

Design Of Human Powered Vehicle: A Concept

Ashwin S. Kubde¹, Dr.G.D. Mehta², Prof. C.K. Tembhurkar³

¹Student of M-Tech, PCE, Nagpur, Maharashtra, India

²HOD & Professor of aeronautical department, PCE, Nagpur, Maharashtra, India

³Assistant professor of mechanical department, PCE, Nagpur, Maharashtra, India

DOI: 10.46335/IJIES.2020.5.10.6

Abstract – This paper presents the selection and enhancement of a human-powered vehicle (HPV) concept. In an environment where fossil fuels are no longer available, the processing of human kinetic energy would offer an immediate solution to numerous mechanical problems and fuel limitations. Harvesting a renewable energy source may also be a method to solve the issue. This project is concerned with the creation of a human-powered vehicle that uses humans to drive a vehicle. The main goal behind this project is to create an effective mode of transport that will allow efficient use of human resources to drive a vehicle that is faster than current human-powered vehicles. For this reason, human strength and weakness, the aerodynamic effect of the fairing, the performance of the drive train, etc. are taken into account. The value of human power as an alternative energy source has been studied since the beginning of the present state and its future reach. Human power credit is primarily due to health benefits as a source of energy. Human control as the prime mover used to run a functioning device is referred to as a human-powered system. The key concern in this study is therefore to minimize human efforts. In developed and developing nations, a significant proportion of people move every day for jobs, shopping, and social reasons.

But transport also consumes a lot of resources, such as time, electricity, materials, and land. While studying the current major modes of transport, we have identified weaknesses such as stability, protection, rider comfort, luggage issues, fatal accidents, and aerodynamic resistance in the use of bicycles. Deficiencies such as carbon emissions, parking issues, repairs, fuel costs, driver skills, and the expense of using a car.

Keywords:- Human-powered vehicle, Ergonomics, Hybrid human drive, Energy.

I- INTRODUCTION

The fuel consumption associated with transportation needs is an issue that is known throughout the world [1], [2], [3], [4]. The world's dependence on petroleum-based fuels needs to transform alternative fuel sources and a new means of transportation itself [5], [6], [7], [8]. This project is a way to design and test a vehicle that is a practical and efficient human-powered vehicle that potentially will serve as a partial solution to these problems [9], [10], [11], [12]. HPVs include vehicles built for air, water, or ground transport, but the common denominator is the integration of a human into the design [13], [14], [15], [16]. They optimize the human's strengths and compensate for their weaknesses. The primary purpose of a human-powered ground vehicle is to transport its rider and cargo safely and efficiently [17], [18], [19], [20]. A human-powered ground vehicle in its most simple sense is the traditional bicycle. Thus finite element analysis (FEA) as well as physical testing was performed to ensure the safety of the rider as well as possible pedestrians around the vehicle.

So, because of that vehicles created more smoke due to improper burning of fuel. Autorickshaw is the main example of this, only the rickshaw which is run by human energy is replace the autorickshaw. But the problem with rickshaw is that it's based on human energy and more energy need to pick up the vehicle during starting condition [20], [21]. In this project, we design such a mechanism that solves the problem of pickup face by rickshaw.

This mechanism works like when the driver pulls the given lever by hand, this lever is connected to the clutch through the flywheel. So after pulling the lever by hand and applying piddle when the vehicle is still on place. The piddling force is store in the flywheel in the form of mechanical energy and this energy is used during pickup of the vehicle.

II - LITERATURE REVIEW

Principles of Human-Electric Hybrid Drives for Human Powered Vehicles [22]

In this paper, they show the human drive hybrid vehicle, the E-bike parallel hybrid. This vehicle functions in such a way that the constant torque should be provided. The concept of the vehicle is that when the vehicle is driving at a flat road or downhill roads with somewhat less energy is required at this stage the battery is getting charged. The dynamometer charging the battery at the stage of piddling and no piddle applied to the vehicle. When the uphill road or whenever if you want that battery power to use you can use to run the vehicle through the motor mounted at the rear wheel. A special function of a parallel hybrid is Michael Kutter's drive system where electric and human power are added using a planetary gear set in the rear wheel hub. In this vehicle, the human power is converted into electric power through the generator.

