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# VIRTUAL PROTOTYPE MODELLING AND ANALYSIS OF LOW COST HAND OPERATED MAIZE DESHELLER

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## ABSTRACT

**The farmers in regions of North Karnataka are very poor, cannot afford power operated maize shelling machine due to high cost. Shelling of maize is done by beating or by nibbling the cobs with fingers. Shelling by beating causes injury to the grains whereas nibbling with hands involves long time and drudgery. Hence a Low cost hand operated Maize Sheller is designed using Virtual Prototyping which mainly consists of shelling unit, power transmission shaft, bearings, supporting base and crank with handle. First all the components were designed and assembled using Solid Edge V19 software. The power from hand was transmitted to the driving shaft and then to the shelling unit. 3D model of Maize Desheller was imported in parasolid format to ADAMS software and conducted the kinematic analysis. Simulation results are presented graphically on the graphs, which show the values of the measured torque and force parameters are given input to ANSYS work bench to do stress analysis. The developed Hand operated Maize Sheller was tested in field as well as operations at load for short durations. The analysis of data collected during the short duration test revealed that the machine is stable and strong and its speed of operation 60 rpm was quite satisfactory. The shelling capacity of the machine was 24 kg/hr with shelling efficiency of 99.95 % and cleaning efficiency of 99.37%. The breakage percentage was 0.406 which is well within the prescribed limit for such machines. The labour requirement was reduced by 89.60 % using this machine.**

**KEYWORDS :** Virtual Prototype, 3-D CAD, Simulation, ADAMS, FEA, Desheller, Maize

In many rural areas of developing countries, the maize corns are removed from the cob by hand. Existing alternatives to shelling maize by hand are often unaffordable or difficult to obtain for subsistence farmers. An estimated 550 million small-holder farmers in the world lack access to mechanized agricultural technology. Generally harvesting of maize crop is being done manually with traditional hand tool sickle. After harvesting, cobs are plucked manually by hand and cobs are dried in sunshine to reduce moisture content to 15-21%.

Industrial maize shellers are prohibitively expensive, with a cost range of Rs.60, 000-90,000; small-scale hand-cranked or pedal-powered maize shellers cost range of Rs.10, 000 -25,000, which is still more than many families can afford. While industrial shellers are highly productive, their energy infrastructure requirements can render them unusable in rural villages. (J. N. Nwakairea, 2011). Furthermore, mechanized equipment and stationary pedal-powered devices are difficult to transport to the users. As a consequence, farmers may be required to travel long distances to process their crops or the technology may not be able to reach the communities who need it most.

In general machinery fabrication industries, CAD technology has been very widely applied to various fields. But Farm machinery still remains an the primary stage, which based on hand work such as objects, models and drawings and samples to complete the whole process of Farm machinery body design method without using the modern CAD design software tools. At present, foreign farm machinery companies have started to use CAD modern technology, while problems such as not precise enough, long design cycle still exist in domestic agricultural machinery companies.

## METHODS AND MATERIALS

Revisions had been made to adopt various improvements in the design of the machine that may affect its performance. The main changes are listed below: An average moisture content of 15% to 18% for maize that was to be threshed or shelled was reported by (Fashina, A.B. and Abdulahi, H. 1994.). Moisture content seriously affects the thresh ability of maize. Another factor that affect the thresh ability of maize in a mechanized system is the size of the maize cob. The mechanical shellers need to be adjusted to the various sizes of cobs. According to (Joshi, H.C. 1981) the various sizes of maize cob ranges from 50mm to 85mm depending on variety.

