

DETI-Maker Lab



Human-Computer Interaction

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Index

Introduction.....	3
Requirement Analysis.....	4
The users:.....	4
Usage Context:	4
Platform Characteristics:	5
Typical Tasks	5
Usability Goals	6
Paper prototype	6
Development Issues	12
Usability Test Preparation and Results	14
The DETI-Maker Lab Application.....	15
Account Management	15
Frequently Asked Questions (FAQ)	16
Home Page	16
User Window	17
Electronic Resources	17
Network Resources.....	18
Create Project.....	19
My Projects	20
Staff Window.....	20
Resource List.....	21
Add Equipment	21
Add Units	22
Add Kit	22
Common	23
Project Page	23
Requisition Page.....	24
Electronic Equipment Page.....	24
Kit Page	25
Conclusions.....	26
Attachments	27
References	28

Introduction

DETI MakerLab is a system designed to manage a modern and innovative room. This room is filled with electronic components and devices, such as Arduinos, Raspberry Pis, 3D printers, a network closet, and many things alike. The space aims at being the room to carry on projects inside DETI.

The DETI MakerLab software will hopefully address all the users' needs to develop their projects at MakerLab.

Requirement Analysis

The users:

All the students and professors from DETI of University of Aveiro will have access to MakerLab's platform, in order to help them manage their projects, particularly those who need some electronic resources (such as RaspberryPis and Arduinos), Virtual Machines and/or a private network (VLAN) to accomplish their goals.

Usage Context:

The MakerLab room is already up and running, however, at the moment the requisitions of electronic resources are performed using a paper form, which it is not very intuitive and pushes away the users who may think it's troublesome to request those resources. On the other hand, the request of Virtual Machines and other network resources isn't available at the moment. If users don't take advantage of all the resources the MakerLab has to offer, there's no point in using it, turning out to be a room like any other.

The purpose of this platform is to provide an easy way to manage projects and mainly make the requisition and delivery processes of the room resources intuitive and simple.

On the other hand, to make this process as simple as possible, staff members must provide all the information to the platform regarding electronic equipments and their respective units, filling in the their forms. The staff may also aggregate units creating special kits of electronic units.

The frequency of the creation and editing of projects may vary widely, as well as the requests of resources (network resources will be less requested than their electronic counterparts, since VMs and private networks may be reused in the different contexts of the same project). There will be projects that will require a lot of resources (development of an electronic controller, e.g.) whereas there will be projects that will only need a VM (to run a web app, e.g.).

On the other hand, the staff will have to add new equipments and/or units when they're delivered at the room by the equipment suppliers.

Platform Characteristics:

The platform is as intuitive and simple as possible, all the options are clear and readable, there's also a FAQ section and some small tips in some options along the way that may help users in trouble.

All the tasks are performed on the DETI MakerLab application, only available for Windows, which gets all its data from a SQL Server database (which only runs locally).

The user has access to all the information related to the projects and resources currently registered, as well as requisitions and other users' profiles on the platform. User credentials, as well as VMs and WiFi passwords, are encrypted and stored securely into the SQL Server database.

The platform is also to be as robust as possible. There's not much that can be done when an error occurs, however, it is always shown an error message to the user, describing the error with as much in detail as possible. If the occurred error happens in a "form" page (requesting resources, registering units, etc.), the system will maintain all the fields filled, trying to save some time to the user.

Typical Tasks

Students & teachers:

- Create user account;
- See user profiles;
- Manage projects (create and edit);
- Request and deliver electronic resources;
- Launch and destroy virtual machines;
- Enable Wireless LAN for VM connectivity;
- Associate ethernet sockets to projects LAN for VM connectivity.

Staff:

- See user profiles;

- Add/edit electronic equipments;
- Add electronic units;
- Create kits of electronic units;
- View projects information and requisitions.

Usability Goals

The DETI MakerLab system will be:

- easy to learn and to achieve maximal performance while using it;
- robust, giving user information about the success of the performed tasks;
- efficient, in such a way, once the user gets familiar with it, (s)he can perform tasks faster;
- easy to remember, even if it isn't used for time;
- not prompt to errors;
- pleasant to use.

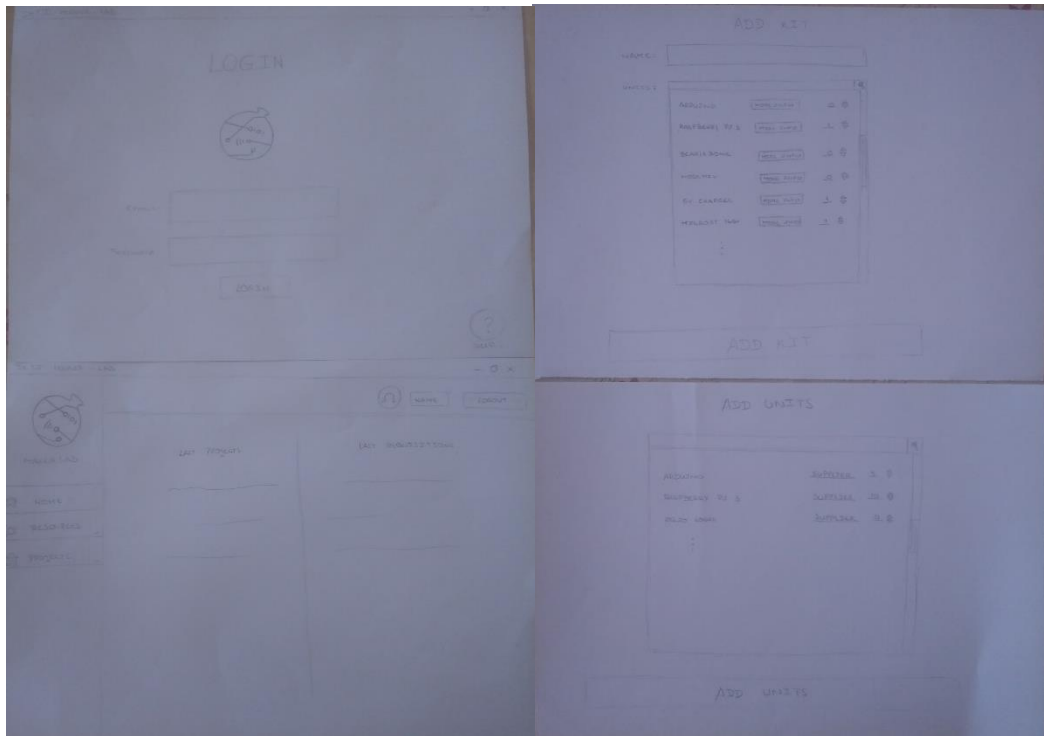
Following those goals, we expect to:

