SEVEN publicações acadêmicas

Use of machining for adaptation of parts with the aid of a four-stroke otto cycle engine for use in rural areas

Crossref doi
https://doi.org/10.56238/uniknowindevolp-022

Paulo Sidnei Stringhini Junior
Environmental Engineer, UEMS, Dourados-MS
E-mail: paulostringhini@gmail.com

Thais Aparecida Santos Lopes
Agricultural Technician, IFMS - Nova Andradina – MS
E-mail: thaisalopes1508@gmail.com

Leandro Madeira de Oliveira
Internet Computing Technician, IFMS, Naviraí-MS
E-mail: Leandromad140@gmail.com

Moises Felipe Ribeiro dos Santos
Assistant building electrical technician, SENAI, Taiobeiras-MG
E-mail: felipe.moises777@outlook.com

Julio Cesar Stringhini
Engineer in Aeronautical Engineering, UFU, Uberlândia,MG
E-mail: julio.aero09@gmail.com

Dalton Pedroso de Queiroz
Dr. in Materials Science and Technology, UNESP, São Paulo-SP
E-mail: dalton@uems.br

Rony Gonçalves de Oliveira
Dr. in Physics, UEM/UEL, Maringá, PR
E-mail: rgoliveira@uems.br

Margarete Soares da Silva
Dr. in Chemistry, UNESP, Araraquara-SP
E-mail: margaret@uems.br

Aguinaldo Lenine Alves
Dr. in Materials Science, UNESP, Presidente Prudente. SP
E-mail: lenine@uems.br

Greicieli de Lima Zandoná Godoy
MSc. in chemistry, UFGD, Dourados. MS
E-mail: greici@uems.br

ABSTRACT
The productive systems of inputs and food in the countryside must reach the demand demanded by cities and urban centers. In this sense, machines provide the necessary productivity for this purpose, where there is a need to multiply human strength, through machines, to perform the heavy tasks in the rural environment. However, parts and machinery are not always found with the specificity necessary for the various tasks required, being a constant of new technologies that assist and facilitate the service of the worker, as well as machining, which promotes from adaptations to the manufacture of parts for use in machines that already exist. A key element in this whole process is the engines. In this context, parts were manufactured for adaptation of use, intermediating the applicability between the thrusters and the mechanisms to be used, making it possible to convert energy into work for the field. It is necessary an investigation, in prototyping to improve the technologies of the rural environment, thus opening the possibility of employability of new sciences for the preparation of methods, processes and mechanisms with new planning, such as 3D modeling.

Keywords: Coupler , Modeling, Engine, Systems, Machining.

1 INTRODUCTION

The activities developed in the field for food production are fundamental for a stable society, since the field is responsible for providing food for large societies (DA CRUZ; MATTE; SCHNEIDER, 2016). In rural areas, manual labor is still very demanding and manual tasks performed by workers, especially small producers, are extremely necessary for the success of the production process (BARBOSA JUNIOR, 2020).

For manual labor in the field to be effective, it is necessary to employ machines that can multiply all this effort, providing greater productivity. In this sense, the internal combustion engine is a great ally, being a type of thermal machine, capable of transforming the energy of the stoichiometric mixture into mechanical work. However, adaptations or even remodeling are often necessary to adapt to some peculiarity of the service to be developed. Thus, methods of design and construction of such models are necessary.

The internal combustion engine is a type of thermal machine capable of transforming the energy of the stoichiometric mixture into mechanical work. The machine chosen for the development of this article falls into the category of MCI (internal combustion engines), thermal machines that convert energy through the combustion of the mixture between fuel and oxidizing within a cylinder or combustion chamber. The engine has a specific working regime, called the Otto cycle four-stroke system. The name is due to the specific type of operation, from the intake of the fuel air mixture, the understanding of such fluids, the expansion through combustion and the exhaust of the post-burn gases, so that the system can work with its uninterrupted cycle (SIMÊNCIO, 2019).

The development of parts and models in three dimensions of coordinates, such as virtual x, y and z, also known as 3D, is widely used for planning as a way to add better compression in the model proposed in the computational scenario, where there are compatible tools in the software to perform a 3D modeling. These plug-ins are typically provided by 3D drawing programs (AGUIAR, 2016).

Machining is a very relevant technique in the manufacture of unique parts and prototypes, being fundamental for these processes to be efficient both in production technique and in their completion, as is done in factories in their operation routines (GRAVALOS, 2008).

Turning is a machining technique widely used in industries, and many companies use this technique, among other machining techniques, to produce products. Another option is the use of milling machines, which remove material through the milling method (FERRARESI, 1970).

