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A HOPE FOR HANDICAPPED: STEERING PROPULSION TRI-CYCLE

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ABSTRACT
With today's tremendous advancements in science and technology, people's need for efficiency in their daily lives is growing. The products that people use reflect this desire and increase in efficiency. Our modest project's first goal was to design a tricycle that would improve the living conditions of the disabled. The optimal and most efficient operation of the tricycle is achieved through a variety of dynamic processes, which increases the need for an affordable wallet among the limb-impaired. In a developing country like India, where tricycles are the most popular and cost-effective method of transportation, there is a growing desire for improving the living standards of the worthy or differently abled. As a result, adding a pure mechanical notion for providing such feasibility was a success. This study analyses the possibilities for the differently abled to use tricycles for travel within small areas for their daily bread, imagining such a revolution in urban transportation. To provide the best with rigorous technological knowledge obtained in order to thrive experience and civility to work in the most trying circumstances of impaired mobility and remain feasible with determination, hard work, and dedication through the use of diverse dynamic mechanical mechanisms.

Keywords: Tricycle, Transportation, Differently Abled

INTRODUCTION
This paper tries to apply academic skills gained for the development of technology and related sectors to improve skills, knowledge and experience through hands-on training and academic research, resulting in the development of a self-propulsive mechanical tricycle using slider cranking and simple steering mechanisms. The goal of this task is to adapt and use the existing framework for the current hand-fueled trike in order to provide tricycle clients with increased degrees of variability, fostering flexibility in movement and group commitment [1].

SSlider cranking mechanisms[6] are used in a variety of industries, including autos, locomotives, and mining.The most prominent obstacles in this vehicle are that the wheel diameters are limited to some extent, that good handgrip is required, and that frequent use of both upper extremities could create significant trouble in longer range use.The use of three-wheeled vehicles for the mobility of differently abled people has increased dramatically. In this paper, we present a design and analysis of a tricycle that uses various mechanisms and human power as an input. According to a survey, some tricycles are not ideal for long distance travel while others are out of reach for the majority of the population.

As a result, tricycles are the most ideal and economical mode of transportation for ordinary people who are manually propelled. The manual tricycle is a popular mode of transportation[2].
This paper is divided into sections that contain design-oriented information and representations of various calculations. Aspects of operation as well as principles are explored.

METHODOLOGY
The frame of the tricycle is made of Mild steel & SAE1025.Wheels are attached with the frame, which are driven by cranking mechanism supported by eccentric sheave assembly. Nut and bolt arrangements and welding are used for joining parts and joints. Steering assembly is used for both propulsion and for steering purpose simultaneously. Exploitation of advantages of leverage are manipulated for the sake of easier propulsion.

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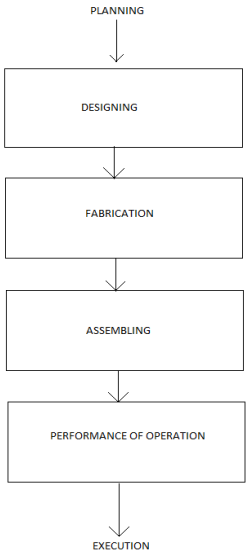

Fig. 1. Methodology

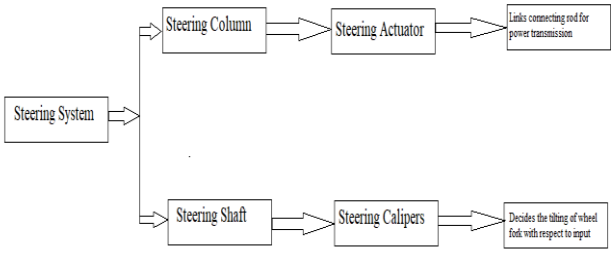

Fig. 2. Layout of the process

DESIGN ASPECTS

The vehicle is composed of various components that are having a greater design significance. The steering shaft coupled to the front wheel is used for steering while the steering column acts as the input device for propulsion. Eccentric crank converts the translatory motion into pure rotation.