- Create a project in less than 30 seconds;
- Request an electronic unit/kit in less than 20 seconds;
- Launching a VM in less than 20 seconds;
- Attaching a WLAN and an ethernet socket in less than 30 seconds;
- Add an electronic equipment in less than a minute;
- Create a kit in less than 30 seconds;
- Add simultaneously electronic units in less than 20 seconds.

Paper prototype

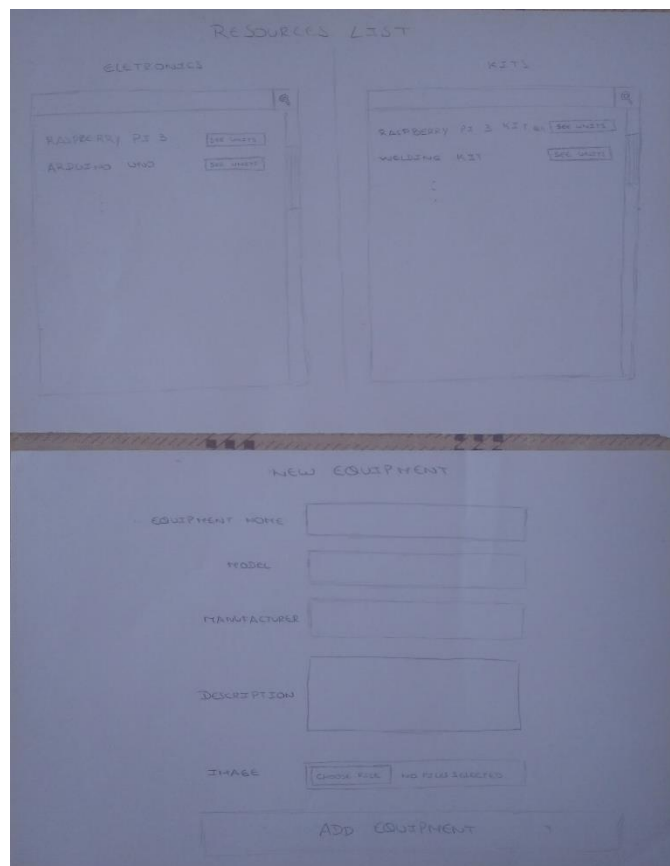
Our paper prototype was based on two different classes of users: students&teachers and staff. Each one had different views of the system. The

students&teachers were more focused on project creation and requisitions, whereas the staff was more focused on equipments and units management.

