A co-design experience: improving mining technologies with communitines in Antioquia, Colombia

UNIVERSITY OF TEXAS ARLINGTON

NSF

retos

diversa

Humanitarian ENGINEERING

U.S. AIR FORCE

MINES

UNIVERSIDAD NACIONAL DE COLOMBIA

Acknowledgments & credits

Professors:
Tom Phelan / US Air Force Academy
Kate Smits / University of Texas-Arlington
Robin Bullock / Colorado School of Mines
Jessica Smith / Colorado School of Mines
Juan Lucena / Colorado School of Mines
Julia Roos / Colorado School of Mines
Oscar Jaime Restrepo Baena / Universidad Nacional de Colombia

Support in-situ:
Casey Gibson / Colorado School of Mines
Jose Velásquez Vásquez / University of Texas-Arlington
Jeison Delgado-Jiménez / Colorado School of Mines
Felipe Rodríguez Novoa / Colorado School of Mines
Gerardo Martínez / Colorado School of Mines

Creation of the current booklet

Photographs in the field:
Oscar Jaime Restrepo Baena / Universidad Nacional de Colombia
US Students

Facilitators:
Diana Duarte / Diversa
Alex Freese / Diversa

Documentation and content:
Natalia Barrera / Diversa

Graphic Assembly:
Aura Flechas Aguilar / Diversa

Participants:
Aruasi Borres-Guerrero / Colorado School of Mines
Nina Guizzetti / Colorado School of Mines
Gloria Quispe Oruro / Colorado School of Mines
Emma Hollenstine / Colorado School of Mines
Emily Robinson / Colorado School of Mines

Ashley Nguyenminh / University of Texas-Arlington
Anson Belcher / University of Texas-Arlington

Jacob Foster / US Air Force Academy
Maliya Hillman / US Air Force Academy
Brandon Kuhl / US Air Force Academy
Grace Proesch / US Air Force Academy
Elizabeth Worthington / US Air Force Academy

Santiago Perez Duque / Universidad Nacional de Colombia
Sara Fernandez Rodriguez / Universidad Nacional de Colombia
Marco Aurelio Hernandez / Universidad Nacional de Colombia
Carlos Andres Quesada Diaz / Universidad Nacional de Colombia
Jessica Lorena González / Universidad Nacional de Colombia
Juan David Valencia Quiceno / Universidad Nacional de Colombia
John Edison Castaño Grajales / Universidad Nacional de Colombia
Paula Andrea Gallego Lopez / Universidad Nacional de Colombia
Natalia Restrepo Gonzalez / Universidad Nacional de Colombia
Rosbel Arcenio Jiménez / Universidad Nacional de Colombia
Isabella Cerchiaro Sanchez / Universidad Nacional de Colombia
Manuel Zacarías Salgado / Universidad Nacional de Colombia
Luis Fernando Ortega / Universidad Nacional de Colombia
María Camila Arango Mora / Universidad Nacional de Colombia
Jorge Almario Tarra / Universidad Nacional de Colombia

Emma Hollenstine, student, successfully testing her team prototype.

Contents

Introduction

This report presents the process and results of the 10-day Workshop led by **Diversa®**, in partnership with the **Responsible mining, resilient communities** project, an interdisciplinary, multi-institutional, global research collaboration funded by the United States National Science Foundation, whose objective is to co-design socially responsible and sustainable mining practices in the hands of communities, engineers and social scientists.

For the workshop, we had the participation of 28 students from different universities, which were divided into 6 teams. Each team devised and prototyped improvements to mining tools created and brought to the workshop by 4 members of the community of artisanal miners from Bajo Cauca and Santa Rita, Antioquia, Colombia.