In this context, the present work aimed at the manufacture and adaptation of parts for engines, increasing their compatibility between thrusters and machines of the rural environment, through the machining of different materials, such as nylon and aluminum.

1.1 GENERAL OBJECTIVE

Present the manufacture and adaptation of parts through machining, developing the compatibility between thrusters and machines of the rural environment.

1.2 SPECIFIC OBJECTIVES

- Offer an alternative machine that generates work for the rural environment;
- Produce nylon and aluminum parts using industrial machines and machining processes;
- Make, through 3D modeling, parts that can be machined;
- Present implement coupler for the Honda GX35 engine;
- Provide comfort in engine transport and usability to the operator.

1.3 JUSTIFICATION

Present a modified machinery option to assist rural workers in their activities and care in the field, offering practicality, reduction of manual labor and a new function to Honda GX35 engines. The option for the production of parts through machining is due to the reuse of parts that would be discarded and the consequent needs of adaptations to the engine for the use of new aspects within the field mentioned.

3D modeling is strongly used for the planning of parts such as couplers and other implements to be manufactured, aiming at the good use of the remains of aluminum and nylon disposal, so that there is no waste of material. The purpose of the application is to provide an alternative that improves food production and that can bring improvements in the quality of life of field workers.

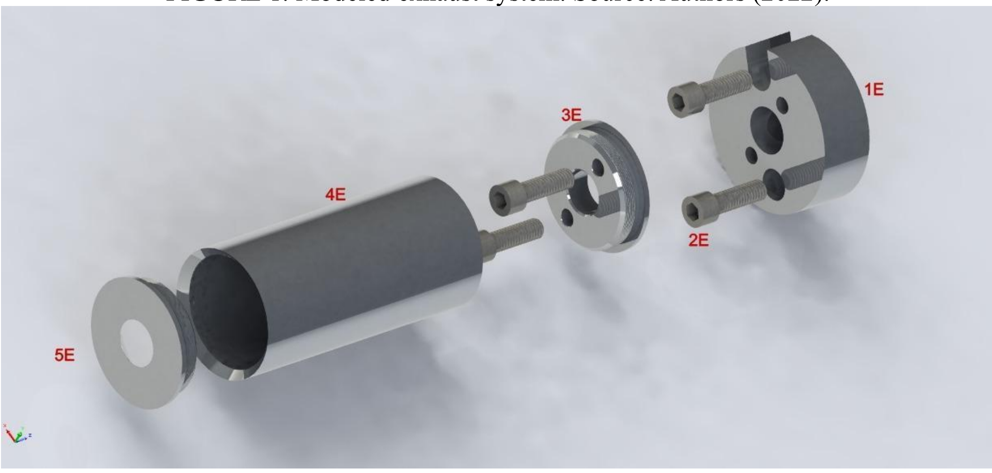
2 MATERIALS AND METHODS

The elements chosen in the making of this project, contemplate the modeling, machining and adaptation of systems.

2.1 PARTS DESIGNED FOR MACHINING

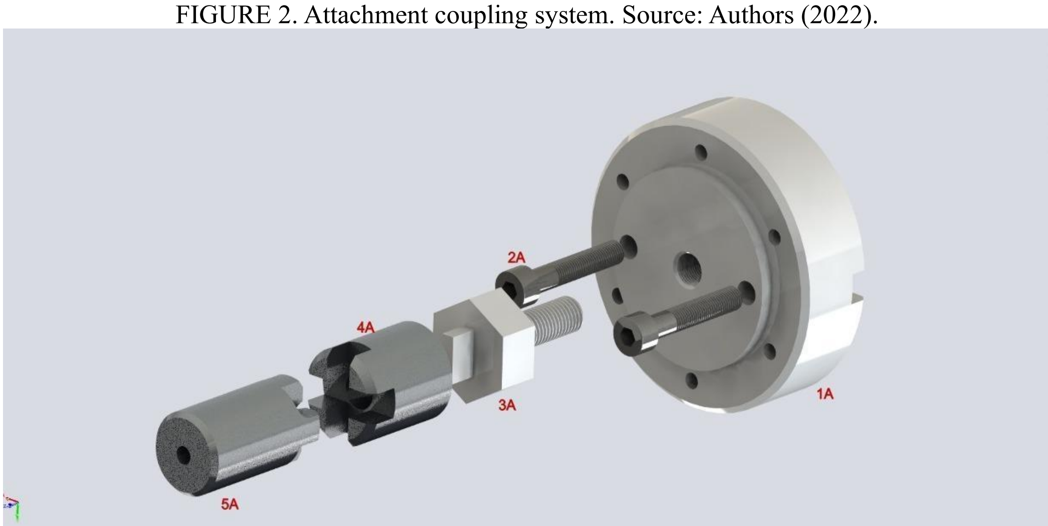
The parts to be adapted in the Otto four-stroke cycle engine, using the SolidWorks version 2020 software, were modeled in 3D for the 3D modeling of two components. Cylindrical Allen screws M6 were used for the exhaust and M8 for the coupling system. Of the manufactured parts there is the exhaust system, which has a set of 5 pieces, a 5E tip with internal conical hole at the angle of 48°, the 4E body, the flange of the exhaust manifold 3E, exhaust manifold 1E and the screws m6 2E for fixation, as shown in Figure 1. The exhaust is capable of accelerating the exhaust gases from the engine.