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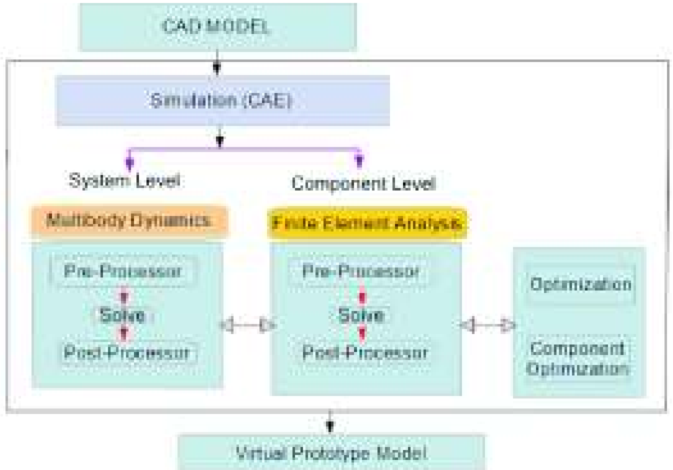


**Figure 1: Virtual Prototype Based Design Approach**

primary stage, which based on hand work such as objects, models and drawings and samples to complete the whole process of Farm machinery body design method without using the modern CAD design software tools Rajashekar[9]. At present, foreign farm machinery companies have started to use CAD modern technology, while problems such as not precise enough, long design cycle still exist in domestic agricultural machinery companies

