing operations.

**Table 3.2:** Estimated cost of manufacturing operations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ENSET OF DOUALA | | | | |
| WORK: BEANS UNWRAPPING MACHINE | | | | |
| CLIENT: EVERYBODY | | | | |
| WRITTEN BY : DONFACK FORTUNE | | | | |
| N° | DESIGNATION | NUMBER  OF HOURS | TIME  HOUR | TOTAL AMOUNT |
| 1 | Drilling | 5 | 1000 | 5000 |
| 2 | Welding | 45 | 1000 | 45000 |
| 3 | Cutting | 15 | 1000 | 15000 |
| 4 | Folding | 6 | 500 | 3000 |
| 5 | Turning | 10 | 2000 | 20000 |
| 6 | Assembly | 6 | 500 | 3000 |
| 7 | Grinding | 15 | 1000 | 15000 |
| 8 | Painting | 6 | 1000 | 6000 |
| Total 2: T2=cost of manufacturing operations | | | | 112000 |
| Approved this estimate for the sum of: one hundred and twelve thousand CFA francs | | | | |

### **III.2.3.3 Logistics and transport**

Table III.3 below shows the expenditure for logistics and transport.

**Table 3 3:**Logistics and transport

|  |  |  |
| --- | --- | --- |
| WORK: BEANS UNWRAPPING MACHINE | | |
| CLIENT: EVERYBODY | | |
| WRITTEN BY : DONFACK FORTUNE | | |
| N° | DESIGNATION | AMOUNT (CFA) |
| 1 | internet connection for 5 months | 50000 |
| 2 | Transportation | 30000 |
| 3 | Miscellaneous expenses | 50000 |
| Total 3 : T3=cost of logistics and transport | | 130000 |
| Approved this estimate for the sum of: one hundred and thirty thousand CFA francs | | |

### **III.2.3.4 Labor cost estimate**

Our machine was designed for a period of one month (30 days). Considering the academic program of the second semester, we worked six hours (6h) of time per day. A working day (6 hours) is billed at 3000 FCFA, hence the cost of labor T4 = 90000 FCFA.

### **III.2.3.5 Estimation of the cost of manufacturing a prototype**

The following calculations allow us to obtain the cost of manufacturing a prototype of the beans unwrapping machine. We have among others:

* Total amount excluding tax (MTHT) = T1 + T2 + T3 + T4: the total amount excluding tax is 802,000 FCFA;
* VAT amount (VAT) = 19.25% × total amount excluding taxes: the VAT amount is 154385 FCFA;
* Final total amount (MTF) = MTHT + VAT: the final total amount is 956385 FCFA.

So the cost of manufacturing a prototype is 956385 FCFA.

### **III.2.3.6 Project budgeting**

The beans unwrapping machine will be used by CIGs and SMEs, thus allowing large-scale production throughout the national territory. An estimate of the investment budget for the manufacture of fifty (50) machines at the rate of five (05) per region was made using the following calculation:

Investment budget = (25% × MTF × 50) + 21% × MTF = 12155654 FCFA.

Hence the budgeting of the project for the manufacture of fifty (50) machines is estimated at 12155654 FCFA.

### **III.2.3.7 Estimation of the selling price of a machine**

* Unit cost price = investment budget ÷ number of machines: the unit cost price is 243114 FCFA;
* Profit on a machine: we opt for a profit margin of 20% of the unit cost price. Hence Profit = 25% × Unit cost price: the profit is 60779 FCFA;
* Unit sale price = Unit cost price + Profit: the unit sale price is 303893 FCFA.

We therefore estimate the selling price of a machine at 303893 FCFA.

## **III.2.4 User guide**

For correct use and long life of the machine, the following instructions must be observed.

### **III.2.4.1 How to use the machine**

For correct use of the machine, the following steps must be followed:

* Make sure beforehand that the bean pods are well dried
* Mount the belt on the two pulleys and start the motor;
* Gradually pour the bean pods into the hopper;
* Check the unwrapping performance at the outlet provided for the seeds; when the latter is satisfactory, continue adding the pods to the hopper;
* Once the operation is finished, stop the engine and clean the machine.

### **III.2.4.2 Machine maintenance**

The maintenance of the machine is carried out by respecting the following rules:

* Avoid using the machine for purposes other than those for which it was designed;
* Dry and sort the seeds by putting the particles (stones or other objects) out of use;
* After use, clean the sheath using a blower or vacuum cleaner.

### **III.2.4.3 User security**

For the safety of the user, safety measures must be observed, namely:

* Never insert your hand into the machine when the engine is running;
* In the event of blockage or intrusion of particles (stones or other objects) please switch off the engine before attempting any repairs.

# **GENERAL CONCLUSION**

This study was conducted to design and build a machine to unwrap beans and automatically sort the seeds. The goal of the machine was to save time and labor for operators, separate the pods from the seeds without physical effort, and obtain a hygienic product without damaging the environment. The machine, called the BUR machine, was designed to be suitable for all varieties of beans without any adjustments, and it has a yield of over 95%.

The machine meets all of the requirements set out in the specifications, including a yield of over 70%. The hopper and sheath are made of galvanized steel for food safety reasons, and a motorized system is used to save physical effort. The BUR machine has the potential to revolutionize the bean processing industry by significantly reducing costs, improving efficiency, and increasing product quality. The machine could help bean processors to meet the growing demand for high-quality bean products in a more sustainable way.

The study encountered some challenges, such as the high cost of galvanized steel sheets and the difficulty of finding a high-quality three-phase motor. However, I believe that the machine has the potential to be a valuable tool for the bean processing industry. Moreover, regarding the amelioration perspectives, I recommend that further work should be done to develop a system to pre-dry the bean pods.

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