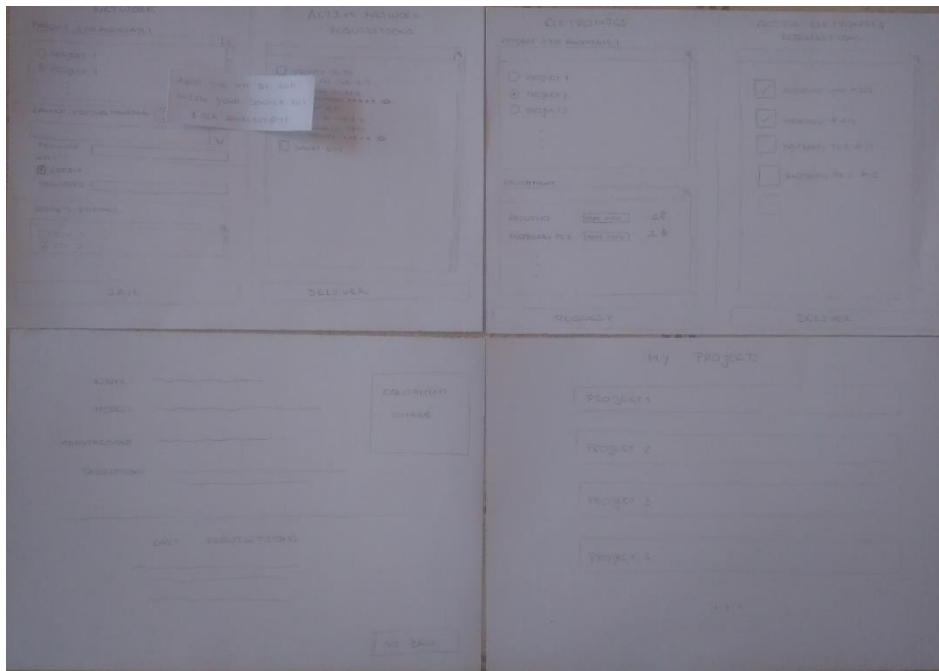


Windows

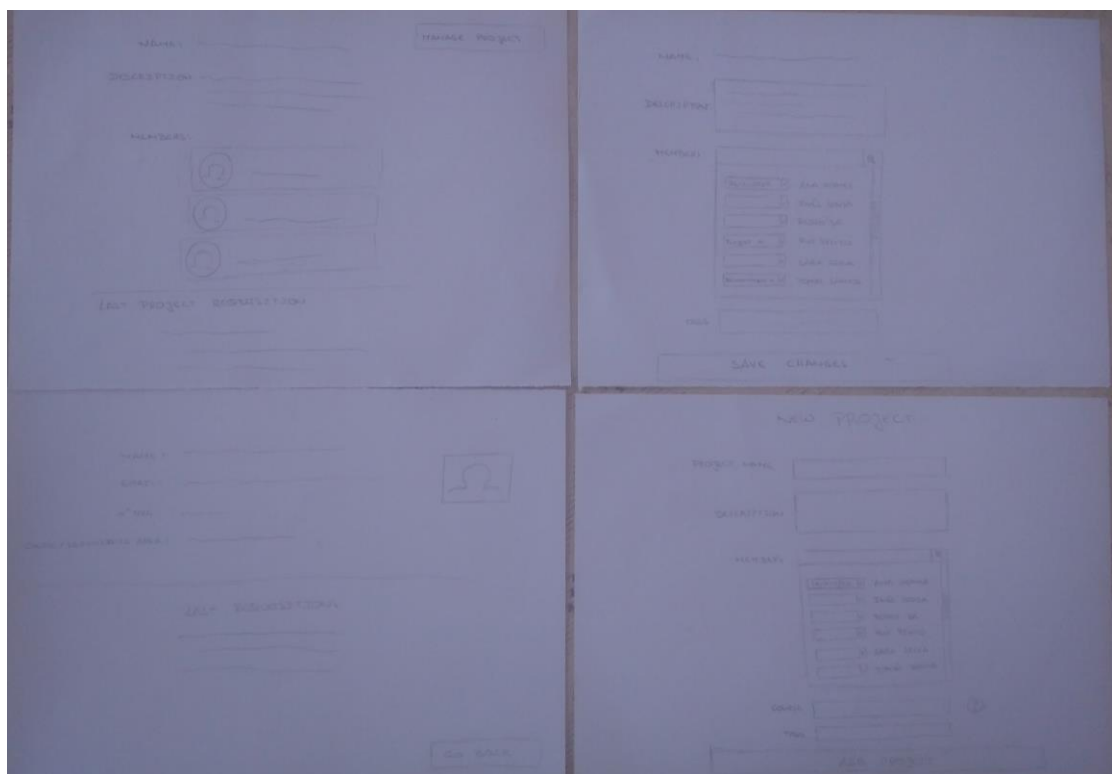
Staff Pages (1)



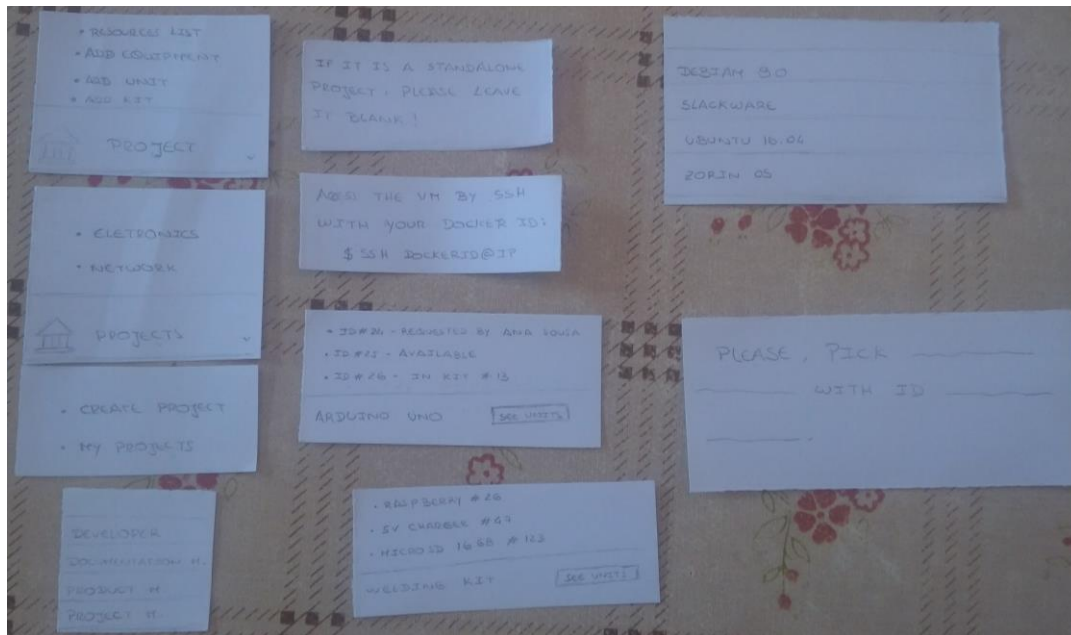
Staff Pages (2)



User Pages (1)



User Pages (2)



Pop-ups and messages

The results of our paper prototype usability test were very satisfying, considering it was still a “blurred” vision of the system.

The two individuals (one male, one female) we asked to try the usability test were both students at DETI (our future users).

The tasks we asked them to perform were the following:

Create Project (create BlueConf):

- Authenticate (user only);
- Locate and select Projects on the main menu;
- Select New Project;
- Fill in all the inputs (name, description, class);
- Select project members by selecting the role they will take on the project;
- Click on Create;
- Click on Confirm to confirm the creation of the project.

Request electronic unit (request Raspberry Pi 3):

- Authenticate (user only);

- Locate and select Resources on the main menu;
- Select Electronic;
- On the left side of the screen, select the project that the requisition will be associated to;
- Select the quantity of units of the desired equipments the user wants to request;
- Click on Request;
- Click on Confirm to confirm the requisition.

Request VM (Debian) and associate it to the project WiFi network:

- Authenticate (user only);
- Locate and select Resources on the main menu;
- Select Network;
- On the left side of the screen, select the project that the requisition will be associated to;
- Choose the VM operating system on the Launch VM section and type the desired login password;
- Select Active on the WiFi section below and also type the desired password to access the network;
- Finally click on Save;
- Click to confirm all the changes.

Although the subjects of the tests were targeted as student users and not staff members, we also asked them to perform some staff-focused tasks. They were the following:

Add electronic equipment (Raspberry Pi 3, Model B, by PI):

- Authenticate (staff only);
- Locate and select Add Equipment on the main menu;
- Fill in all the spaces of the form;
- Click in Add Equipment;
- Click to confirm all the changes.