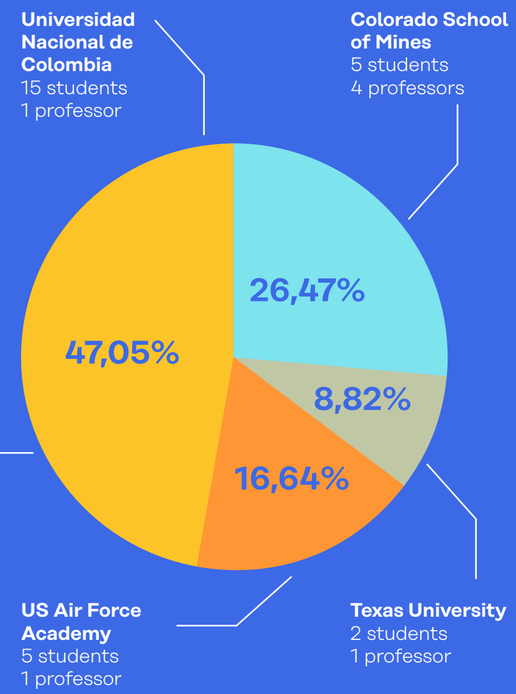
Actors of the experience

4 **Members of the artisanal mining communities**

34 **Participants**
Students + Professors

5 **Graduate Students**
(Campus Support)

5 **Guests**



Objectives and workshop components

The learning objectives that motivated this 10-day workshop are:

→ Recognize the problems of Artisanal and Small-Scale Mining (ASM) as socio-technical challenges.

→ Understand the importance of community participation to better frame challenges in ASM.

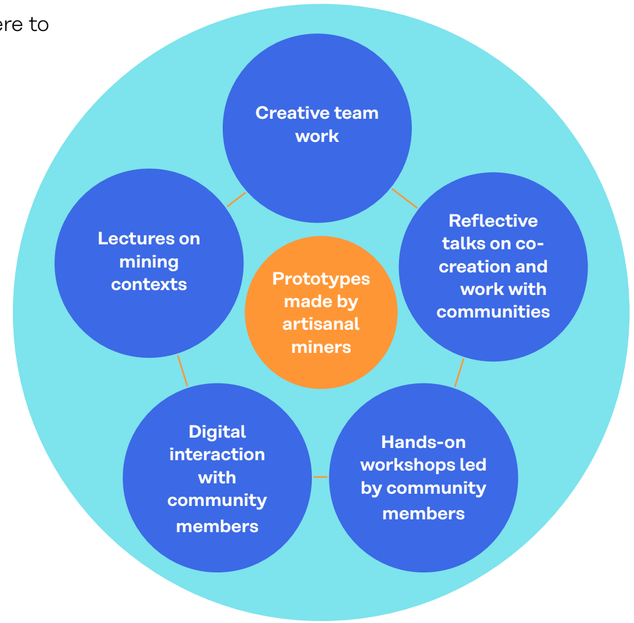
→ Recognize local knowledge and resources as key variables to identify challenges in ASM.

→ Apply learning on how to jointly identify and frame problems or challenges with communities within digital environments.

→ Reflect on issues related to co-design, ethics, power relations, predispositions and imaginaries, intersectionality, among others, as important issues for integral professionals.

→ Generate improvement ideas for the challenges framed, either around the innovations made by the participating community members, or around other challenges encountered in the process.

To achieve the objectives of the workshop, the main pedagogical strategy was to start from the technological innovations made by the participating artisanal miners, and from there to deploy the creative work of the teams:

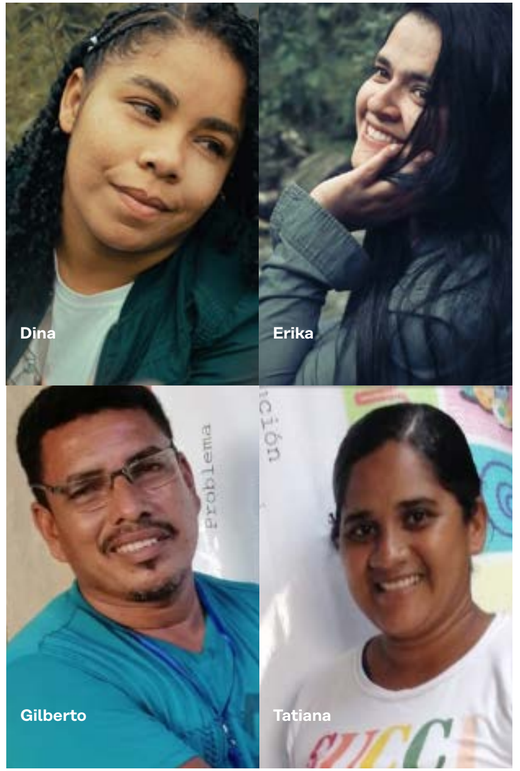


Community context

The mining sector represents approximately 1.38% of the Colombian GDP, and of this total, that of gold and metals represents 31%; likewise, at the level of mining exports, Gold represents 37% together with other precious metals[1]. In Colombia, we find from large-scale multinationals, to Artisanal and Small-Scale Mining (ASM) and even the so-called Subsistence Mining . These last two are characterized by being informal activities carried out by individuals, groups or communities generally of low economic resources, using little technology and machinery, which implies low productivity, high physical effort, absence of security measures and generally absence of environmental protection measures.

1. Taken from the National Mining Agency. Written on April 21, 2021: https://www.anm.gov.co/?q=colombia tiene-un-potencial-de-exportacion-ilimitado-hacia-los-mercados-internacionales

[04] Community context

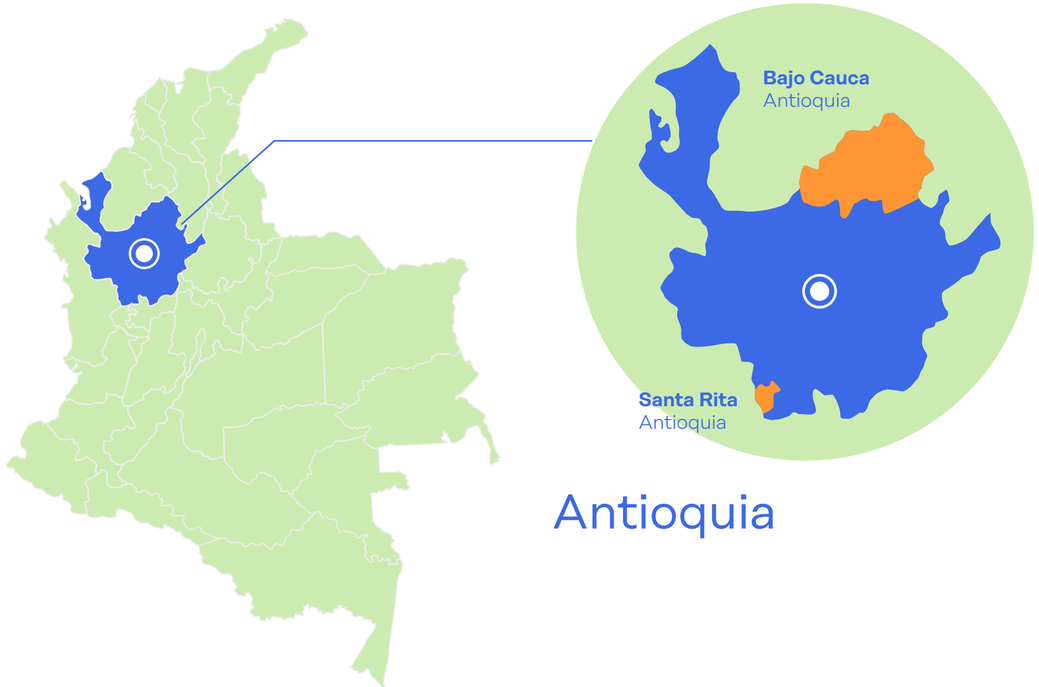


Erika, Dina, Tatiana and Gilberto are artisanal miners from the department of Antioquia. Erika and Dina reside in the Corregimiento of Santa Rita, in the municipality of Andes, south of the department; they mainly practice sinkhole (de socavón) mining. Tatiana and Gilberto reside in the Bajo Cauca subregion, to the north of the department, and mainly perform alluvial mining.

These four miners have been in-person and virtual participants in projects and initiatives that Diversa has developed in the territory over two years. Thanks to these programs, they have managed to innovate some of their work tools in the mining context.