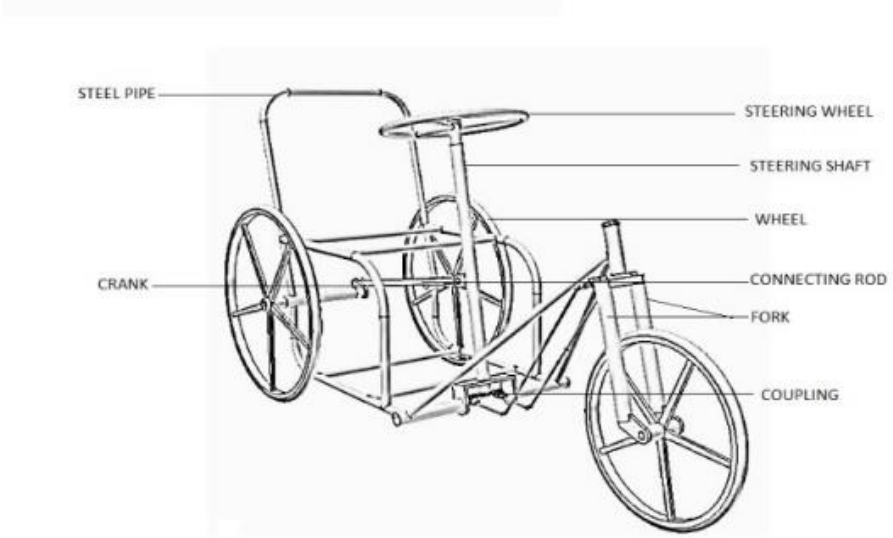

Fig. 3. Design Synopsis

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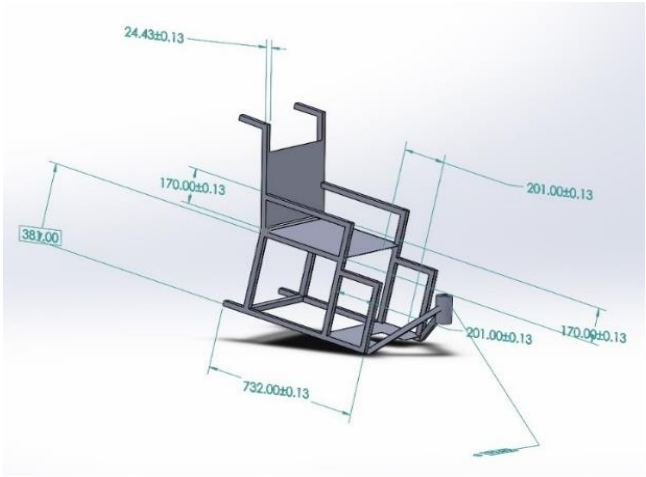

Fig. 4. Dimensional synopsis of frame

The eccentric crank absorbs the very most responsibility of conversion of linear motion between a dipolar limit to rotation, which being the key process in the whole-propulsion of vehicle, as a result of the input power that is transmitted through a steering column, through which steering shaft passes, that undertakes the accountancy of steering that is coupled with front wheel.

Rear wheels being the power absorbers are the largest when compared to front, whilst the front wheels are designed only for the purpose of direction change, they are smaller.

COMPONENTS

Seat
This is made out of mild steel cold rolled closed annealed square tube of size 25mm x 25mm cut for the lengths of 440mm---2nos, 360mm—21 nos 420mm---4nos, all are cut and straightened by hammering and then corner ground and are welded to each other to make two number of rectangular frames of size 360mm x 420mm and another frame of size 420mm x 440mm. 1mm mild steel sheet is used for covering area of frame to make it as a seat.

Rear Support
This is made out of CRCA (cold rolled and closed annealed) steel square tube of size 25mm x 25mm cut for the length of 330mm---2nos, 420mm--1nos and then flattened by hammering and then corner grinding is done and then all three are joined, the base as 420mm and the vertical legs as 330mm at both the end of 420mm. This is then welded with the frame to make the main skeletal frame of the vehicle.

Rear Axle
This is made out of SAE1025 steel cut from the material of 16mm for length 365mm---2nos and welded with wheel hub. It is faced from the opposite side to make the entire length as 420mm. Such axle is made for this project. Cranking offset crank is attached with this axle shaft.

Eccentric Sheave
This is made out of 2 mild steel flat discs of diameter 160mm and 5mm thick being cut and flattened by hammering and then marked for the distance of 50mm from one end and then drilling for the hole diameter of 16mm is done and then welded to the one rear axle.