Add electronic units (add two Raspberry Pi 3 and 1 Arduino Uno):

- Authenticate (staff only);

- Locate and select Add Units on the main menu;
- Search for an equipment and add the number of units and the supplier of those units;
- Click in Add Units;
- Click to confirm all the changes.

Create a Kit of electronic equipments (Raspberry Pi 3 Kit):

- Authenticate (staff only);
- Locate and select Create Kit on the main menu;
- Select the quantity of units of electronics equipments the kit will contain;
- Click in Create Kit;
- Click to confirm all the changes;

The results of the tests, in a scale from 1 to 5, being 5 “easy task” and 1 “difficult task” were as follows:

Student 1

- Create project (BlueConf): **5**
- Request electronic unit (request Raspberry Pi 3): **5**
- Request VM (Debian) and associate it to the WiFi network: **3.5**
- Add electronic equipment (Arduino Uno): **5**
- Add electronic units (add two Raspberry Pi 3 and 1 Arduino Uno): **4**
- Create Kit of electronic equipments: **5**

Student's observations:

- There wasn't a button to cancel changes in some pages;
- The WiFi creation process was not very explicit, neither its purpose;
- Show the number of available units when adding them to the platform.

Student 2:

- Create project (BlueConf): **4.5**
- Request electronic unit (request Raspberry Pi 3): **5**

- Request VM (Debian) and associate it to the WiFi network: **3**
- Add electronic equipment (Arduino Uno): **4.5**
- Add electronic units (add two Raspberry Pi 3 and 1 Arduino Uno): **5**
- Create Kit of electronic equipments: **5**

Student's observations:

- Make adding a member to a new project more intuitive or add a tip;
- The WiFi creation process was not very explicit.

Based on these results, we tried to improve DML's platform, mainly its network component, which was a little complex.

Development Issues

The DETI MakerLab platform was developed using WPF and C#, with all the information being stored on a SQL Server database.

One of the main challenges was to create a simple and intuitive user interface using WPF without any external plugins and/or toolkits, to keep it as light and uniform as possible.

The platform was intended to have a modern look and design, similar to web pages nowadays. Having this in mind, we built a layout from scratch, only based on primitive objects, carefully placing each element in its proper place and introducing a vertical menu with collapsable submenus, on our own.

Although we have initially defined we wouldn't use any toolkits, we ended up using two of them because we thought these features were essential to an improved user experience and overall robustness of the platform.

Thus, we used Ookii to create a personalized MessageBox to avoid showing the full errors' messages to the common users, mainly those generated by the database, and to give them the option to see the full error message clicking on a "Show more" button, which is particularly useful for expert users or system maintainers; and we used

Extended WPF Toolkit simply to use the DecimalUpDown boxes for an improved user experience when selecting the number of units to add to the app, to request, etc.

Other challenge was to edit ListBoxes to perform some actions we intended to, such as adding TextBoxes inside of them with the intention of choosing the number of units to request/add to the platform, ComboBoxes to select user roles in projects, and many others. The solution we came up with was to create item templates for each one of the ListBoxes and design its UI and all the necessary logic to access its fields accordingly, which was particularly challenging since we had to deal with asynchronous tasks, listeners and item containers.

Another concern we had throughout the development of the platform was to prevent SQL injection, so we used specific AddWithValue() methods to add parameters to queries, instead of using raw concatenated text, as well as User Defined Functions and Stored Procedures for increased security and functionality.

Keeping in mind those concerns, we wanted the platform to be as robust as possible.

Therefore, we implemented a series of verifications in every page where the users can perform modifications to the platform. We also implemented confirmation MessageBoxes before executing the changes the user desires, as well as “discarding changes” MessageBoxes that pop up when a user leaves any form before submitting the performed changes.

Our usability goals are intended to make the user experience as optimized as possible, allowing the users, as the time goes by, to get more familiar and efficient with the platform. Therefore, we implemented some key shortcuts, more specifically the Enter key in order to submit any changes or forms throughout the platform.

As for our network management, although it is fully functional, our interface cannot really perform any of those tasks, such as really creating wireless networks, attaching ethernet sockets to VLANs and running virtual machines. We just decided to create the interface since the network API that will be used at DETI MakerLab is still under development on a similar project.

Usability Test Preparation and Results

At the time of the usability test, we hadn't still bound the database to the platform itself, so we used hard-coded data to populate the app. Therefore, any changes applied during the usage of the app wouldn't be saved in the database and would be discarded if the user changed pages.

The selected users to perform the tests were also students at DETI; since that's our targeted public, they were perfect candidates to test the real platform.

We opted to ask the users to perform the very same tasks we asked them at the time of the paper prototype, since they could be considered nuclear tasks. As described previously with more detail, they would be:

- [User] Create Project (create BlueConf)
- [User] Request electronic unit (request Raspberry Pi 3)
- [User] Request VM (Debian) and associate it to the WiFi network
- [Staff] Add electronic equipment
- [Staff] Add electronic units (add two Raspberry Pi 3 and 1 Arduino Uno)
- [Staff] Create a Kit of electronic equipments (Raspberry Pi 3 Kit)

In general, the feedback the users gave us was very positive, letting us know that the platform was indeed very intuitive. Noteworthy is the fact that some users pointed out that the FAQ section the platform will be the perfect addition to the system, in order to ease the learning curve and the usage of the platform, as well as, on a (not so) negative side, minor visual bugs (wrong color formation, request for adding some icons to the menus in order to make it more visually pleasant, adding some more tips).

All the Post-Usability Test quizzes are attached at the Usability Tests folder.

