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The improvement of equipment for cassava milling at the Mamirauá Sustainable Development Reserve (Amazônia - Brazil)

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Abstract
Mamirauá Sustainable Development Reserve (MSDR), in the Amazon region, is the largest Brazilian protected várzea (flooded forest) area. This area is unique, not only because of its high level of biodiversity, but also because it is the first Brazilian conservation unit designed to integrate the preservation of fragile habitats with the sustainable development of local resident communities.

Some economic alternatives have been explored by the ‘Ecological Extension Program’ adapted to the working conditions in the flooded forest area. One of these is related to the agricultural production, by the improvement of equipment to mill the cassava for flour fabrication. Improvements in its performance and ergonomics were necessary, built on local technology of manufacturing and observing the cultural local factors.

This paper relates the work developed by a design team of the Universidade Federal do Pará (UFPA), local agricultural extensionists and producers. Its aim is to design new equipment, with low cost and easy technology making it possible to increase the flour production and the family income, reducing greatly the human effort and the damage to the environment.

Introduction
Located 600 Km (about 370 miles) west of Manaus in the State of Amazonas (see Figure 1), the Mamirauá Sustainable Development Reserve is the largest (1,124,000 ha) Brazilian protected area conserving flooded forest ecosystems, and the only operational area conserving the bottom land flooded forest.

This unit is important not only because of its unique biodiversity and endemism, but also because it is the first Brazilian conservation unit designed to integrate the preservation of internationally significant biodiversity resources, fragile habitats, sustainable resource management and participatory management with traditional communities.

Integrated Conservation and Development Projects have been widely discussed in environmental and sustainable development meetings, but at Mamirauá, this approach has been developed and applied in the field since 1992. The state government in mid 1996 formally approved this approach, when the area was reclassified as a Sustainable Development Reserve. General operational aspects, the conservation and development objectives were defined.

Within the development objectives, there are many efforts to accomplish social...
development, like health programs and improvement of incomes. The improvement of incomes has been developed with the orientation of technicians that identify better ways to work (at agriculture, handicraft, etc.) without damaging nature.

So, the communities need to improve equipment, designed and constructed by the local people, to mill the cassava for flour fabrication. This equipment did not have a good concept, despite its features of easy manufacturing, easy assembly and low cost. Some improvements were necessary to gain productivity.

A design team formed by Professors and undergraduate students of the Universidade Federal do Pará (Brazil) is working together with local resident communities to redesign a new machine with better performance than the first one.

The cevaciclo and its features
The machine has a goal: to introduce low cost technology with easy maintenance, encouraging agricultural production as an economic alternative for the communities' development. This alternative is feasible through the increase in flour production, simplification of fabrication, improving the output and reducing the risks of accidents on its use.

With the traditional method of cassava milling at the Mamirauá Sustainable Development Reserve (MSDR) people had to do it with their own hands, leading to several problems like: fatigue, accidents with hands and the tool used to mill, and low productivity.

The low productivity caused an additional problem: people plant cassava in the dry channel of the river (more fertile) in summer and the harvest of cassava begins in winter, at this time the level of the rivers at MSDR rise by about 12 meters (13 yards). So, people could not mill the cassava as fast as the rising of the river level and frequently there were big losses.

A MSDR employee, Mr Otacílio Soares Brito, developed equipment to mill the cassava faster and more safely than the traditional method. It received the name of CEVACICLO (see Figure 3). It is the joining of a bicycle framework and a Catitu, equipment well know in the Amazon that works when coupled with a motor.

It works with two users, the first operates the pedals moving the mechanism to a working velocity, and the second inserts the cassava to mill in the Catitu, a revolving cylinder with blades.

At the communities, there is no electric energy and the use of gasoline or diesel engines is not possible because it will increase the cost of production and the big distances lead to problems on maintaining the engines.

The Cevaciclo attains high levels of productivity compared with the traditional method of cassava milling. When you mill 60 Kg (132 lb.) with your hand in 3 hours, the...
Cevaciclo does it in 20 to 30 minutes (improvement of 600%) with less risk of accidents. Other features of Cevaciclo are less fatigue (use of legs and flywheel, big reduction gearing 28:1), low cost of manufacturing, easy assembly, use and maintenance.

The problems are caused by some design considerations of the Cevaciclo, such as: the user chair, the bicycle framework, and the Catitu. The Cevaciclo’s chair brings some problems for the user (see Figure 4). The position is troublesome, the chair is very high to sit on, very heavy, big, uncomfortable and expensive in relation to its user value.

