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MODELLING AND VALIDATION OF LOG PULLING ARCH

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Abstract - *Timber production is only one of the reasons that families own woodlands, many owners like the idea of being able to cut and use some of their own timber, regardless of whether you are gathering fire wood for your own use or making lumber and wood products for a profit, removing logs or poles from the woods can be challenge, this is especially true because most wood land owners do not have commercial logging equipment specifically designed to safely and efficiently drag and haul logs from the woods. In many instances their designs can make them inherently dangerous when dragging timber from the woods. A number of steps can be taken to ensure your safety when dragging logs and poles from the woods with tractors or four wheelers, and a number of equipment manufacturers have designed attachments to allow for the safe removal of timber with these types of equipment. A large number of attachments have been designed to help wood land owners safely haul logs out of the woods while there are many different designs, they all have one thing in common with commercial logging equipment: They are designed to lift the front end of the logs off the ground.*

Key Words: Log, Arch, Frame, Haul, Tong, woodland

1. INTRODUCTION

A healthy forest often requires some active management. An enlightened manager may wish to remove small numbers of logs from the forest without damaging what is left behind:
1) To salvage individual blow down trees as an ordinary periodic chore.
2) To carry out a judicious timber thinning for the benefit of the remaining trees in the stand.
3) To undertake a systematic small wood harvest as a modest commercial venture, while preserving most of the best trees.

Logs are usually large and heavy relative to people. Major challenges when moving logs from the forest include lifting great weights on unpredictable terrain, overcoming friction, protecting residual vegetation and assuring personal safety at all times. Large scale loggers overwhelm these problems, often recklessly when operating on other people's property, with massive and expensive mechanized equipment that can create serious environmental problems by damaging vegetation and soil. Large equipment operators are also inclined to remove the largest and best trees, which is frequently inadvisable for the continued prosperity of the forest. There are many advantages in using smaller and less expensive log-moving equipment, but such equipment is just now becoming available in this country. The devices described below are suitable for small-scale, low-impact logging in the forests, where parcels are small, tree growth is slow, soils are vulnerable to long-term damage, and the prominent commercial loggers are irresponsible.

1.1 Elephant Logging

Elephant logging is not just a relic of the past. It is still being used today. With elephant logging, trees are generally felled and bucked by hand with a chainsaw and then skidded by single elephant or a team of elephants.

Fig. 1 Elephant Logging

The elephants are equipped with a harness and haul either a single or double tree load, depending on whether using a single elephant or a team. Many elephant loggers use a bar with chain hooks attached to it and hook the logs with short chains. Some use small skidding arches, which are basically a set of wheels that get the front of the logs off the ground, increasing the load that an elephant can pull.

1.2 Conventional Logging

With conventional logging, trees are felled by hand sawyers and either bucked into logs and limbed in the strip, or tree-length skidded into the landing and then limbed and bucked by hand into logs. After being

felled, the trees or logs are skidded with either crawlers or rubber tired skidders that are fitted with skidding winches and arches. The winch is fixed with a long piece of heavy cable that is the mainline. Chokers with sliders are placed on the end of the mainline.

Fig. 2 Conventional Logging

The operator backs up to the first log, drops the blade down and sets the brake. Then the winch is put into neutral and the operator pulls the mainline and chokers to the first log.