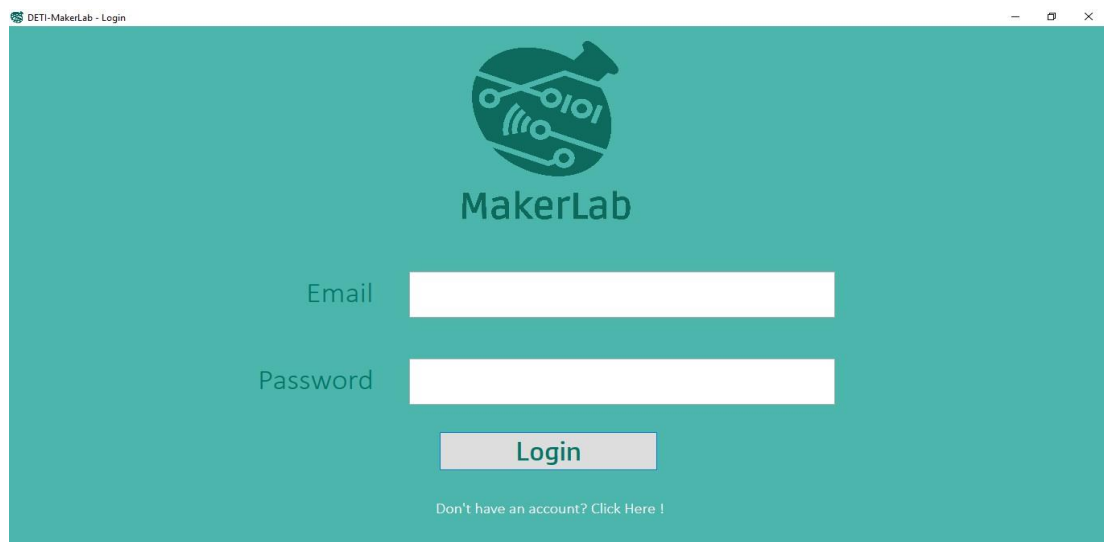
The DETI-Maker Lab Application

Account Management

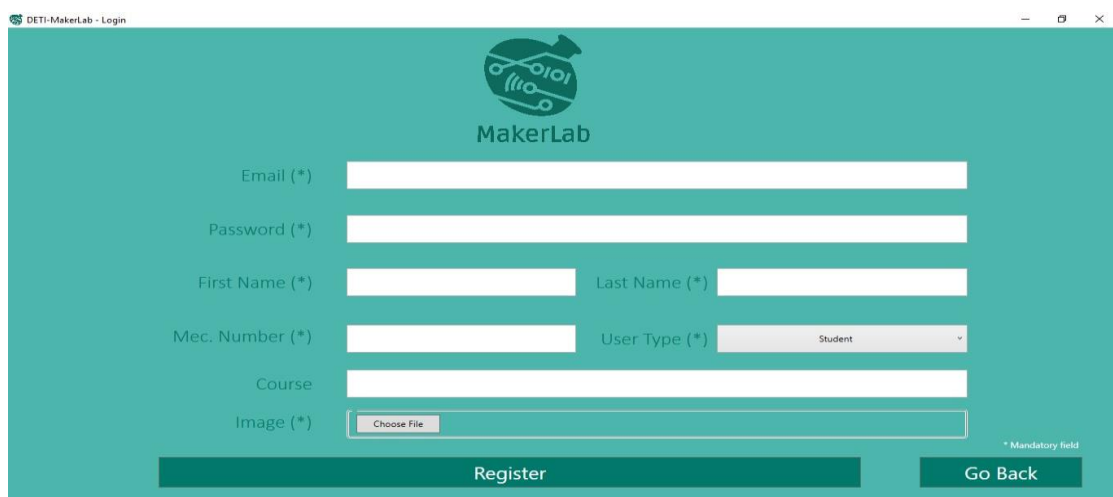
When launching the DETI MakerLab software, the first window the users sees is the login window. Both student/professors and staff users use the same login page, being redirected to a specific window after the session has been activated.

If the user is not yet registered in the platform, (s)he can easily do so by accessing the sign-up form, filling it in and submitting the request.

From the login window (or at any point on the platform), the users can visit the FAQ section, which we believe to be extremely helpful for users in trouble.



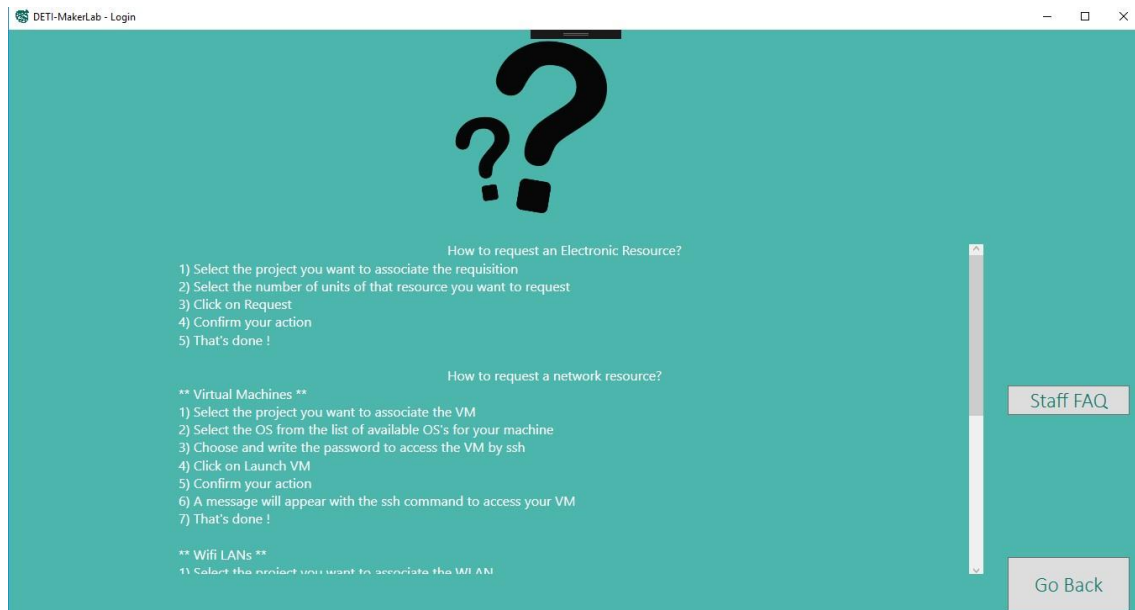
The screenshot shows the login window of the DETI-MakerLab application. The window has a teal background and a logo at the top center. The logo consists of a stylized house shape with a circuit-like pattern inside, and the text "MakerLab" below it. Below the logo, there are two input fields: "Email" and "Password". Below these fields is a "Login" button. At the bottom, there is a link that says "Don't have an account? Click Here !".