The chair was designed originally by observing the cyclist. The height and the position of the chair were defined by the same features found in a bicycle. However, to have optimum use of human power, Woodson (Woodson, 1992) recommends a chair with the same height as the pedals (bicycles are different to improve the equilibrium and the visualisation).

However, on this occasion, changing the chair height was not a satisfactory solution because the height was defined by the bicycle framework geometry. Therefore, the best solution is to look for a new geometry to support the pedals and the wheel. This alternative will bring a new concept for the chair.

Improvements necessary to the cevaciclo
Despite its good characteristics, the Cevaciclo had problems because it was developed without enough knowledge of ergonomics, manufacturing and assembly. So, some design improvements were necessary.

Through user interviews and local observations the design team gathered some points to improve and develop:
• The Cevaciclo’s weight is very high;
• The dimensions are too big;
• It has an uncomfortable position for the user;
• There is a big possibility of accidents with the Catitu;
• There is vibration on the Catitu;
• The MSDR co-ordination wanted a primer to disseminate the use of the Cevaciclo.

Figure 3  Cevaciclo developed by Mr Otacílio Soares Brito. Photo  A E Braga Jr

Figure 4  User operating the Cevaciclo
Photo  A E Braga Jr
framework that will be lighter, smaller, and easier to construct (due to the need to disseminate the Cevaciclo by a primer). The user chair will be designed for the new framework using recommendations for this kind of chair.

The Catitu needs some improvements too (see Figure 5). Observing the user who inserts the cassava, we concluded that its dimensions are too big for its purpose, the length and the width should be half that of the original version. The cassava are inserted one by one and are not very large, the biggest are 8 cm diameter (3.15 inches; see Figure 2).

Using QFD (Quality Function Deployment), the team reviewed the characteristics to the new redesigned Cevaciclo:

- lower costs of manufacturing;
- easier maintenance and construction;
- more comfort to users (less muscular fatigue);
- more safety to users (less risk of accidents);
- more productivity;
- lower weight and smaller dimensions (better to transport and to store);
- increase durability;
- easier to collect the milled cassava;
- easier to clean;
- versatility.

The need for versatility is linked with the desire to develop the communities’ incomes. The MSDR co-ordination wants the development of other machines like a lathe for ceramics and a water pump, both operated by pedals. So, versatility is required to extend machine actuation to other applications.

Conclusion

The work objective is to improve the activities developed by the local residents at Mamirauá Sustainable Development Reserve. The Cevaciclo is very important to them because it facilitates the work of flour fabrication, increasing the productivity and reducing the losses.

The improvements listed are being developed. Many discussions are necessary now to define what will be the best for the users and manufacturers. This moment is very important to the students because they may see that the best technical alternative is not always the best solution for the user. This is the most exciting phase of the project to them, searching for a solution using creativity is a challenge.

This is the first initiative to improve the work conditions in communities using machines of easy construction and operation. This philosophy is necessary due to the communities’ limitations on manufacturing and comprehension of Mechanics. Other equipment will be developed with the same goal.

Figure 5  Catitu. Photo A E Braga Jr

The second problem observed, and more dangerous, is the high risk of accidents with hands. Due to the high work velocity (with a transmission ratio of 28:1 it is very easy to reach high speeds with the pedals) and no hand protection against the revolving cylinder, an accident will bring serious damage to hands of the users. So, it is necessary to include an element to ensure the minimum safe distance of users hands and the blades, but without work detriment.

The third problem observed by the design team is the actual blade configuration parallel to the axis, which generates vibrations on the Catitu (inclusion of an angle between the axis and the blades reduces this problem). But, this solution must be tested because it leads to more complex manufacture, and a decision has to be made: reduce the vibrations hampering the manufacturing or maintain the vibrations with an easier solution to construct.
The new design version of Cevaciclo will be described in a primer available in June 1998. This document will have information about the construction and usage of the Cevaciclo and its maintenance. The objective is to disseminate more easily the results found from this work. A video will be made with the same information.

The Mamirauá Conservation model depends upon the acceptance of mutually agreed rights and responsibilities for all stakeholders, and their effective implementation. For local communities, this means active participation in the development and enforcement of sustainable resource management schemes and acceptance of further restrictions based on diversity and conservation issues. For Mamirauá Sustainable Development Reserve, this means going beyond traditional research and conservation programs, developing appropriate resource management practices and participatory mechanisms for reserve management. The most significant of all is the importance of the preservation of Nature and its beauty.

Figure 6  Mamirauá Sustainable development Reserve floating house. Photo A E Braga Jr

References