Design and analysis of foldable human-powered vehicle [23]

Now a day the human power vehicle which is available is pretty big in size you couldn't take with you anywhere you are going. The paper shows they made a three-wheel foldable human-powered vehicle. There are parts of the human-powered vehicle that can be foldable to reduce the self vehicle space. The important body part of the vehicle is folded while the wheels of the vehicle and other parts remain unchanged. The design of the vehicle consists of a compact joint, when the main body of the vehicle it folded it gives overlap condition. Then, the seat of this HPV also can be folded and adjusted for a user comfortable purpose. The drawing of the vehicle is also designed on designing software CATIA & CAD. The concept of design is made to keep in mind ergonomics, aerodynamic, highly engineered, easily manufactured, and keeping the safety. Proper analysis will also be done on this vehicle. This is an innovative modal. The main advantage of this type of vehicle is that we should carry anywhere with you. This paper shows

that the carrying problem of the vehicle will also be solved.

Design, Analysis, and Fabrication of a Human Powered Vehicle [24]

The paper shows they made a design of both three-wheel bicycle and car combine in one vehicle. Even the design of the vehicle has also undergone some tests and software this makes the vehicle safe and eco-friendly and precise. This vehicle is also some aerodynamic touch to increase the speed of the vehicle. The cost of the vehicle is also low as say in the paper anyone can afford it and drive it with no excuse.

DESIGN OF FAIRING FOR HUMAN POWERED VEHICLES CONSIDERING AERODYNAMICS & AESTHETIC [25]

This project is funded by cal poly HPV. Their goal is to design, test, and build a bicycle frame that the HPV club can attach to a fairing of their design. The primary design will be done like the speed of the vehicle, cost, rider ergonomics, reliability. This vehicle will be made to compete in ASME's Human Powered Vehicle Challenge (HPVC) series of races. The purpose of a human-powered ground vehicle is to transport its rider and cargo safely and efficiently. In this, the vehicle is available of its simplest form and FEA testing was also performed. This vehicle consists of three wheels, two wheels at the rear and one wheel are at the front. This vehicle is run by simple piddling and sitting arrangement is ergonomically designed with the best and comfortable sitting arrangement. The vehicle is a single sitter. This vehicle is more like a car with an up shed at its top.

Design and Development of a Hybrid Human Powered Vehicle [26]

In this, they design a new version of a bicycle with three wheels, two wheels in front, and one in the back of the vehicle. Their main aim is to build such a vehicle which is based on human power and it will carry or transport in use. The chassis of the vehicle completely consist of stainless steel tubes, the minimum number of tubes is used to reduce the weight of the vehicle. This makes the vehicle stronger and safer. A hub motor is fitted at the rear wheel. The motor turn on when the rider is tired of piddling, work till the battery is exhausted. The battery is charged when the rider piddles the vehicle. Seating adjustment is also there to adjust the seating arrangement of the rider from up or down. A CFD analysis is also

done on ANSYS to reduce air drag and increase the speed of the vehicle. The fairing material used will be thick transparent plastic with bamboo sticks as it is a skeleton which is overall an innovation. This vehicle is more practical to use and easy to maintenance.

A Review on Human and Electric Powered Vehicle [27]

The main focus of this project is on transportation and solve the problem of fossil fuel and pollution, using the human-powered vehicle to travel at a specific distance while run on human power. This vehicle consists of a three-wheel bicycle in which two wheels are in front and one wheel is at the rear position, driven by two members with a side seating arrangement. The vehicle would be equipped with a battery, motor, and transmission belt to transmit the power to the wheels of the vehicle. The tadpole type configuration is used for this vehicle in which two wheels are mounted on the front side and one wheel in the backside of the vehicle. Even disc brakes also mounted at all the three wheels for proper and effective braking. This vehicle is good for a short drive at a short distance.

Design selection and analysis of human-powered vehicle [28]

This paper shows the design selection, improvement, and analysis of a human-powered vehicle. The components like chassis, suspension, and hub are the components of HPV that are designed by using design CATIA software. Whatever problems are facing by vehicle are find out and redesigned the same vehicle by analyzing. Even proper stress distribution of the vehicle is done practically and the factor of safety also. In this paper, the methodology of this project will be explained in detail about the research methods performed to produce an excellent result.

An Energy-Efficient Human-Powered Hydraulic Bicycle with Flexible Operation and Software Aids [29]

This paper shows an innovative design of a new hybrid human-powered vehicle with flexible operation and software aids. In this, the bicycle is operated in four modes pedaling, charging, boost this all for riders driving modes. The aluminum chassis also designed to function as a system reservoir and customize to optimize the riding comfort, space for components, and durability of the vehicle. Because of using aluminum the body of

the vehicle is so free and lightweight to drive and also drive with less power with high speed.