The screenshot shows the register window of the DETI-MakerLab application. The window has a teal background and the same logo as the login window. Below the logo, there are several input fields: "Email (*)", "Password (*)", "First Name (*)", "Last Name (*)", "Mec. Number (*)", "User Type (*)" (with a dropdown menu showing "Student"), "Course", and "Image (*)" (with a "Choose File" button). At the bottom, there are two buttons: "Register" and "Go Back". A small asterisk (*) indicates mandatory fields.

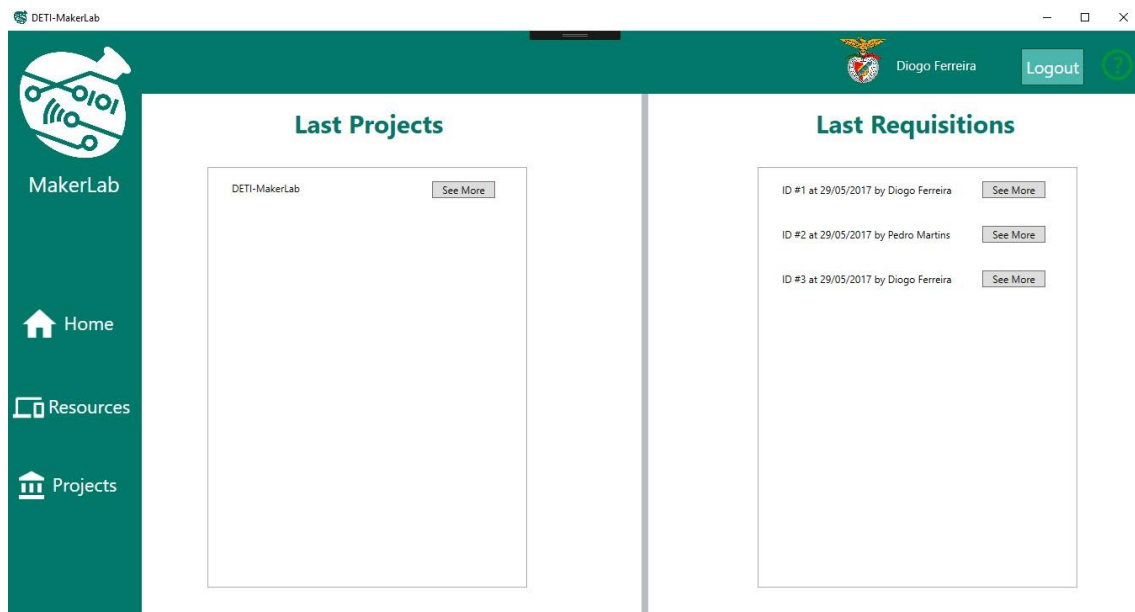
Frequently Asked Questions (FAQ)

If you manage or use DETI-MakerLab's (and our managing app), you'll be faced with so much information, so many equipments and features that it is quite normal to feel a bit helpless. The FAQ section is intended to solve this problem by presenting the steps you have to take, so that you can do what you really intend to.



Home Page

The Home Page is the same for both students/professors and staff. There, it is displayed the last projects that were created in the platform, as well as the last registered requisitions. If the user clicks in a project, (s)he'll be redirected to its page; the same applies to the requisitions.

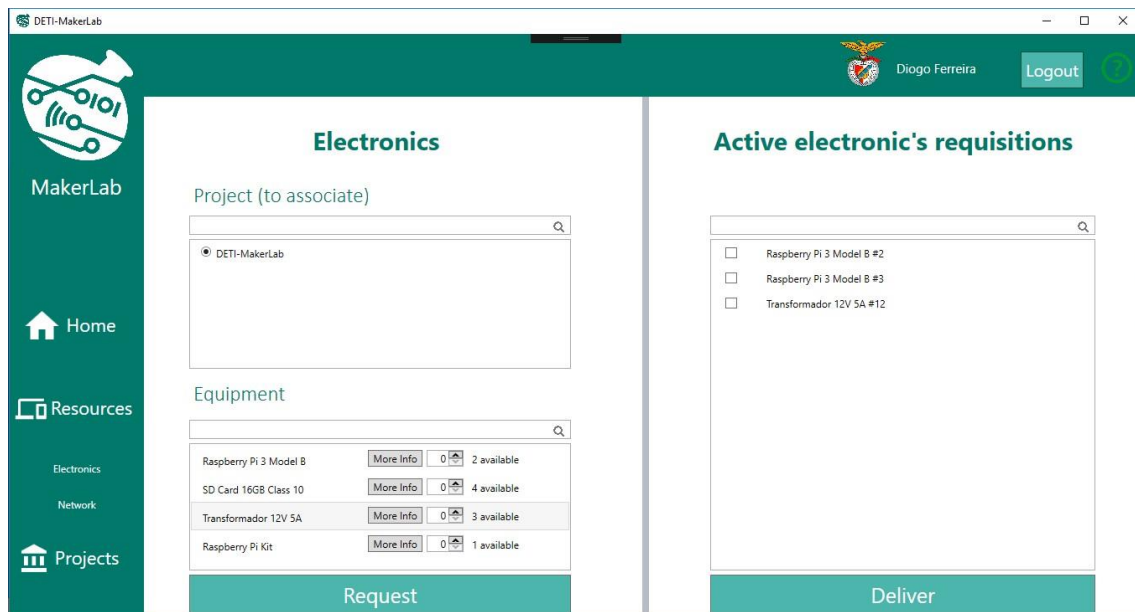


User Window

Electronic Resources

The electronic resources section is one of the nuclear components of the DML platform. It's where users can request equipments and kits of electronic units for their projects. To be able to do that, they must first select the project they want the requisition to be associated to, and from that moment on, they will be able to search and select which and how many units of the desired equipments they want to request.