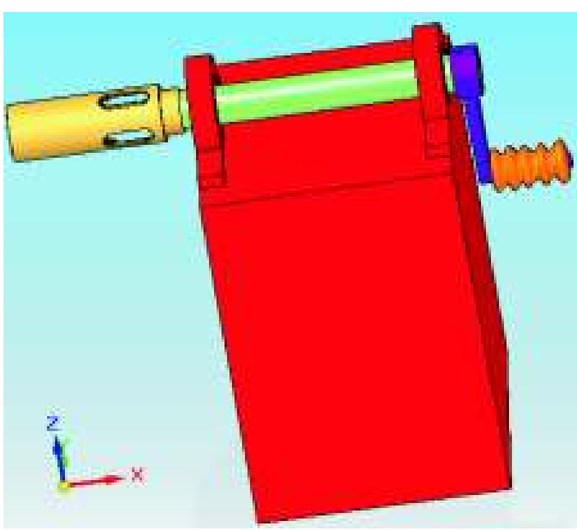


**Figure 2 : Solid Edge CAD model of Maize Desheller**

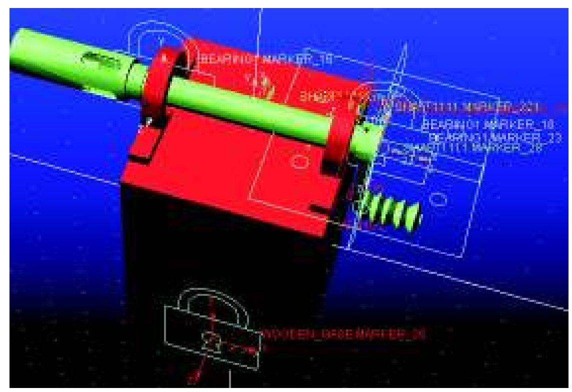

**Figure 3: Imported Assembly Parts Reaming in ADAMS**

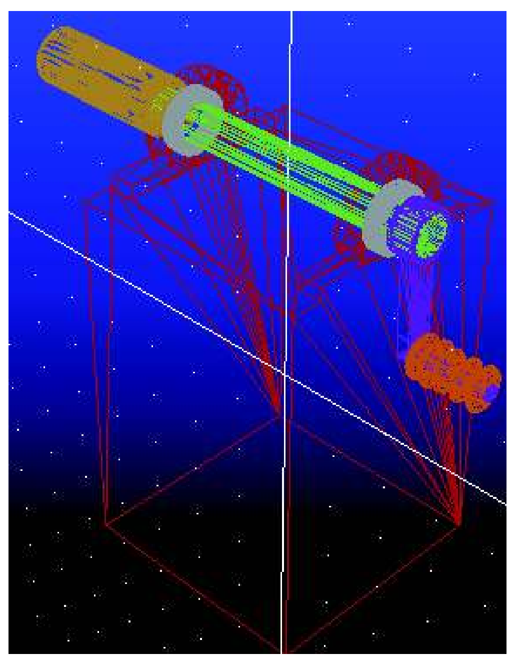

**Figure 4 : Wire Frame Model of Maize Desheller in ADAMS**

**Table1 : Physical Properties of MAIZ Corn**

| Sl.No. | Particulars | Detail |
|---|---|---|
| 1 | Mean diameter,mm | 53.5 (+) 5.5 |
| 2 | Mean length, mm | 223.4 (+) 23 |
| 3 | Weight of cob, g | 80 to 260g |
| 4 | Grain moisture content, % | 15-21 |

**Table 2 : Performance Criteria for MAIZ Corn Sheller**

| Performance Criteria | Data |
|---|---|
| Shelling Recovery, %, minimum | 97.0 |
| Shelling Efficiency, %, minimum | 99.5 |
| Losses, %, maximum | 03.0 |
| Purity, %, minimum | 98.0 |
| Mechanically Damaged Kernel, % | 03.0 |
| Net Cracked Kernel, % maximum | 05.0 |

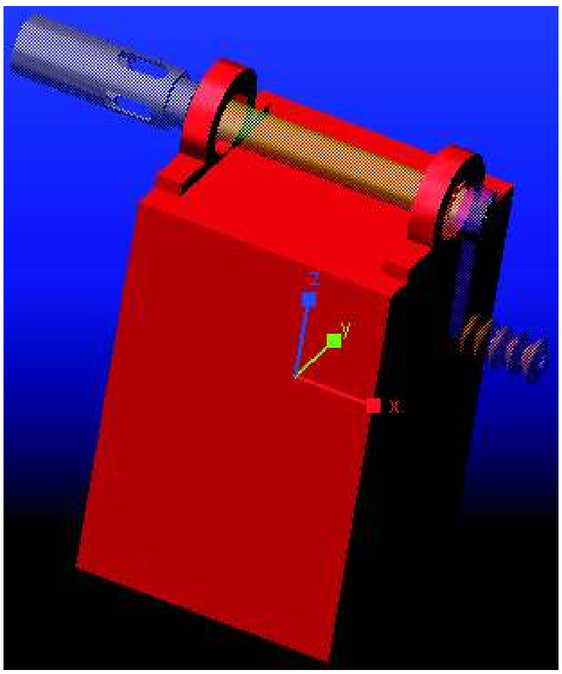

**Figure 5 : ADAMS Model with Materials Properties**

**A. Design considerations**

Involves the data collection from farmer needs and other problems and then design of an appropriate Sheller to meet their needs, and determine whether their problem was solved. The uniqueness of this design is that it works on a different principle of threshing. The earlier mentioned design by [1], worked on the principle of impact force, while this design works on the principle of abrasion; an application of force tangentially on a surface. On the field determination of farmer shelling capacity was determined.

- definitions and classifications of corn and corn sheller;
- performance criteria were changed based on the result of actual test conducted
- performance parameter was included to meet the set performance criteria;
- materials of construction for shelling elements was specified; and

Force required to thresh the maize is given by

$F = m\omega^2 r$------------------------------------ (2)

Where F = force required to Deshell maize corn,

m = mass of threshing bars,

ω = angular velocity of shaft.