In this occasion, they showed students their innovations with the goal to collectively work on new ideas for improvement.

[04] Community context



Map taken from: https://en.wikipedia.org/wiki/Bajo_Cauca_Antioquia#/media/File:Colombia_-_Antioquia_-_Bajo_Cauca.svg

Challenges brought by the community participants

Now that we are clear about the context, objectives, and components, we can give way to show the technologies to improve brought by the community, then the implemented methodology expressed in the timeline of the process, to then move on to the improvement ideas against the challenge that each team chose; most of them, related to innovations brought by the community members, but you will also find a couple that seeks to address new challenges encountered during the virtual interaction between students and artisanal miners. Finally, some testimonials will be given about the experience and the next steps that we will take with the results.

[04] Community context

How to improve the Sluice Box made by the artisanal miners?

Photo of Mr. Gilberto, from Bajo Cauca, with his Sluice Box improved, the one he brought to be iterate.

What is it?

It is a tool that miners use to wash material such as mud from sinkholes and rivers, and recover the gold it contains. (This element usually has in its internal surface different kinds of mesh).

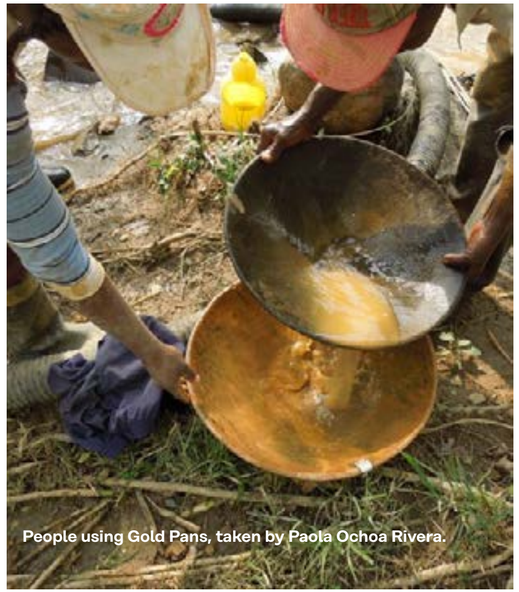
Why did they make this new version?

The original version was too heavy (100% solid wood, +/- 50 pounds). Women have to walk and climb long distances from their houses to mining zones. New local innovation has made this tool weigh +/- 10 pounds.

What current challenges or opportunities for improvement did the students focused on?

→ Still a bit heavy
→ Due to its size and shape, it is difficult to transport.
→ You have to stand for long periods of time when it is used, which can be very uncomfortable.
→ Might face problems of efficiency and loss of gold.
→ he gutter does not have legs, it doesn't stand on its own and they must improvise on where to put it.

How to improve the Gold Pan made by the artisanal miners?



People using Gold Pans, taken by Paola Ochoa Rivera.

What is it?

Artisanal mining tool to wash material and recover gold; it is like a conical plate (so the gold, which is heavier, stays at the bottom) of 2-3 inches deep.
It is used directly in alluvial mining, but also as a complement to the Sluice Box (by washing its mesh to collect the thinnest gold). It is better if its color is dark, so that the gold is easier to recognize.

Why did they make this new version?

It was traditionally made of solid wood: the trunk of a tree was cut into slices and its conical shape was carved by hand. As a result, it had a high manufacturing and environmental cost, its lifetime was short, it was heavy and difficult to handle. The current innovation is made of PVC pipe, which is easier to access, easy to mold, and the dark color can be given with an oil paint so that it does not fall off easily.

What current challenges or opportunities for improvement did the students focused on?

→ In the construction process, wrong cooling parameters can lead to breakage of material.
→ Due to the mold is made on the ground, small stones stick to the material of the Gold pan.
→ To shape the PVC, they use their feet, which is dangerous due to heat.