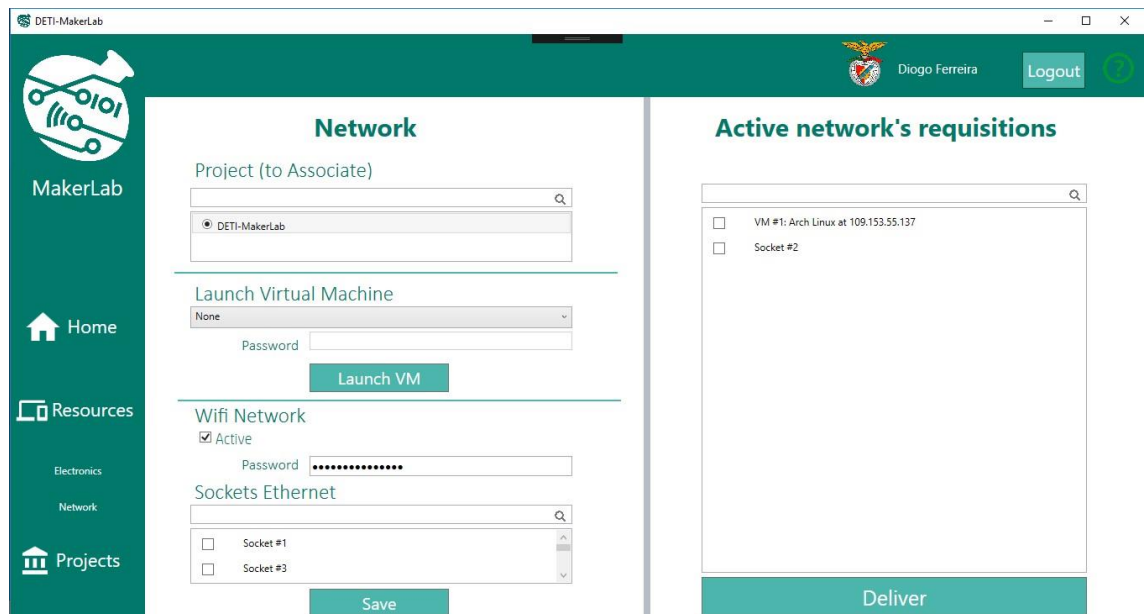
All of the current requested units are displayed on the panel on the right and may be easily delivered when the users want to.



Network Resources

For the development of a more software-oriented project, networking components are essential. The network resources section of DETI MakerLab provides the users the possibility of creating a private network for each project they're a member of. To access to those networks, they can associate a wireless LAN (defining their access password) and/or ethernet sockets that would be spread out of the DML room. Those private networks are really useful to allow communication between devices connected to them (something that University of Aveiro's network does not allow) and to access remotely VMs. The users may also launch VMs to work and deploy their projects, selecting the OS that better suits their needs and defining their private password.

When the users don't want the running VMs or are not using the ethernet sockets anymore, they can deliver them. On the other hand, to disable the WiFi network, they only have to uncheck the "Active" checkbox under the WiFi subsection.



Create Project

To allow the user to request any kind of resources, they have to create projects. Under the Projects submenu, there's the Create Project page, where, by filling in a project name and a description (brief description of the project's goals or full documentation), selecting user members of the project by giving them one of the available roles (only those with roles belong to a project) and selecting a class where the project will be developed or, otherwise, a standalone project, the users can create their own projects on the platform.

New Project

Project Name (*)

Description (*)

Members

Role	Name
Role: Not a Member	Joaquim Madeira
Role: Not a Member	Beatriz Santos
Role: Distinct Member	Diogo Ferreira

Class (*)

* Mandatory field

Create Project

My Projects

Under the Projects submenu, there's also a page to list all the projects the logged user is currently a member of.

My Projects

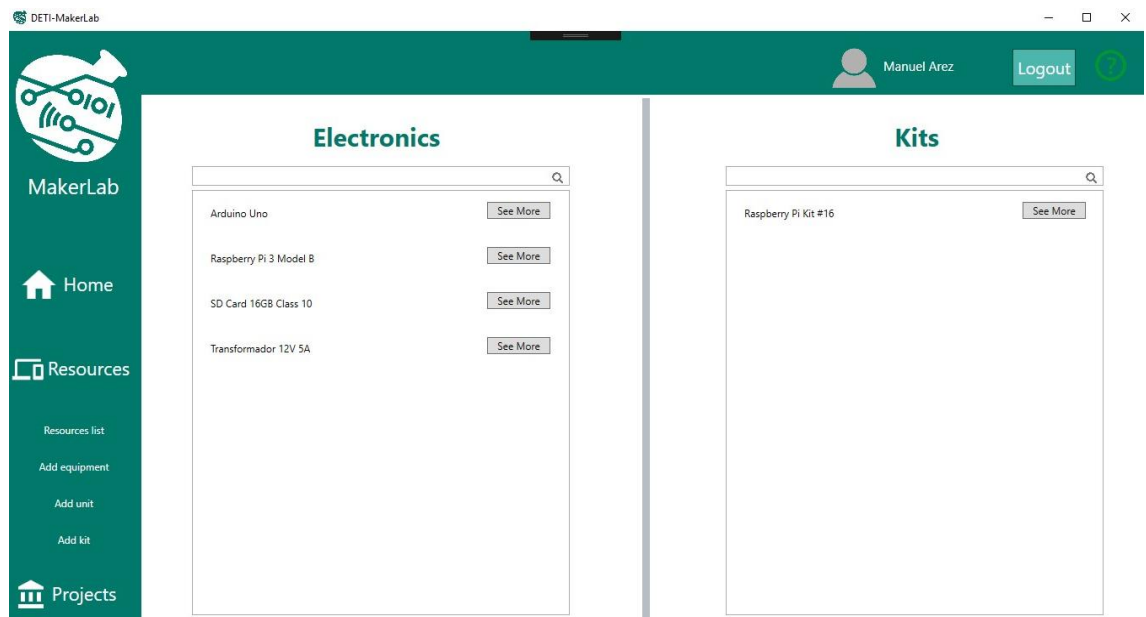
DETI-MakerLab Lab's management
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Staff Window

The staff window allows the logged user to manage all the items available on the platform. Thus, the Resources submenu is totally different from the User one.