$\omega = 2\pi N/60$---------------------------------- (3)

Where

N = speed of Deshelling which is in revolutions/min

The power delivered by the shaft is

$P = F\omega r$. -------------------------------------- (4)

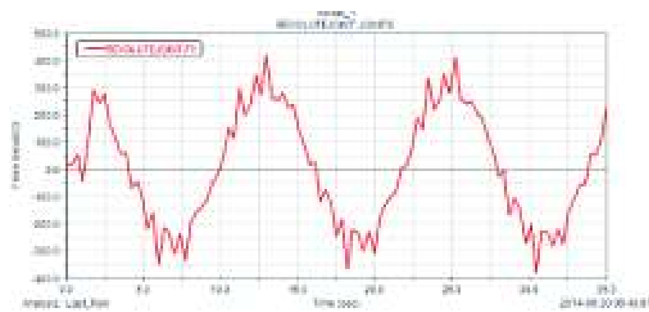

**Figure 6 : Variation of Force on Crank Handle**

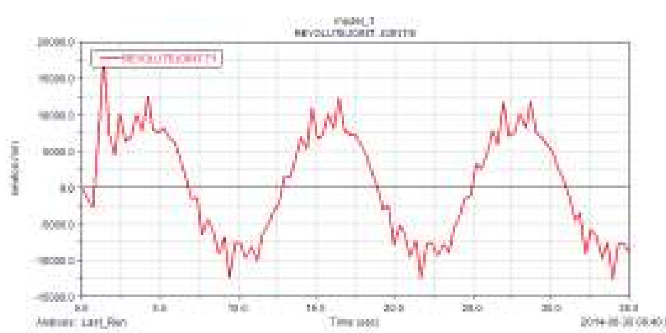

**Figure 7 : Variation of Torque on Crank Handle**

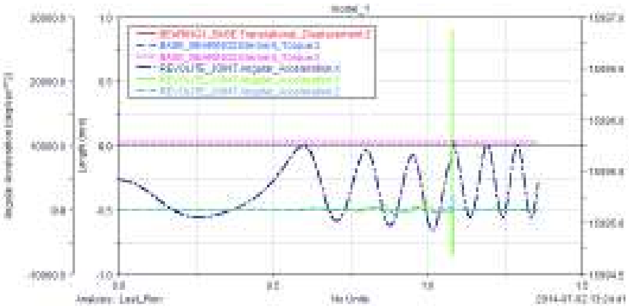

**Figure 8 : Variation of Torque and Acceleration Components**

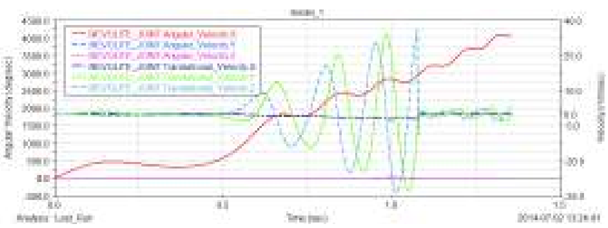

**Figure 9 :Revolute Joint Angular and Translational velocity components**

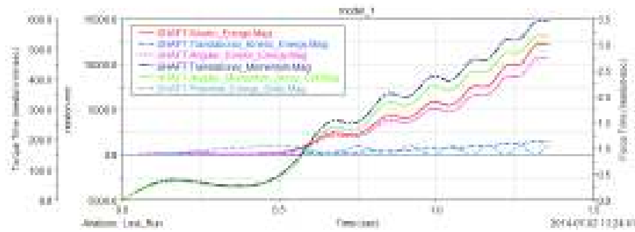

**Figure 10 : Variation of Kinetic and Potential Energy Components on Shaft**

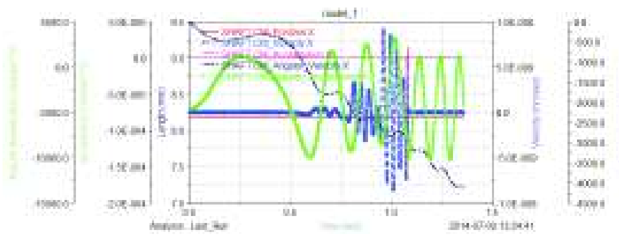

**Figure 11. Shaft Position, Velocity and Acceleration v/s Time**

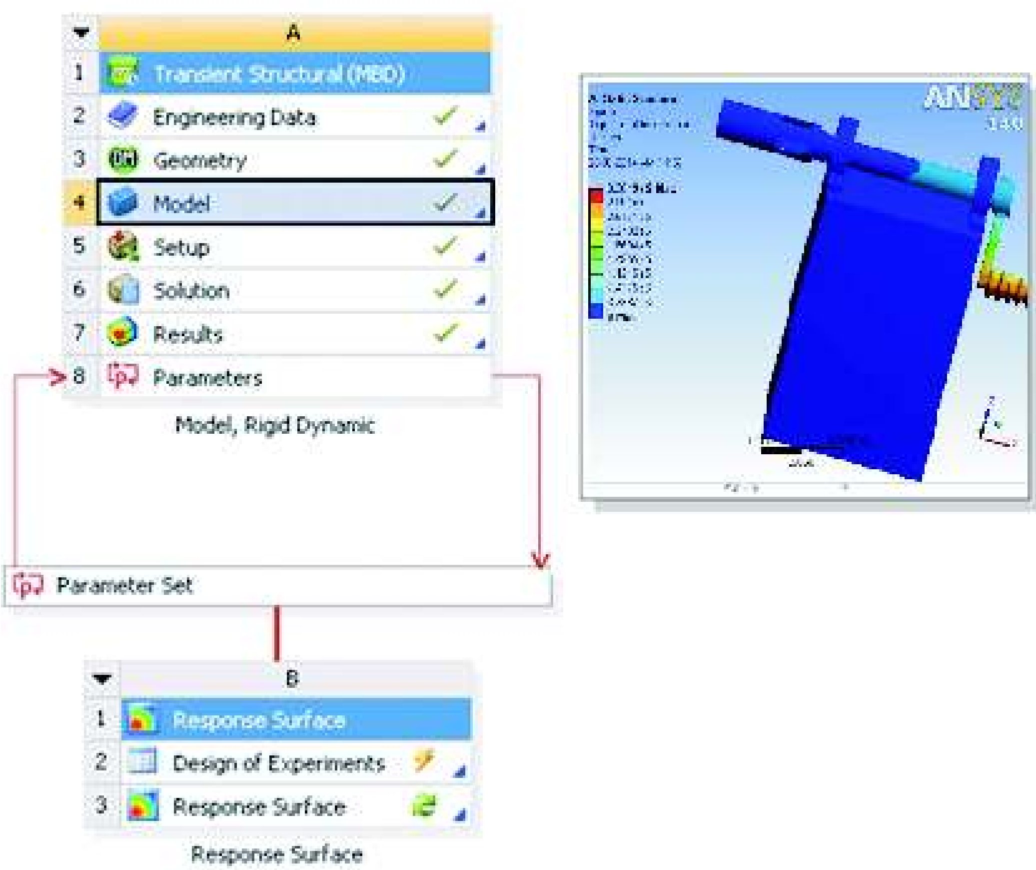