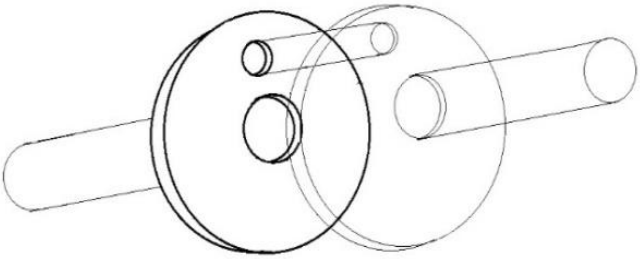

Fig. 5. Eccentric sheave

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On the hole made, a round pin of diameter 16mm of length 50mm is welded to create the offset cranking pin. Connecting rod that attached to this cranking assembly is 530mm.

Steering wheel
This is made out of mild steel flat of size 100mm x 5mm thick being cut for the length of 1100 and then flattened by hammering and then marked for the drill hole size 16mm at both the ends and then marked for the bending at 40mm distance at both the ends. Two numbers of arms are made for this project. Steering shaft is coupled with steering wheel in order to provide a direct drive control for steering.

Steering Shaft
This is made of SAE1025 of 16mm diameter and 770mm length that penetrates through the steering column coupled with a bearing for the sake of easier power transmission. Lower end of the shaft is attached to a coupling from which the calipers, are bolted with a 12mm standard steel bolt, accounts responsibility of wheel tilting.

Steering Column
CRCA round tube of 70mm diameter having a thickness of 5mm is used for the fabrication of steering column. Length of the column is 620mm.Connecting rod from the sheave is attached with the steering column using a bracket which is welded with column. At the lower end of the column a steering actuator is coupled.

Steering Actuator
Mild steel bar of 5 mm thickness 140mm length-1 no. and 70mm-2 nos. of 30mm breadth are welded and drilled to make steering actuator. From the either side (that of 70 mm) bearings are attached for the sake of its function. This facilitates the forward and backward motion of the steering column that feeds the input for propulsion.

Rear Support
Mild steel bar of 2mm thick and 450mm length are used and 20mm each from both sides are bent at 45° angle to make steering calipers. These calipers are attached with a T offset that is coupled with steering shaft that facilitates the steering of front wheel fork.

Wheel Fork

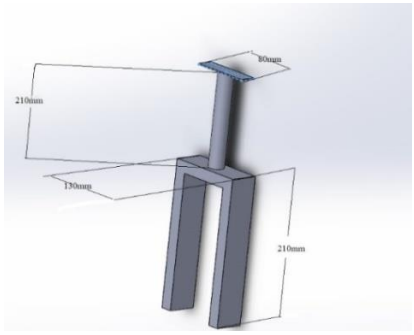

Fig. 6. Wheel fork

CRCA mild steel pipe of 40mm x 20mm of 550mm length is cut into 3 pieces of 210mm-2 nos and 130mm-1no. respectively and welded together to form the wheel fork. SAE1025 circular cross-sectional rod of 16mm diameter of length 210mm is welded at the precise center of fork head(at the middle of 130mm) to form, the fork extension. A rectangular mild steel bar of 80mm length is fixed at the top end of extension to which the steering calipers are bolted together by drilling a 12mm standard bolt drill that facilitates steering.

Cap Assembly
CRCA hollow tube of 5mm thickness 60mm diameter and 150mm length is used to make the shell of the cap assembly, to which bearings that fixes in perfectly are welded on its either side. Through the bearings a CRCA shaft of diameter 16mm and 210 mm (that mentioned with fork assembly) is passed to form the cap assembly completely that accounts the responsibility of the pure working of the entire assembly.

Rear Support
SAE1025 steel rod of 16mm diameter and of length 530mm is connected to eccentric sheave at one end and the other to steel bracket which is welded to the steering column. Steel bracket and the connecting rod are

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joined together by a standard bolt of 12mm. Connecting rod takes the prior responsibility of converting the reciprocating action to pure rotational.