Process timeline

1. Introductions

2. Bajo Cauca and Santa Rita Context; challenges and team organization.

3. Valuing local knowledge:practical workshop given by the community: Sluice Box

4. Design cycle and Co-creation

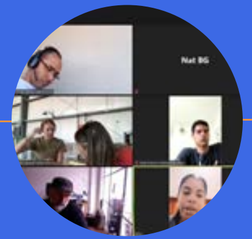
5. Valuing local knowledge: practical workshop given by the community: Gold Pan

10. Showcase, feedback and closure

9. Talks about mining contexts: conflict, restoration and agriculture, health and safety

8. Reflection sessions: Latin America: analysis, power dynamics, and referents of community work.

7. Choosing a path: students ideas of improvement and community feedback



6. Digital visit and dialogue with the communities: framing challenges

Team 1

Students:

Jacob Foster
US Air Force Academy

Gloria Quispe Oruro
Colorado School of Mines

Santiago Pérez D.
Universidad Nacional de Colombia

Sara Fernandez R.
Universidad Nacional de Colombia

Jorge A. Tarra A.
Universidad Nacional de Colombia

Marco A. Hernández O.
Universidad Nacional de Colombia

What is your proposal?

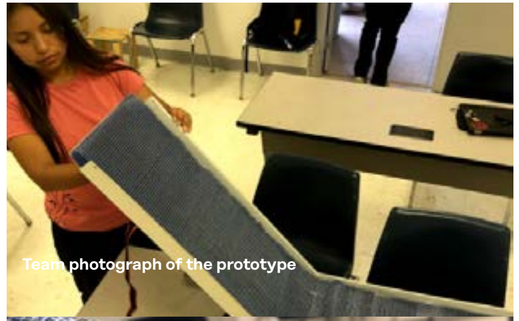
In response to the need for communities to work comfortably in difficult situations, we collectively created a PORTABLE, DURABLE and EASY TO BUILD prototype of Sluice Box that can be used virtually anywhere.

The main improvements are:

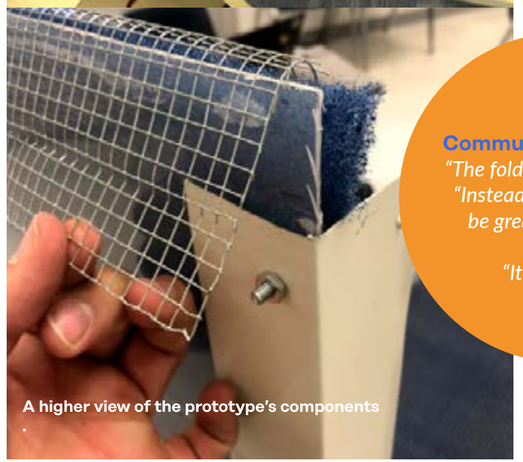
→ Reduction of weight of the box by using square-shaped metal roof material for the side sides of the box and plastic containers for the base.
→ Using a two-piece foldable design to improve portability.
→ Added straps to resemble it to a backpack.

Next steps

→ Use a pin / latch to secure the two halves when bending instead of nuts and bolts.
→ Use a material to catch the gold and allow the drawer to bend.
→ Add legs to the frame to give it the desired height of use.



Team photograph of the prototype



A higher view of the prototype's components

Community feedback

"The folding concept is great"
"Instead of screws, it would be great to use hooks or snaps."
"It's really light!"

Student carrying the prototype

Team 2

Students:

Grace Proesch
US Air Force Academy

Ashley Nguyenminh
University of Texas-Arlington

Carlos A. Quesada Diaz
Universidad Nacional de Colombia

Jessica L. González G.
Universidad Nacional de Colombia

Juan David Valencia Q.
Universidad Nacional de Colombia

What is your proposal?

DIY Sluice Box Design, separated into two sections that can be joined to form a purse.

We proposed to use old and reused tires in the form of horizontal grooves that a trap for gold with removable metallic mesh and sponge-like material with high porosity to capture the smallest particles. A shell made from folded tinplate and a joint made with a system similar to a screw and adjustable nut.

Next steps

→ Tires will not be used in the new design due to community recommendations.