**Figure 12 : Stress Analysis of Maize Desheller using ANSYS Workbench**

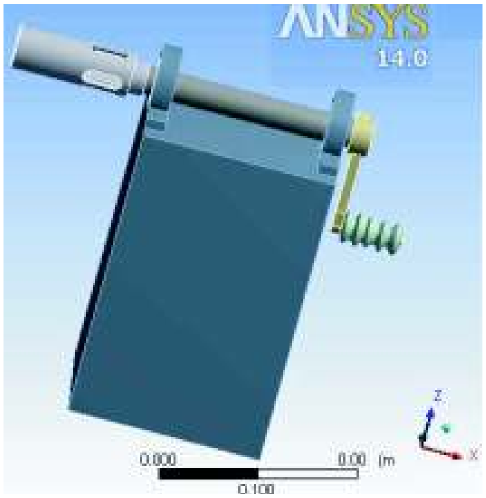


Figure 13 : Imported Sheller Assembly (.step format) in ANSYS

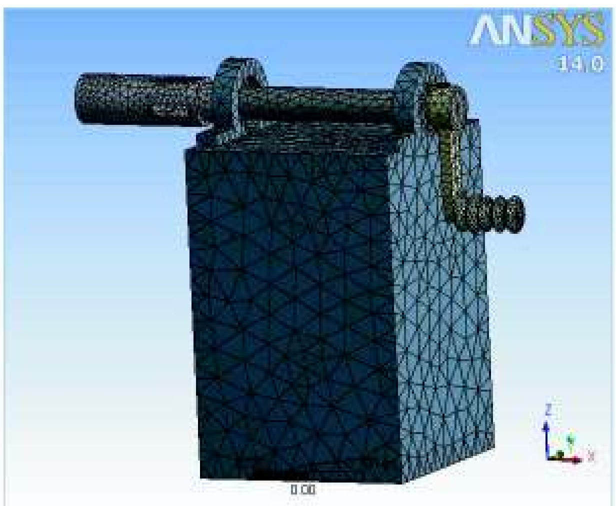


Figure 14 : FEA Meshed Desheller Model

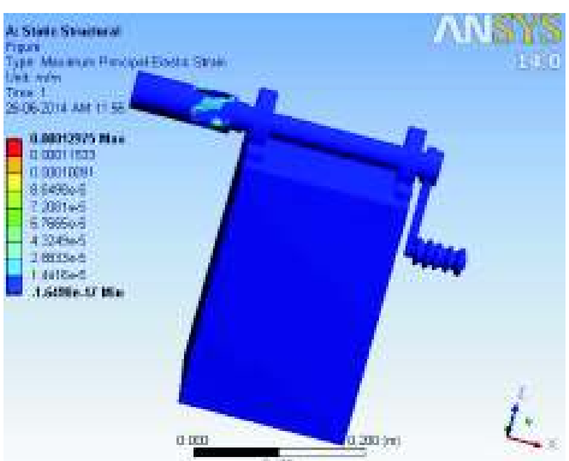


Figure 15 : Maximum Principal Elastic Strain occurs at Sheller unit

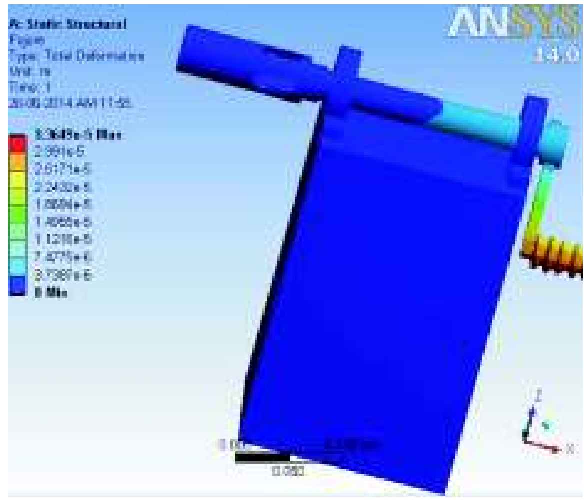


Figure 16 : Total Deformation occurs at Desheller transmission shaft and handle

## CONCLUSION

The analysis of kinematic behaviour of the Sheller unit with a shaft mounted on bearings. The supporting wooden frame predicted the behaviour during operation already at the simulation design process. The use of computer method allowed reflects a real behaviour of Maiz Desheller. Obtained a rich collection of results, both in the form of tabular or graphic. This has led to take action to achieve the best solutions for each element of machine construction and eliminate any collision. The next stage of works will be field tests of prototypes of machines which will verify the correctness of developed kinematic analysis. The economic benefits of using maize Sheller come from replacing the labour costs involved in manual shelling. It was not a problem for farmer or owners of maize shellers to estimate labour required for shelling one acre of maize cobs because they were accustomed to hand-operated shellers in the past. Farmers reported that it takes 15 - 20 person-days to manually shell an acre of maize at 30 kg per hour. Using 15 person-days, we calculate substituted labour costs.

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