FIGURE 1. Modeled exhaust system. Source: Authors (2022).



Next, a 3D model of the attachment coupling system was produced with the M8 screws for fixing the set, consisting of a 5A male coupler, a 4A female coupler, a male hexagonal screw for 3A support, a cylindrical allen screw 2A and a coupler support 1A, as shown in Figure 2.

FIGURE 2. Attachment coupling system. Source: Authors (2022).



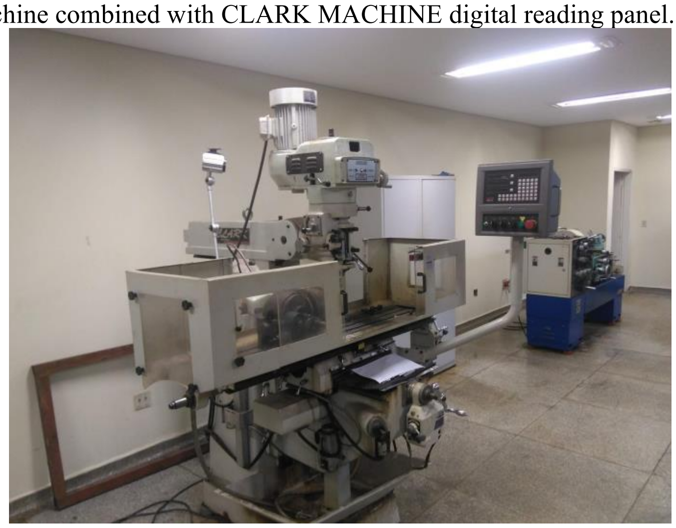
2.2 MACHINERY AND RAW MATERIAL

Aluminum and nylon billets were used and parts of them were reused. Among the machines, a Mascot MS 205-NARDINI lathe was used, Figure 3, for the turning of the billets.

FIGURE 3. Mechanical Lathe turning aluminum billet. Source: Authors (2022).

To mill the billets, a milling machine with protection and a dividing head were used, as shown in Figure 4.

FIGURE 4. Milling machine combined with CLARK MACHINE digital reading panel. Source: Authors (2022).



2.3 ADAPTATIONS

A Honda GX35 engine and a carburetor model WYJ-250/616-426 from WALBRO were used. For transport purposes, a 3M handlebar with holes was adapted for fixing by a 6M threaded bar and tightening using 4M nuts and 5M washers. The set also has a 1M trigger and a 2M wrist, originally from a hand cutter, as shown in Figure 5.

FIGURE 5. Adapted mobile system model. Source: Authors (2022).

2.4 MANUFACTURE OF THE EXHAUST SYSTEM

For the manufacture of the parts related to the exhaust system, the machining processes already mentioned were used, obeying the 3D planning, taking into account the choice of materials, such as billet, aluminum tube and the steel present in the screws.

The machining of the flange was produced by the movement of cutting and faceting on a universal lathe for the removal of spare parts. Subsequently, two holes were drilled using the coordinates of the milling machine.

The exhaust tip was made using the same cutting movement mentioned above, and then a hole was drilled that crosses the piece, followed by a conical hole arranged at an angle of 48°.

On the cylinder body of the exhaust part, it was not necessary to modify it, since it was already in accordance with the projected 3D model.

2.5 ATTACHMENT COUPLER

For the machined implement coupler, the making of the part only became possible through the turning processes, so that the nylon billet reached the expected results of the project. In the milling machine, 6 mm milling cutters were used; 8 mm; and 10 mm, for the realization of the holes, with the purpose of fixing screws for coupling the equipment compatible with the system and finally the removal of surplus materials.

The coupler holder 1A was machined using a nylon billet on a lathe to suit the design models. Nine holes were drilled, two of them for the passage of M8 screws, six for other adaptations, in order to increase compatibility with various types of future implements, and a last central hole of 10.5 mm was made.