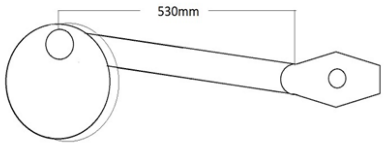

Fig. 7. Connecting rod

POSTULATIONAL PERSPECTIVES

Slider crank converts reciprocating linkages to a rotating output. Four linkages being pivoted by three articulations are prismatic and are offset. As the input slide is strenuously applied, the slider slides in between the dipolar extremities in turn are associated to a rotating disk, by a connecting rod, that transmits output as rotation.[6]

In-line slider mechanisms used for the composition of this vehicle. The sliders is positioned so that the mobility of articulated joints passes through crank base. Symmetric range of motion being its key beneficial is exploited.[6]

Thorough the steering wheel, trike chauffeur transfers the propulsive feed which is transferred through the steering column in, to and fro dipolar limits. This provides the very primitive workforce for cranking. As the column shaft moves forward and backward, the connecting rod (that takes the responsibility of a slider as well as connecting rod) is being pulled and pushed simultaneously, that in turn results in rotation of the circular eccentric disk that is attached to the other end of the connecting rod, From the eccentric disk rear wheels are coupled using axles and bearings that facilitate propulsion.

As the chauffeur tilts the steering wheel in either direction, the steering shaft tunneling through the steering column tends to tilt in the corresponding boulevard which tilts the coupling plate coupled at the lower terminal of shaft. As the coupling plate is tilted in the very corresponding direction, calipers attached between the shaft and the leading wheel-fork engenders a pulling or pushing force. Since, both calipers are pinned to either sides of the wheel forks, pulling or pushing action creates less hustle for the fork to tilt towards corresponding analogy. That helps vehicle for its change of direction during its maneuver.

To generalize, this vehicle propels on a very simple and very efficient dynamic mechanism, slider cranking, and uses caliper supported steering mechanism for its change of direction when necessary thorough out its mobility.

PERFORMANCE RENDITION

Distance travelled by tri-cycle

in 10 seconds = 43m

Linear velocity V=$\frac{43}{10}$

Therefore, V=4.3m/s

4.30 × $\frac{18}{5}$ =15.48 km/h

Total force = $F_{rolling}$ + $F_{gradient}$ +$F_{aerodynamic\ drag}$(1)

$F_{rolling}$ = Force due to rolling resistance

$F_{gradient}$ = Force due to gradient resistance

$F_{aerodynamic\ drag}$

= Force due to aerodynamic drag

Rolling force

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Rolling resistance is the force resisting the motion, when a body rolls on a surface. The formulae for calculating force due to rolling resistance is given by the equation,

$F_{rolling}$= C_{rr} ×M × g(2)

C_{rr}=Coefficient of rolling resistance

M =mass in kg

g =acceleration due to gravity=9.81 m/s^2

Assume C_{rr}=0.02 , M =100kg

$F_{rolling}$=0.02×100×9.81=19.62N

Power in rolling

$P_{rolling}$=$F_{rolling}$ ×V =19.62×4.3 =84.366 W

Gradient force

When a vehicle is driving on an uphill or downhill, the third force acting on the vehicle is the gradient force. The equation for the gradient force is given by,

$F_{gradient}$=Mg sinθ(3)

θ = angle made by the vehicle with surface

[Here, the vehicle is moved in plain land, therefore θ is zero]

ie, $F_{gradient}$ = 0 N,

Hence Power is also 0 W

Aerodynamic Drag

Drag is a force resisting the relative motion of an object on motion with respect to a surrounding fluid. The equation for the aerodynamic drag is given by,

$F_{aerodynamic}$= 0.5 × C_d ×A× ρ × V^2(4)

Assume

Co-efficient of drag C_d= 0.44

Frontal area, A=1.6m^2

Density of air ρ = 1.2kg/m^3

Linear velocity V= 4.3 m/s

$F_{aerodynamic}$ = 0.5 × 0.44 × 1.6 × 1.2 × $(4.3)^2$

= 7.81 N

Power required = $F_{aerodynamic}$ × V (5)

=7.81 × 4.3=33.583 W

P_{total} = 84.366 + 33.583 = 117.94 W

We have to consider losses

$M_{tractive}$(Mechanical power output), =$\frac{P_{total}}{\eta}$(6)

η=Efficiency of the system =75%

25% loss to overcome resistances

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$M_{tractive}$= $\frac{0.11794}{0.75}$ = 157.25W

ie. $M_{tractive}$= 157 W

Tangential force (F_t)

Tangential force defined as the force experienced by a moving object in the direction of the tangent to the curved path of the object.