Design of Efficycle-Human Powered Light Weight Hybrid Tricycle with Inbuilt Rear Wheel Steering and Use of Universal Joint in Front Axle [30]

The design of this vehicle is done on the SOLID WORKS and the design analysis is done on ANSYS. In this, their main aim is to reduce vehicle weight. The vehicle has a tadpole type design, which is ergonomically engineered and easy to manufacture. The vehicle will provide easy maintenance, best performance, and safety to the user. In this, they provide the UV joint to the front axle so that it is convenient to climb the uphill, and also the rear-wheel steering is also be provided. UVB joints can be used in tricycle instead of the wishbone to minimize their weight and simultaneously provide a base independent suspension. This vehicle is dependent on the best frame design. It is an eco-friendly drive vehicle with an electric drive system such as a lightweight tricycle that can be used as transport and also is used as disaster management.

Human-Powered Energy-Efficient Vehicle Design [30]

In this paper, industry-sponsored the student project of human-powered vehicles. It allows a single rider to move in all types of terrain by transferring power to the drive train through the use of a biodegradable hydraulic fluid. Besides the design criteria specified by the project sponsor, functionality, safety and reliability, manufacturability, and cost-effectiveness are the focus of this design process. The overall design objective is to minimize the weight and maximize the energy efficiency of the low power hydraulic drive train. Among the innovative human-powered transportation ideas, an upright carbon fiber configuration is adapted. It optimizes rider comfort, weight and provides support of all hydraulic components and drive train. The pedal power of the rider runs a fixed displacement axial piston pump and transfers the pressurized fluid to a hydraulic motor of similar classification driving the rear wheel. A pressure sensing hydraulic circuit allows the storage of the pressurized fluid in a hydraulic accumulator and releases the fluid on demand such as during the uphill motion. A lightweight mechanical drive train provides appropriate torque to drive the pump and driving wheel under all driving conditions.

III - THE BASIC CONCEPT OF MECHANISM

The first stage of spur gear (G_1) is in meshing with the first shaft and the second one. This gear (G_1) is transferring motion through the pinion (P_1) to the second shaft which is parallel to the first shaft. The second shaft is rotation at speed 370.62 rpm, the speed of the shaft is increases by decreasing the amount of torque. The second shaft is followed by the flywheel, clutch, and gear (G_2). the flywheel is used to design by the use of conditions of vehicles and afterward, the clutch is mounted exactly above the flywheel. Which engages and disengages the motion of the vehicle. It is controlled by the driver. Afterward, gear (G_2) was there meshing with the pinion (P_2) which is mounted on the final and third shaft. The third shaft is rotation at speed of 2223.72 rpm. On this shaft, the pinion is mounted and the wheels of the vehicle are also there, the wheel is directly in contact on the surface. All the vehicles were facing the problem of pickup. This point of driving takes more piddling force to take off the vehicle at the desired speed.

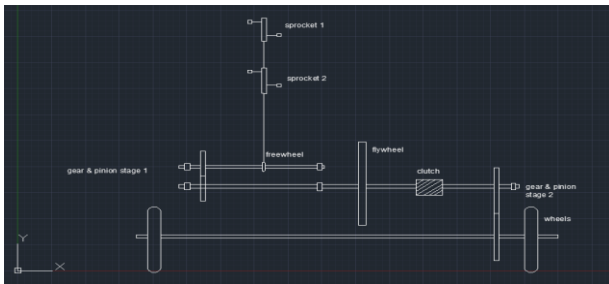


Fig. 1- 2d schematic of mechanism in AutoCAD

IV- METHODOLOGY

The assembly design of a human-powered flywheel vehicle is designed in AutoCAD and I believe. The main objective of this project is to build a process in such away. If the rickshaw driver is driving the rickshaw in a pick-up state, he can take less effort when in the starting position. In this project, this is a personal or passenger vehicle that depends solely on human power. This vehicle is designed to be a tandem type two-seater arrangement. Each part is technically developed first and then in software.

V- RESULTS & DISCUSSION

Discussion about the design output of the proposed HPFV.

- Based on the energy stored in the flywheel, the power needed to move the vehicle is calculated.

- Based on strength, the components used to drive the vehicle are determined. Their measurements could be achieved with the aid of the transmission of electricity. However, the location of the part is determined based on the available state.

