



REGISTRATION FORM

Leading student: _____,
first name last name

e-mail address: _____

Faculty member endorsing the project: _____,
first name last name

e-mail address: _____

University: _____

Program of studies: _____

Second team member: _____,
first name last name

e-mail address: _____

Third team member: _____,
first name last name

e-mail address: _____

Fourth team member: _____,
first name last name

e-mail address: _____

Project description (less than 100 words): _____

NOTE: Those invited to continue to **Phase 2** will send the video before the date set in the calendar to the email address that will be provided in the invitation.



The Distillation Column Web
Laboratory

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Abstract

WebLab means access to real labs and devices through the Internet. The goal is to enable interactivity with devices, control and monitoring, and cooperative work. Therefore, this work aims to present the DistLab, a distillation column that was adapted for batch operation remotely, attending the demands of Education 4.0. A distillation column is used to separate components from a liquid mixture by volatility difference and it is applied to many industrial processes. For example, production of alcoholic beverages and the separation of petroleum. Thus, the engineering courses, mostly chemical engineering, will have a product at the service of the academic community that will allow remote access to the experiment.

1. Problem definition

It is very important that undergraduate students have practical classes and activities. Developing these activities, the students have contact with situations that possibly will be on their professional routine. As a result, the students will become more qualified professionals.

The global covid-19 pandemic brought new challenges, one of them was the need of social distancing and, consequently, remote classes. Because of this situation, many practical activities could not be developed, however it stimulated the use of resources and tools that allowed classes to remain happening remotely.

Although there are works and research projects on remote practical laboratories for engineering study fields, there is a shortage for the thermofluid field, which is studied, principally, in courses as mechanical, chemical and food engineering. Hence, this work has the purpose of presenting the DistLab, a weblab distillation column, located at São Francisco University - Brazil, which was adapted to remote operation and introducing, in a didactical way, the concept of “industry 4.0”. A distillation column is



used to separate components from a liquid mixture by volatility difference and it is applied to many industrial processes (FOUST, 1982).

As a consequence, the distillation column operation can be done without neither the professors nor the students being at the lab physically, making the demonstration of experiments and functionality of the equipment easier. From the point of view of a service, the remote access could be charged for every 180 min (enough time to run two distillation batches) previously scheduled by the user.

2. Business Model CANVAS

PARTNERS	KEY ACTIVITIES	VALUE PROPOSAL	RELATIONSHIP	CUSTOMERS
Payment Management Company	Develop experiments proposals/scripts	Guaranteed Service	Instruction Manuals and Technical Guides	Individual students or professionals
USF	Customer relationship	Security	Experimental proposals	Universities
Professor Felipe Cavalaro	Maintain technical knowledge (R&D)	Repeatability		Schools
Professor Filipe Coelho	Partner management	Accuracy of generated data		LACCEI
Fabriko Ltda	Schedule access to the remote laboratory			
	Allow access to the remote laboratory			
	KEY RESOURCES		CHANNELS	



	Professor Daniel Loureiro		Social networks	
	Distillation Column		WebLab Platform	
	Electronic devices		Direct Sale	
	Server hosting		Congresses/Workshops/Academic meetings	
	Supplies			
	Development environment			
COSTS		INCOME FLOW		
Online payment services		Rent service		
Consultants payment				
70%-30% profit share DistLab company/USF partner				

3. Product Market Fit

There are very few remote practical laboratories for the chemical engineering fields, so the market does not offer this option yet.

The goal of a remote lab is to enable experiments and the use of the equipment, in a didactic way, without neither the professors nor the students being at the educational institution presentially. Any engineering student in the world can pay to use the DistLab and have access to experiments.

Using Brazil's Ministry of Education system data, it was verified that only in Brazil there are 280 active chemical engineering courses (e-MEC, 2021). That data shows the



big potential of DistLab users locally, but that potential increases considering that there are thousands more active courses in other countries.

4. User Profile

The DistLab user can be any person who is interested in the functionality of distillation columns; Educational institutions that do not have the equipment needed, or are interested in doing thermofluid practical classes and activities remotely; LACCEI by making low cost experiments available.

5. Product Functionalities

DistLab is a weblab, which the access is offered by renting scheduled time slots in order to use the equipment. The user pays for each time slot that allows 180 min access, enough time to execute two batches of ethanol/water separation. It is allowed to rent up to three time slots a day.

This is an instrumented batch distillation column that operates in stages, providing separation of a 50%v/v ratio mixture of ethanol and water. The column is made of a typical borosilicate glass allowing the bubbling to be fully visible on each stage's hold-up, captured by a video camera. With this equipment, it is possible to perform separation experiments by distillation, monitorate temperature profile from the start-up until the end of the batch and verify the distillate composition. It is also possible to adjust the top pressure of the column.

The user has access to the experiments scripts that can be remotely performed, such as, generating the column temperature profile up to a forced steady state with total reflux and the effect of the column pressure in composition and the column inner flows.

This experiment provides chemical engineering students a practical learning of the functionality of a very important equipment used in many industries worldwide.



6. Minimum Viable Product

MAIN VALUES FOR CUSTOMERS	WHAT IS OR NEEDS TO BE OFFERED TO MEET EACH VALUE				
Service assurance	Schedule 180 min of DistiLab use	Technician available for maintenance	Reschedule in case of mechanical/technical fault	Instrument calibration	Equipment maintenance
Security	Technician available for maintenance	Alarms are available during the operation	Interlocking systems		
Repeatability	Refund in case of server flaw	Refund in case of hardware flaw	Ambient temperature controlled		
Accuracy of generated data	Instrument calibration	Equipment maintenance			

7. References

e-MEC. **Cadastro Nacional de Cursos e Instituições de Educação Superior**. Available at: <<https://emec.mec.gov.br/>> . [Accessed 15 October 2021].

Foust, A., Wenzel, L., Clump, C., Maus, L. and Andersen, L., 1982. ***Principles of Unit Operations***. New York.