2. DESIGN PROCESS

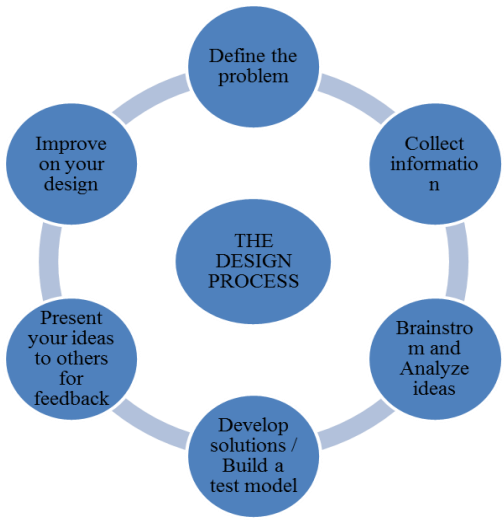

Fig. 3 Design Process

The notion of useful work is basic to machine functioning, as there is always some energy transfer involved. The mention of forces and motion is critical to our concern as in converting energy from one form to another. Machine creates motion and forces. It is an engineer's task to define and calculate those motion, forces and changes in the energy in order to determine the size, shape and material needed for each of the interrelated parts of the machine. The goal in machine design is to size and shape the parts (machine elements) and choose the appropriate material for manufacturing process so that machine is expected to perform its intended function without failure. In this design project there is negligible acceleration so static force analysis will be sufficient. Static force analysis deals with structure which is to be designed against failure to external. The process of design is an essentially exercise in applied creativity. Various design process have been defined to help organize to attack upon un-constructed problem definition is vague for which many solution exist. Some of this design process as shown below consist of 10 steps but it can be extended to 25 steps.

1. Identification of need
2. Background research
3. Goal statement
4. Task specification
5. Synthesis
6. Analysis
7. Selection
8. Detailed design
9. Prototyping and testing
10. Production

Concept of Iteration

The above description may give an erroneous impression that this process can be accomplished in a linear fashion as listed on the contrary iteration is required within the entire process moving from any step back to any previous step in all possible combination and doing this repeatedly. The best ideas are generated at the step (5) will invariably be discovered to be flawed when later analyzed.

Definition stage

For designing and fabricating this log pulling arch, number of methods have been used. First of all a process planning had to be done, this will act as a guide for the next process so that final model meets the requirement and time could be managed. This would determine the efficiency of the project to be done regulating and analyzing these steps are very important as each of it as its own criteria to be followed.

Design of the Tong

When the tong starts to hold the log, the tongs tips are first placed in the gap between the logs. Then the tongs are gradually closed. Since the tong is symmetric in structure, the forces acted on the tong can be described as shown in figure. The resistance distribution on the external face of the tong is discrete and usually does not follow a pattern and varies depending on the method of holding. Therefore, the resultant force is used to represent this resistance in the model.

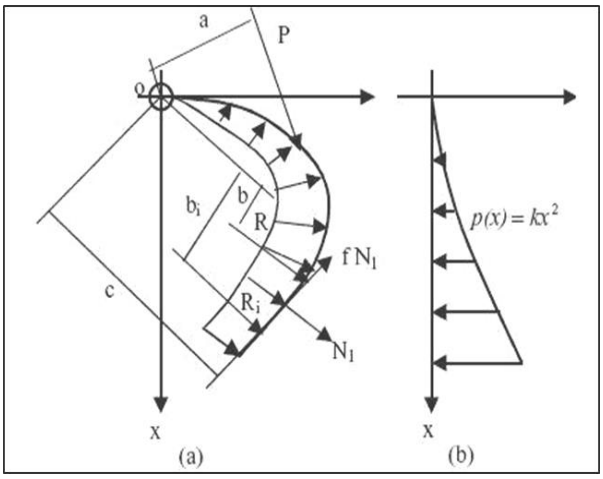

Fig. 4 Diagram of the forces acting on the tong

Comparision of Rolling friction and Sliding friction value

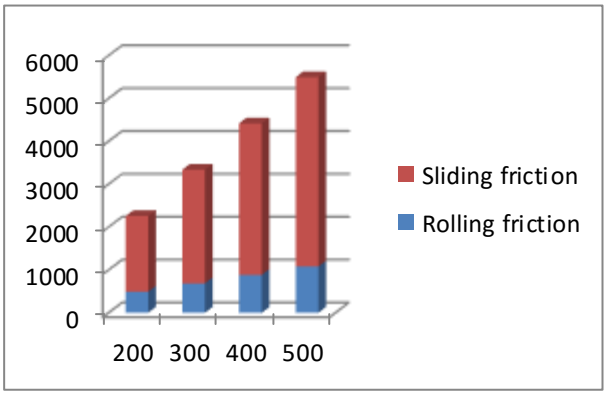

Fig. 6 Force Required (N) v/s Weight of Log (kg)

F. TIMBER DENSITY

Timber varies in density (kg/m^3) based on wood species and moisture content. Freshly cut timber contains considerable moisture and can weight twice as much green-cut as when air-dry (<20% moisture). Typical densities for several species of timber common throughout the Northeast and upper Midwest are listed in Table 1. Because uncut logs dry slowly the green density is generally most representative of recently sawn or down timber.