Student testing her team's prototype

Community feedback

"It's a great prototype"
"Aluminum wings need to be bent several times to make them stronger."
"Rubber may not work much, it is a heavy material, difficult to access and difficult to modify."

Student showing her team's prototype

Team 3

Students:

Brandon Kuhl
US Air Force Academy

Nina Guizzetti
Colorado School of Mines

John Ed. Castaño G.
Universidad Nacional de Colombia

Paula A. Gallego L.
Universidad Nacional de Colombia

Natalia Restrepo G.
Universidad Nacional de Colombia

What is your proposal?

We want to improve the production process of the Gold Pan that they taught us, by means of a cement mold, so that there will be no small rocks that adhere to the material. They will not have to stand on hot PVC and the PVC will be shaped without the risk of breakage.

Next steps

It is possible to experiment in the construction of the Gold Pan in order to find new solutions; for instance:

→ You can vary the shape of the Gold pan when building it, as well as the handles: this can make the extraction process more comfortable and efficient (for example adding steps, which help to trap more gold.)
→ Tailings could be added to the concrete mix: reusing waste from mining processes. It would add value to the process making it more sustainable.

Photo of all components of the mold.

Photo of the mold base.

Community feedback
"The idea of a cement mold is really good, so it will not have any blemishes while reducing harming risks during manufacturing."

Photo of Gold Pan successfully made by the students with the mold they created.

Team 4

Students:

Maliya Hillman
US Air Force Academy

Aruasi Borres-Guerrero
Colorado School of Mines

Rosbel A. Jiménez Ibáñez
Universidad Nacional de Colombia

What is your proposal?

A Sluice Box that is lighter, more portable and more comfortable to use. We change the wood to PVC to make it lighter.
We put backpack straps and it is foldable to make it easier to carry. It has a pocket to have only one thing to carry. It has legs to improve efficiency and comfort when using it, by not having to bend down so much.

Next steps

→ Change the dimensions of the artifact.
→ Further testing should be done to verify community observations and make any necessary adjustments.
→ Improve anchoring when folded and extended.

Photo of the prototype tieded up.

Community feedback

"Good idea"
"We would have to try, but we do not know if the PVC legs and frame will hold up."
"That it has legs will surely relieve us from the effort on the back."
"Make sure there are no leaks where material can be lost"

Photo of some team members with their prototype spread out

Team 5

Students:

Emma Hollenstine
Colorado School of Mines

Anson Belcher
US Air Force Academy

Luis Fernando Ortega
Universidad Nacional de Colombia

Isabella Cerchiaro S.
Universidad Nacional de Colombia

What is your proposal?

It is a complement to the mud sifting system; it gives it a solid base, it allows to give angle and height.

It consists of a wooden base with inclined grooves in its 4 columns to anchor the base at a desired angle over which the uncomfortable and laborious process of mud sifting can be done in a better way. We achieved that this base resists at least 90 kilos!

Next steps

→ Inquire about alternative materials that are resistant to water and resistant to weight.
→ Reduce the length of the base in half.

Community feedback
"It is a very creative solution"
"Think or propose another more durable material."
"Use waterproof varnish."

Photo of the team's prototype.

Student, successfully testing her team prototype.

Team 6

Students:

Elizabeth Worthington
US Air Force Academy

Emily Robinson
Colorado School of Mines

M. Camila Arango M.
Universidad Nacional de Colombia

M. Zacarías Salgado C.
Universidad Nacional de Colombia

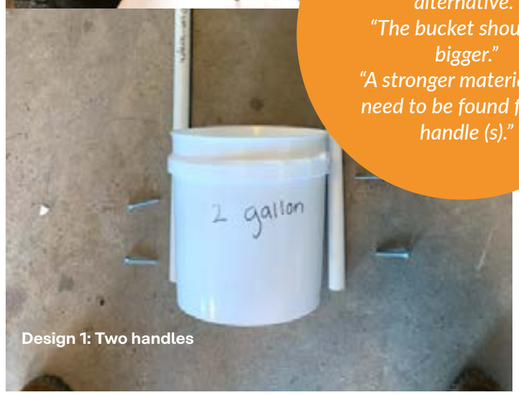
What is your proposal?