VI- CONCLUSION

Existing street vehicles are found to run on petrochemicals and to cause pollution that indirectly affects human health and the environment. The number of vehicles is also increasing day by day so that pollution appears to be a major problem of global warming. In the event of avoiding such problems as set out in the first stage, a human-powered vehicle or an electric vehicle first came to mind, such vehicles are alternatives to the replacement of vehicles operating on petrochemicals.

REFERENCE

- Waghmare S.N., Sakhale C.N., Tembhurkar C.K., Shelare S.D. (2020) Assessment of Average Resistive Torque for Human-Powered Stirrup Making Process. In: Iyer B., Deshpande P., Sharma S., Shiurkar U. (eds) *Computing in Engineering and Technology. Advances in Intelligent Systems and Computing*, vol 1025. Springer, Singapore
- Waghmare S.N., Shelare S.D., Tembhurkar C.K., Jawalekar S.B. (2021) Development of a Model for the Number of Bends During Stirrup Making Process. In: Prakash C., Krolczyk G., Singh S., Pramanik A. (eds) *Advances in Metrology and Measurement of Engineering Surfaces. Lecture Notes in Mechanical Engineering*. Springer, Singapore
- Shelare S.D., Kumar R., Khope P.B. (2021) Formulation of a Mathematical Model for Quantity of Deshelled Nut in Charoli Nut Deshelling Machine. In: Prakash C., Krolczyk G., Singh S., Pramanik A. (eds) *Advances in Metrology and Measurement of Engineering Surfaces. Lecture Notes in Mechanical Engineering*. Springer, Singapore
- Waghmare S., Shelare S., Sirsat P., Pathare N, Awatade S. (2020) Development Of An Innovative Multi-Operational Furnace. *International Journal of Scientific & Technology Research* Volume 9, Issue 04, April 2020. Pp 885-889.
- Mehta G. D. and Modak J. P., "An Approach to establish vibration Response at all Bearings of a Counter shaft due to all Machine Elements on it ", 13th world congress in Mechanism & Machine Science, Guanajuato, Mexico, 19-25 June, 2011.