b. Difference between force required for pulling a log with and without log pulling arch

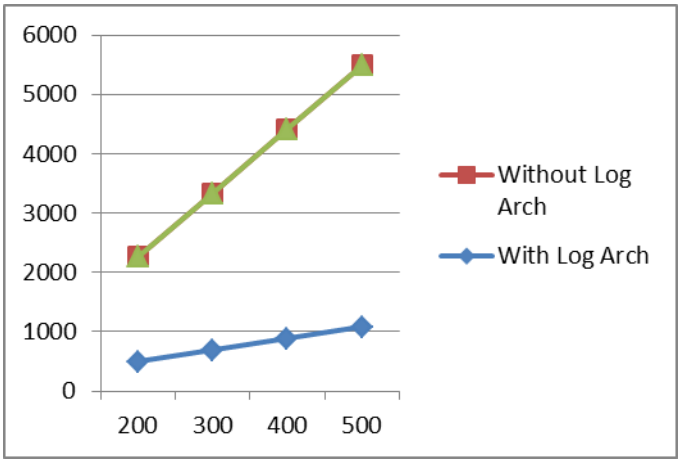

Fig. 7 Force Required (N) v/s Weight of Log (Kg)

Table 1: Typical densities of green and air dry timber

Wood species Green Air-Dry	Density in kg/m^3
Beech	54.46
Cherry	46.36
Cottonwood	60.29
Elm	56.36
Hickory	70.54
Sugar Maple	58.46
White Oak	61.49
Red Oak	63.46
Red Pine	34.33

2. DESIGN PROCESS

A. 3D Drawing

a. Frame of log pulling arch

The below figures shows 3D view of frame, made up of Mild Steel the frame, Handle for Log Pulling Arch, which is made of Mild Steel, Tong for holding the Logs, having sharp pins at the end. The tong is made of mild steel in forging.