Two types of Buckets with handles for sifting the mud; an alternative to the current sieving process. It will allow you to do the work standing up with your back straight, which would be much more comfortable than the current form. The bucket has small holes to filter and separate the mud from the gold.

Next steps

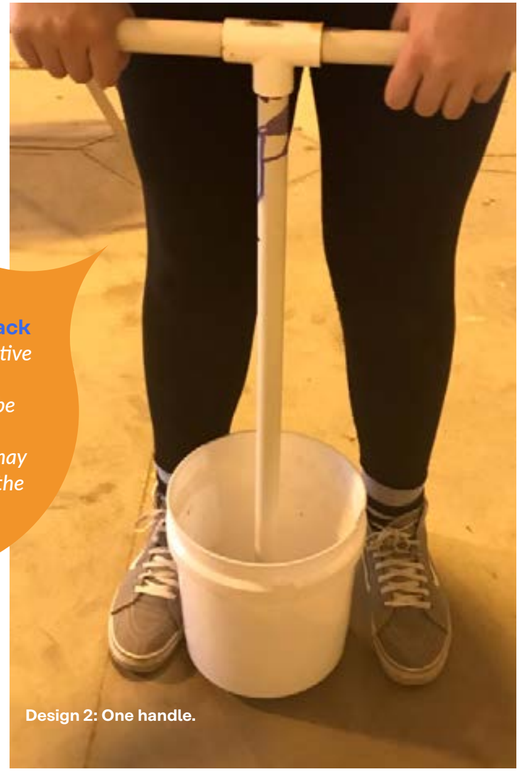
→ Design 1: Include PVC plugs at the base of each handle to prevent mud from entering the base of the handle
→ Design 2: Use two bolts on the base to prevent rotation of the handle.
→ Both designs: Add recycled tire rubber to the handles for a better grip, they could be attached to the PVC with the same PVC glue.

Opening holes in the bucket.



Design 1: Two handles

Community feedback
"Great idea, an innovative alternative."
"The bucket should be bigger."
"A stronger material may need to be found for the handle (s)."



Design 2: One handle.

Some testimonials

"Before starting the project, I had the expectations of learning ways to help my community. The project helped me to see even further dimensions about community development. It exceeded my expectations. I learned about the importance of working with a socio-technical approach. Considering the community knowledge will add value to the project and will open the possibility to create more innovative and sustainable ideas."
Gloria Quispe Oruro

"Being able to speak with community members and collaborate with students (from other universities) was an extremely educational and fun experience. I learned a lot about teamwork, time management, culture, and some spanish :)"
Nina Guizzetti

"From a relative simple tool it can emerge several interesting solutions."
John Edison Castaño

"I learned that this type of work makes me feel very passionate and excited, and I want to do similar things with my career one day."
Emma Hollenstine

"Co-creation, I think it is a term that I will never forget."
Jessica González Guzmán

Next steps

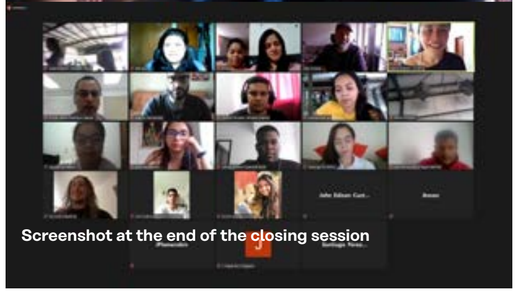
Some of the next steps that we will take with the community, its challenges and the improvements made by the students are:

→ Leave as a basis the improvements made to technologies and new ideas for future teams of students who can build upon them.

→ Continue working with artisanal miners in framing and addressing different challenges they face at work on a daily basis.

→ We will enhance the experience for future scenarios based on internal feedback provided by participating teachers and students.

→ For more information go to https://www.retos.co/



Screenshot at the end of the closing session

diversa.co

Facebook: diversa.co
Twitter: DIVERSACO
Instagram: diversa.co
Linkedin: diversacolombia

diversa®
co-creación comunitaria