- [6] Jawalekar, S. B., and S. D. Shelare. 2020. Development and performance analysis of low cost combined harvester for rabi crops. *Agricultural Engineering International: CIGR Journal*, 22 (1):197-201.
- [7] S. D. Shelare, P.S. Thakare and Dr. C. C. Handa, "Computer Aided Modelling and Position Analysis of Crank and Slotted Lever Mechanism", *International Journal of Mechanical Engineering and Production engineering Research and Development*, Volume 2, No 2, June 2012, PP 47-52.
- [8] Mehta, Girish and Deogirkar, Sagar and Borkar, Prerna and Shelare, Sagar and Sontakke, Sonam, Estimation of Vibration Response of a Bridge Column (February 24, 2019). *Proceedings of International Conference on Sustainable Computing in Science, Technology and Management (SUSCOM)*, Amity University Rajasthan, Jaipur - India, February 26-28, 2019, Available at SSRN: <https://ssrn.com/abstract=3356326> or <http://dx.doi.org/10.2139/ssrn.3356326>
- [9] Mali, P., C.Sakhale, and S. Shelare.2015. A literature review on design and development of maize thresher. *International Journal of New Technologies in Science and Engineering*, 3(9):9-14
- [10] Tirpude, V.D., Mehta, G. D., Modak, J. P. Vibration based condition monitoring of rolling mill. *Int. J. Sci. Eng. Res.*, 2(12), 1-10.
- [11] Shrikant A. Thote, M.K. Sonpimple and G.D. Mehta., "An Approach to Find the Stresses Induced In a Flat Belt during Half Rotation of a Driving Pulley" *International Journal of Innovative Technology and Exploring Engineering*, 2013.
- [12] Atul B. Meshram, Girish D. Mehta, Jayant P. Modak, Estimation of Natural Frequencies and Mode Shapes of a Shaft Supported by more than Three Bearings, *Journal of Mechanical Design and Vibration*, 2014, Vol. 2, No. 1, 11-24
- [13] Kumbhare H., Shelare S.. (2020) Innovative Advancement in Drone Technology for Water Sample Collections -A Review. *International Journal of Scientific & Technology Research Volume 9, Issue 03, March 2020*. Pp 7266-7269.
- [14] Mowade S., Waghmare S., Shelare S., Tembhurkar C. (2020) Mathematical Model for Convective Heat Transfer Coefficient During Solar Drying Process of Green Herbs. In: Iyer B., Deshpande P., Sharma S., Shiurkar U. (eds) *Computing in Engineering and Technology. Advances in Intelligent Systems and Computing*, vol 1025. Springer, Singapore
- [15] Mathew J.J., Sakhale C.N., Shelare S.D. (2020) Latest Trends in Sheet Metal Components and Its Processes—A Literature Review. In: Sharma H., Govindan K., Poonia R., Kumar S., El-Medany W. (eds) *Advances in Computing and Intelligent Systems. Algorithms for Intelligent Systems*. Springer, Singapore
- [16] Sakhale C.N., Bapat P.M. and Singh M.P., —Design Of Experimentation And Application Of Methodology Of Engineering Experimentation To Investigation Of Processing Torque, Energy And Time Required In Bamboo Processing Operations, *International Journal of Bamboo and Rattan*, April 2011 Vol. 9. 1&2, Jbr 284, Pp:13-27.
- [17] Waghmare S., Mungle N., Tembhurkar C., Shelare S., Sirsat P., Pathare N. (2019) Design and Analysis of Power Screw for Manhole Cover Lifter. *International Journal of Recent Technology and Engineering*, Volume 8, Issue 2, July 2019. Pp. 2782-2786, DOI: 10.35940/ijrte.B2628.078219
- [18] Sakhale C.N., Bapat P.M., Singh M.P., Modak J.P., "Design of a Comprehensive Bamboo processing Machine", *IFTToM: PICA-2006*, 11th-14th July, 2006, Vol.1, Pp.51-54.
- [19] Sahu P., Shelare S., Sakhale C. (2020) SMART CITIES WASTE MANAGEMENT AND DISPOSAL SYSTEM BY SMART SYSTEM: A Review. *International Journal of Scientific & Technology Research Volume 9, Issue 03, March 2020*. Pp 4467-4470.
- [20] Waghmare S., Sirsat P., Sakhale C., Shelare S., Awatade S. (2017) A Case Study on Improvement of Plant Layout for Effective Production. *International Journal of Mechanical and Production Engineering Research and Development*, Volume 7, Issue 5, Oct 2017. Pp. 155-160
- [21] Shelare SD, Handa C. Tsynthesis in Simulation and sensitivity analysis of quick return mechanism. *LAP LAMBERT Academic Publishing: December (2012)*.
- [22] Dr. Andreas Fuchs, Gutenbergstrasse 24, 3011 Bern, Switzerland "Principles of Human-Electric Hybrid Drive for Human Powered Vehicles" 6th European Seminar on Velomobile Design Copenhagen, October 16-17, 2009.
- [23] Mohd Azman Abdullah, Mohamad Alif Fayumi Ahmad, Shafizal Matl, Faiz Redza Ramli, " Design and analysis of foldable human-powered vehicle" *Proceedings of Mechanical Engineering Research Day 2017*, pp. 128-129, May 2017.
- [24] J Abhilash, Mada Rukmini Sai Rupa Sri" Design, Analysis and Fabrication of a Human Powered Vehicle" *International Journal of Engineering Sciences & Research Technology*
- [25] Manoj Rawat, Prof.Mithir Pandey, UpendraTripathi " DESIGN OF FAIRING FOR HUMAN POWERED VEHICLES CONSIDERING AERODYNAMICS & AESTHETIC".

- [26] Swarnim Shrishti , Anand Amrit “Design and Development of a Hybrid Human Powered Vehicle”.
- [27] Vikas Verma¹, Dr. S S Chauhan², Asst. Prof. Ranjeet Kumar³” A Review on Human and Electric Powered Vehicle”.
- [28] M.A. Abdullah, M.Z. Azis¹, M.H. Harun, F.R. Ramli^{1,2} and S. Mat^{1,2}” Design selection and analysis of human-powered vehicle”.
- [29] Gianluca Marinaro ^{1,* ID} , Zhuangying Xu ², Zhengpu Chen ³, Chenxi Li ^{3 ID} , Yizhou Mao ² and Andrea Vacca ^{2,3,4}” An Energy-Efficient Human-Powered Hydraulic Bicycle with Flexible Operation and Software Aids”.
- [30] Abhay Tiwari, Ishan Jaswal, Sulipt Das and Anshu Singh”Design of Efficycle-Human Powered Light Weight Hybrid Tricycle with Inbuilt Rear Wheel Steering and Use of Universal Joint in Front Axle” ISSN: 2167-7670 Tiwari et al., Adv Automob Eng 2017, 6:3 DOI: 10.4172/2167-7670.10001.