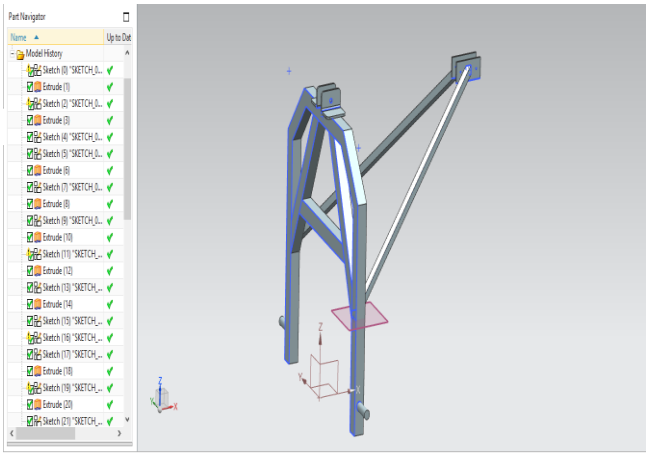

Fig. 8 Frame

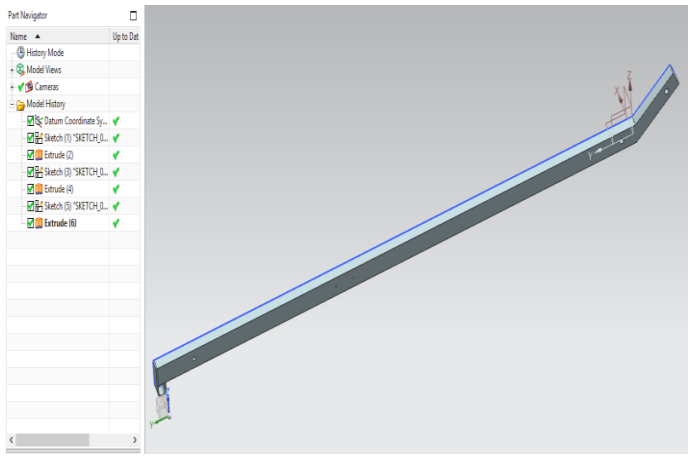

Fig. 9 Handle

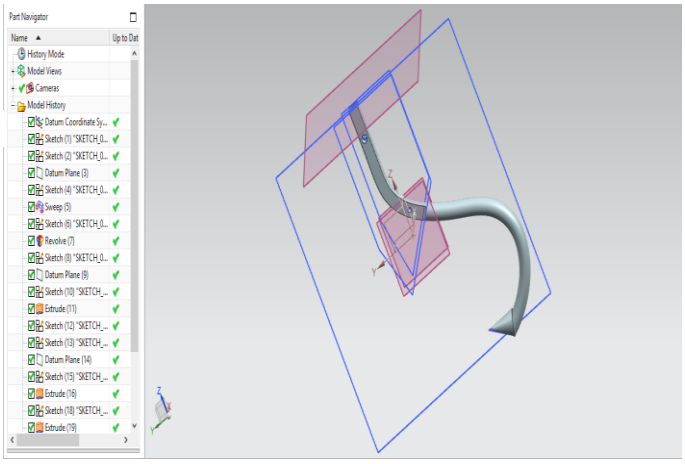

Fig. 10 Tong

Table 2: Parts used in assembly

Sl. No	Parts Name	Quantity
1	Frame	1
2	Handel	1
3	Tong	2
4	Ring	1
5	Chain Link	2
6	Bent hitch pin	2
7	Nut and Bolts	6

2D ASSEMBLY DRAWINGS

a. Isometric view

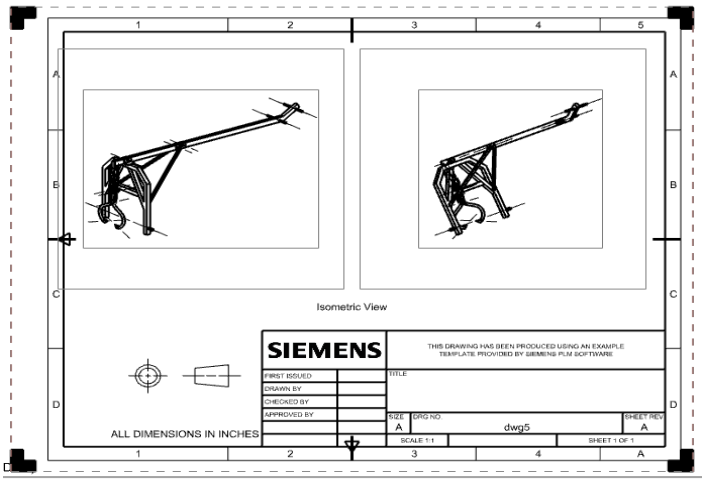

Fig. 11 Isometric view of assembly

WORKING PRINCIPLE

Log pulling arch is an indispensable tool for moving smaller logs by hand. The log pulling arch is light enough to be carried by hand but strong enough to last lifetime. This log pulling arch can also be used for felling hang ups, bunching logs and to cut firewood off the ground. The optional extension handle is used for longer logs or walking greater distance.

For the logs by this arch, first the arch will be straddle on the log, it will be adjusted to find the midpoint or the balance of the log. Such that it will be moved easily without any resistance for the easy movement of the log the reach will be set in the upright position and it is pulled down. For more convince pivot the tongs to the log and by using the handles it can be pulled to the location where it has to be transferred.

Better pulling the log to the desired position the tongs can be released from log pulling arch moving the arch in upward direction. By this the log will be dropped downwards and then strike down on the tongs with the nose of the arch. Buckling of fire wood, before buckling of firewood all the wood should be pre bunched trail

side then set the tongs by straddling arch over the firewood and pull down the reach. Push reach down and set down on the ground near log.

For the log pulling arch to work properly the log should be of flexible length and diameter. Hence in order to pull the felling hung up-trees. It should be cut into proper length and the tongs should be set perpendicular to the trunk of the hung up tree. By pulling down on the reach, the arch will pick the log off the stump you will now pull the log back away from the stump until it falls. Be aware of your path and be prepared to drop the log if it tends to push you the log will act as a brake.