The 1/2-inch Whitworth male tool was used to make the thread step of part 1A, which has the function of attaching part 3A. Finally, in part 1A a tear was made with a 10 mm cutter in order to better accommodate it to the steering wheel of the engine.

The material for the making of the 3A piece used a nylon billet, in which a 1/2 inch Whitworth thread was made on the lathe and later a hexagonal head with the aid of a milling machine and the splitter head. For the finishing, it was fixed again to the universal lathe and a cutting movement was performed to remove spare material.

In the making of the 4A piece, an aluminum billet was used and a hole was drilled in the center of the piece through the universal lathe, in view of the need for a reference point to make the next steps possible. Giving segment to the production of the piece, the fixation was made in the walrus of the milling machine to center the cutter in relation to the piece, enabling the last two movements. Two perpendicular tears were made with reference to the central hole of the piece.

Part 5A was machined through the milling process, with the aid of the divider head, applying ten turns on the handle for each milling pass, using a 10mm milling cutter. In sequence, a central hole was drilled using the lathe. The proposed part was created in order to generate compatibility of the engine with various implements, enabling the transmission of force from the engine to the proposed equipment.

2.6 ASSEMBLY PROPOSAL AND MODIFICATIONS PRESENT IN THE PROTOTYPE

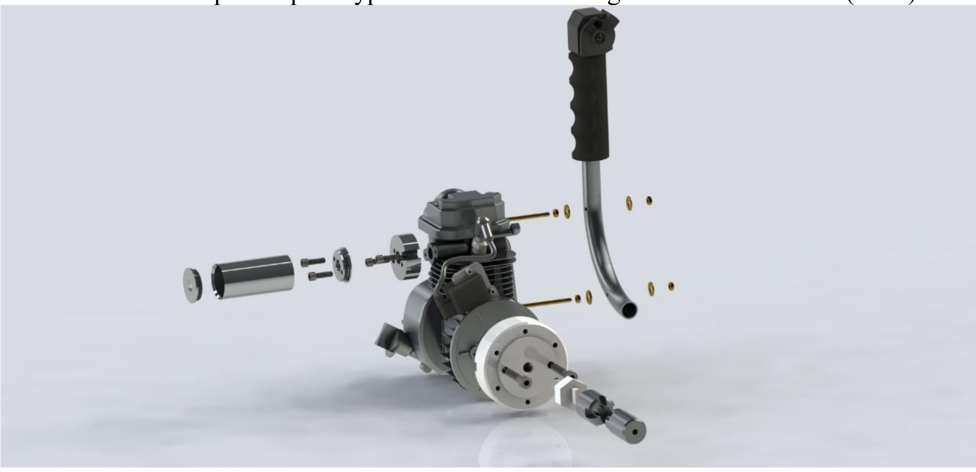
The adapted mobile system model was fixed to the engine by means of two holes in the 3M part, requiring the removal of the original screws and their replacement by threaded bars with M5 thread to fix the handlebars in the prototype through nuts and washers.

It was necessary to adapt the carburetor so that it could provide the right amount of air and fuel, being the changes: throttle stroke, aiming at the most efficient control of the engine rotation, and a hole in the slow passage of the carburetor inside the part, to enable the proper functioning of the system.

The 1E exhaust manifold was fixed through screws and sealed with adhesive engine gasket glue for use at high temperatures.

From the expected results of the project with all the proposed systems, Figure 6 is obtained, where the parts produced for fitting in their respective operating places are shown, to increase the range of possibilities of employability of the engine in rural areas.

FIGURE 6. Expected prototype of modeled final engine. Source: Authors (2022).



3 RESULTS AND CONCLUSIONS

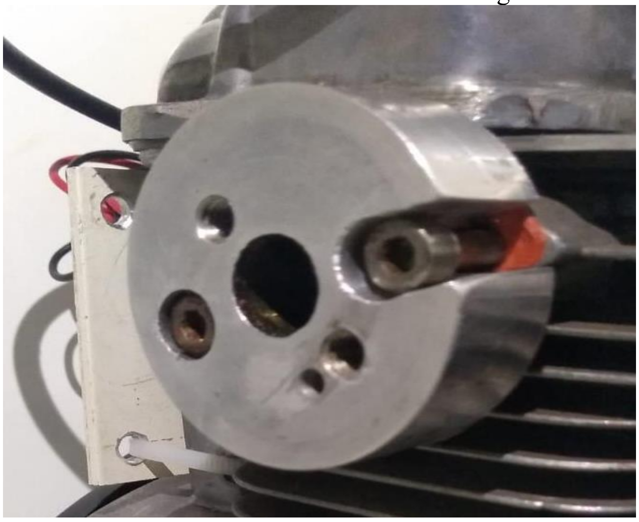
Of the final pieces machined, there is the exhaust system and the coupler of implements that were first modeled to meet the fittings of the parts present in the projects.