P=F_t × V(7)

157=F_t × 4.3

F_t=36.51 N ≈ 37 N

Speed of wheels

Linear velocity (V) = Angular velocity (ω) × Radius of wheel(r)

V = $\frac{2\pi N}{60}$ × r(8)

N= $\frac{60\times V}{2\pi r}$

= $\frac{60\times 4.3}{2\pi\times 325\times 10^{-3}}$ =126 rpm

Torque

P= $\frac{2\pi NT}{60}$(9)

157= $\frac{2\pi\times 126\times T}{60}$

T=11.89 Nm

Design of shaft

Weight of disc = 0.5 kg × 9.81

= 4.905 N ≈ 5 N

Tangential force (F_t) = 37 N

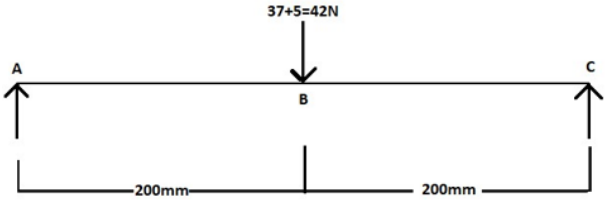

Fig. 8. Force diagram

Moment at C = 0

42 × 200 =R_A ×400

R_A = 21 N

R_A + R_c =42 N

R_c=21 N

Calculation of bending moment[8]

Taking bending moment of C,

M_C=0

at C

M_B=42 ×200=8400 Nmm

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M_A = 42×200- R_A ×400

42 × 200 – 21 × 400=0 Nmm

Maximum bending moment is at point B, M_B=8400Nmm

Shaft material used is SAE1025

σ_{ut}= Ultimate tensile strength of the material = 426 MPa

σ_{yt}= Yield tensile strength of the material = 234 MPa

FoS= Factor of Safety = 3

σ_{max}= σ yt / FoS = $\frac{234}{3}$ = 78 MPa

τ_{yt}= σ max/2 = 39 MPa

According to maximum normal stress theory [3],

$$d= \left[\frac{16}{\pi\sigma_{max}} \left(C_m M + \sqrt{(C_m M)^2 + (C_t T)^2}\right)\right]^{\frac{1}{3}} \quad (10)$$

C_m, C_t is the numerical combined shock and fatigue factors to be applied to the computed bending and torsional moment respectively.

C_m=1.5

$$d=\left[\left[\frac{16}{\pi\times 78} (1.5\times 8400+\sqrt{(1.5\times 8400)^2 + (1\times 11.89\times 10^3)^2}\right)\right]^{\frac{1}{3}}$$

C_t=1

d=12.5 mm

Standard diameter of shaft, d = 14 mm

RESULT AND DISCUSSION

This vehicle is a combination of components that is accountable for its best working. While the steering mechanism undertakes the duty of change of direction of the trike, steering column assembly contributes for the most efficient propulsion. Eccentric sheave set converts the reciprocating motion corresponding to the input that is fed into a pure rotation. The thesis of the slider crank mechanism is the vertebra of this process. The eccentric crank absorbs the prior responsibility of propulsion from feed that fed between a dipolar limit into rotation, which being the key process in the whole propulsion of vehicle, as a result of the input power that is transmitted through a steering column, through which steering shaft passes, that undertakes the duty as a keystone element of steering that is coupled with front wheel. Rear wheels being the power absorbers are the largest when compared to front, whilst the front wheels are designed only for the purpose of direction change, hence they are smaller for the sake of easier direction change.

As these processes and components are assembled with support of analysed research and homework, the result we were expecting was the most satisfactory. Reduced strain for operation was in the prior consideration and by exploiting various design aspects, the achievement received on advantages made us in high spirits. Hence, by powering the vehicle, even in a minimal and optimal load the vehicle is capable of exhibiting the best of its working and is satisfactory.

CONCLUSION

To recapitulate, this trike accounts the responsibilities of mobility of a person who is having different ability for his/ her lower limb. By the composition of plethora of dynamicmechanisms that support the efficient working of the trike makes this design unique, distinctive and more convenient than the existing chain driven machines. Due to its profusion of dynamic elements that enables the efficient operation of the vehicle makes this more appropriate for disabled. Usage of lever powered tricycle is expected to be more comfortable, pleasant and much easier to furnish.

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