PROCESS FLOW CHART

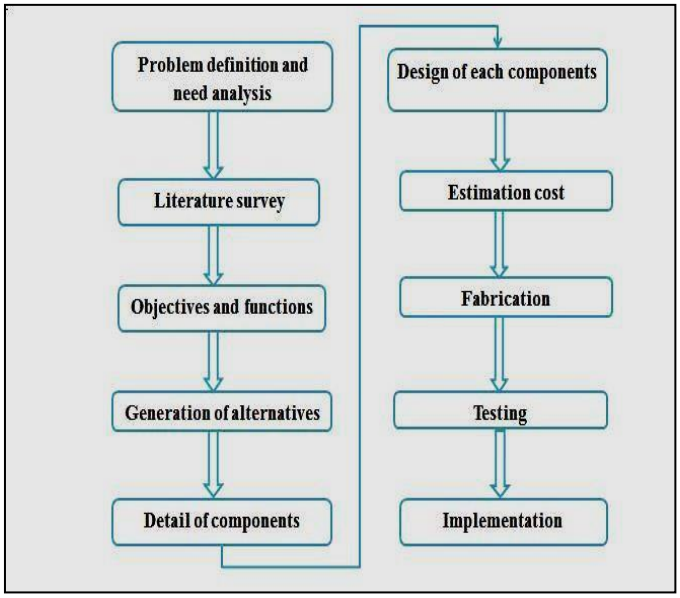

Fig. 12 process flow chart

The flow chat starts with the introduction here the introduction is first plan to start the project. The supervisor request for understanding of the project and make some research about the project title. Student makes project synopsis, objective, and scope of work, problem statement and planning. Once introduction has been done and then superior request for the good understanding of the project. Thus, literature review on the title is done thoroughly covering all the aspect of the project.

The medium for this research are via internet and books. Essential information related to the project is gathered for referencing. In conceptualization, few designs are done using the sketching which is then saved to be reviewed. Sketch four concepts suitable for the project with a 3-dimentional and understanding. The sketching is first step for designer used of the time. The designs and concepts are than reviewed and recalculated to fit the best dimensions and performance of log pulling arch. After four design sketched, design consideration have been made and one design have been chosen. The selected design sketched is then transfer to NX10.0 software for modeling application. Software is used because it gives a better dimension of log pulling arch compared to manual draw and is much easier to use. However, the drawing using software is just a guideline to be followed to improve the log pulling arch.

After drawing is done, the project proceeds to next step that is fabrication process. The finished drawing and sketching is used as a reference by following the measurement and type of material needed. The fabrication process that involved is cutting, welding, drilling, forging and other. After every process was finish, they are check to make sure that the output of the process obeys the product requirement. If all the parts had been processed, the parts are joined together to produce log pulling arch. The log pulling arch will be test to see if it fulfills the requirement such as easy to pull the log and to bring anywhere. During the testing, if problem occur such as can't pull the large logs, the log pulling arch will step back to previous process to fix back the problem. The log pulling arch is expected to have an error that any cause the part to be redesigned again. The log pulling arch is finished by doing some finishing process such as painting.

After all parts had been joined together, the last phase of process that is result and discussion. The finish product will be compair with the report to make sure that there is no mistake on both project and report. After the product and report had been approve by the supervisor, the report is rearrange and print out submit at supervisor, the project coordinator and faculty of Mechanical Engineering. In this stage, the final presentation was also being prepared and waited to be present.

3. CONCLUSION AND FUTURE WORK

The Log pulling arch is an indispensable tool for moving smaller logs by hand it is light enough to be carried by hand but strong enough to last a lifetime. The Log arch can also be used for felling hang-ups, bunching logs and to cut firewood off of the ground. The optional extension handle is used for longer logs or walking greater distances. As it also reduces the labor requirement for transporting the logs is sawmills. Log arches allow for low impact operations in sensitive areas, minimal ground disturbance and clean logs for sawmilling.

Future work

Existing log pulling arch can be used for industrial purpose by changing of tongs into buck. The buck comes with two possible configurations the basic arch and wheels can be fitted with a hand use package with tongs and a handle for normal towing or a tow package with a drop tong, winch and trailer hitch. It is ergonomically well designed and well manufactured, the welding and powder coat finish are excellent, as are wheels, tires and winch.

Log pulling arch is versatile implement for tractor arch with 8feet available in the reach fully suspended loads of up to 16feet in length can be carried or forwarded through the woods or to the portable sawmill. Longer logs can drag a tail or be used in tandem with another arch or tag axle. The tractor arch also has receiver provisions front and rear for special rigging or the addition of a power winch to the system.

Fig. 13 Fabricated Log pulling arch

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