3.1 MACHINED EXHAUST SYSTEM

The exhaust system Figure 7 presented plausible results, because with the material machined in aluminum, it proved satisfactory to withstand the thermal work performed by the system.

FIGURE 7. Set of machined aluminum exhaust parts with their screws. Source: Authors (2022).

FIGURE 8. Exhaust manifold 1E machined and fixed to the engine. Source: Authors (2022).



3.2 MACHINED COUPLING SYSTEM

The machined parts of the coupler system of machined implements Figure 8, had components of nylon materials are they: coupler bracket 1A fixed to the flywheel of the engine and male hexagonal screw for support 3A. The coupling components machined in aluminum were coupling of the prototype motor male coupler 5A and the female coupler 4A, which is intended to be attached to the attachments so as to be coupled to the engine system.

FIGURE 9. Machining system machined in aluminum and nylon with screws. Source: Authors (2022).

The motor prototype shown in Figure 10, presented success in all project processes, from the manufacture, adaptation and application of the system presented. It is important to note that the pieces manufactured in nylon were used at an experimental level, considering that the tests were carried out on a bench scale.

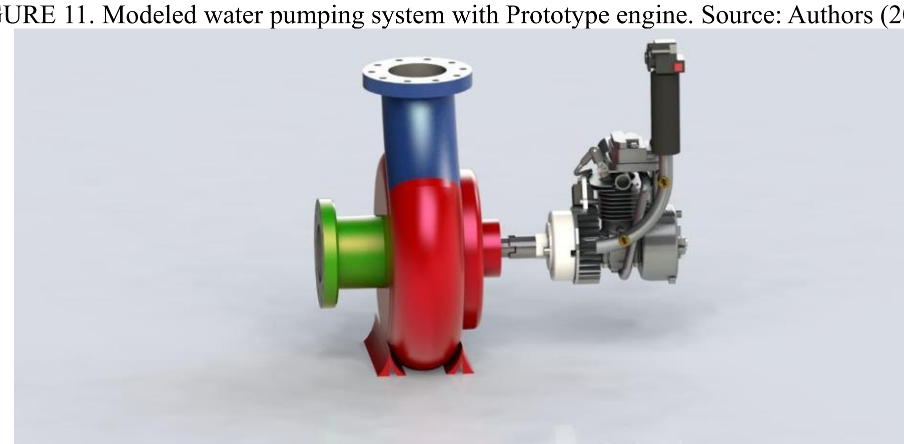
FIGURE 10. Engine prototype. Source: Authors (2022).

The prototype has as a condition of use the need for the coupling of the machined parts 4A and 5A, so that the work of the engine is transferred to the implement in question.

It can be cited as a final result its modification to meet the various needs of the field, and before such an engine had as its sole function to generate work for a manual brushcutter.

It can be applied as an example, a pumping system Figure 11, where the prototype can be used to assist the rural operator, for activities that require water supply.

FIGURE 11. Modeled water pumping system with Prototype engine. Source: Authors (2022).



Where the figure above demonstrates the implement fixed to the engine, the pump body is represented by the color red, the flanges are being demonstrated by the colors green and blue, which indicate the passage of fluids, the flange being green, the liquid inlet to be transported, and the flange in blue the liquid outlet that should be pumped.

It is concluded that the prototype met the expectations of design, from its modeling to the preparation and tests to verify the proper functioning of its systems. It is essential to emphasize the importance of modeling parts for good project management and optimization of resource expenditures, in addition to materializing ideas through the rendering of computational models, which is a crucial step for materialization through machining. After all machining process with the lathe and the milling machine, it is concluded that the results were satisfactory, considering the similarity between what was proposed through 3D computer modeling and what was verified through the tests in real situations.

Of the proposed materials, nylon proved to be the most suitable for prototyping, due to its practicality and handling in the turning and milling processes. Aluminum has the advantage of its high strength compared to nylon. All the pieces present fulfilled their respective functions with the materials duly selected. The attachment coupler system was highlighted due to the potential of application in several works, multiplying the human force in the field.

Overall, the prototype achieved success in all pre-established objectives, providing the Honda GX35 engine with greater employability from its use in the rural environment.

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