Resource List

This page lists all the electronic resources and kits registered on the platform and provides an easy way to search and access its pages to get more information about them.



Add Equipment

The Add Equipment page is simply a form to add a new equipment to the database.

The screenshot shows the 'New Equipment' form in the MakerLab application. The sidebar is identical to the previous screenshot. The main form area has a title 'New Equipment' and several input fields: 'Equipment Name (*)', 'Model (*)', 'Manufacturer (*)', 'Description' (a larger text area), and 'Image (*)' with a 'Choose File' button. A note at the bottom right of the form states '* Mandatory field'. At the bottom of the form is a large teal button labeled 'Add Equipment'. The top header shows the user 'Manuel Arez' and a 'Logout' button.

Add Units

The main goal of this page is to register new units that may be now available at the DML room. For that, the staff member just needs to select how many units need to be registered and which company supplied them.

The screenshot shows a web application titled 'Add Units'. The interface includes a dark green sidebar on the left with the 'MakerLab' logo and navigation links: Home, Resources (with sub-links: Resources list, Add equipment, Add unit, Add kit), and Projects. The top header is dark green, displaying the user 'Manuel Arez' and a 'Logout' button. The main content area has a light blue background with the title 'Add Units' in large green text. Below the title is a table with three rows of electronic components. Each row contains the component name, a 'More Info' button, a 'Supplier' input field, a quantity spinner (set to 0), and a '0 inserted' status. The third row, 'Transformador 12V 5A', is highlighted in light blue. At the bottom of the main area is a large teal button labeled 'Add units'.

Component	More Info	Supplier	Quantity	Status
Arduino Uno	More Info	<input type="text"/>	0	0 inserted
SD Card 16GB Class 10	More Info	<input type="text"/>	0	0 inserted
Transformador 12V 5A	More Info	<input type="text"/>	0	0 inserted

Add units

Add Kit

The Add Kit page has the objective of assembling some electronic units forming a kit, allowing the users to request all of them at once.

To create a new kit, the staff member just needs to describe the kit and select how many and which units will be part of it. For convenience, the kits currently added to the platform are displayed in a ComboBox at the top and may be replicated.

DETI-MakerLab

Manuel Arez Logout

Add Kit

Available Kits

Kit Name (*)

Units (*)

Create Kit

* Mandatory field

Common

There are pages that are accessible for both user and staff.

Project Page

This page shows the users all the information that describes a project and the current equipment units the members have requested and are still in their possession, as well as a list of the last requisitions associated to the project (even if some of the items have already been delivered, they'll be listed as items of a requisition).

The only difference between the user and staff space is that, when a user belongs to the project, a button that redirects him/her to a page to manage that project is shown.

DETI-MakerLab

Diogo Ferreira Logout

Project Name: DETI-MakerLab

Description: Lab's management

Members:

76425	Diogo Ferreira	Project Manager
76551	Pedro Martins	Project Manager

Class: Interação Humano Computador

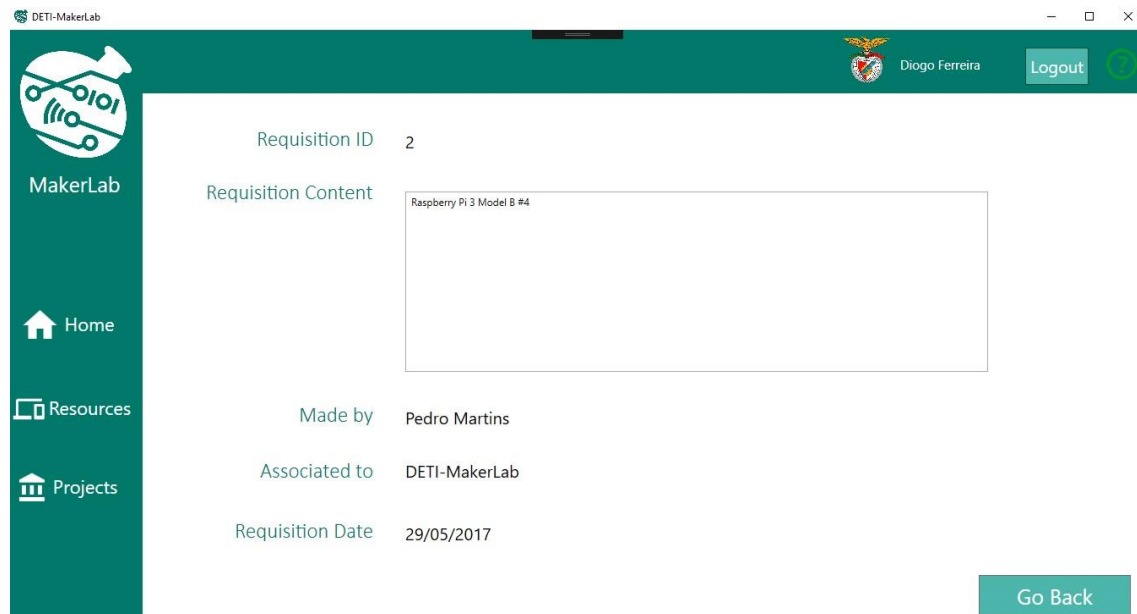
Active Requisitions

Last Project Requisitions

Manage Project Go Back

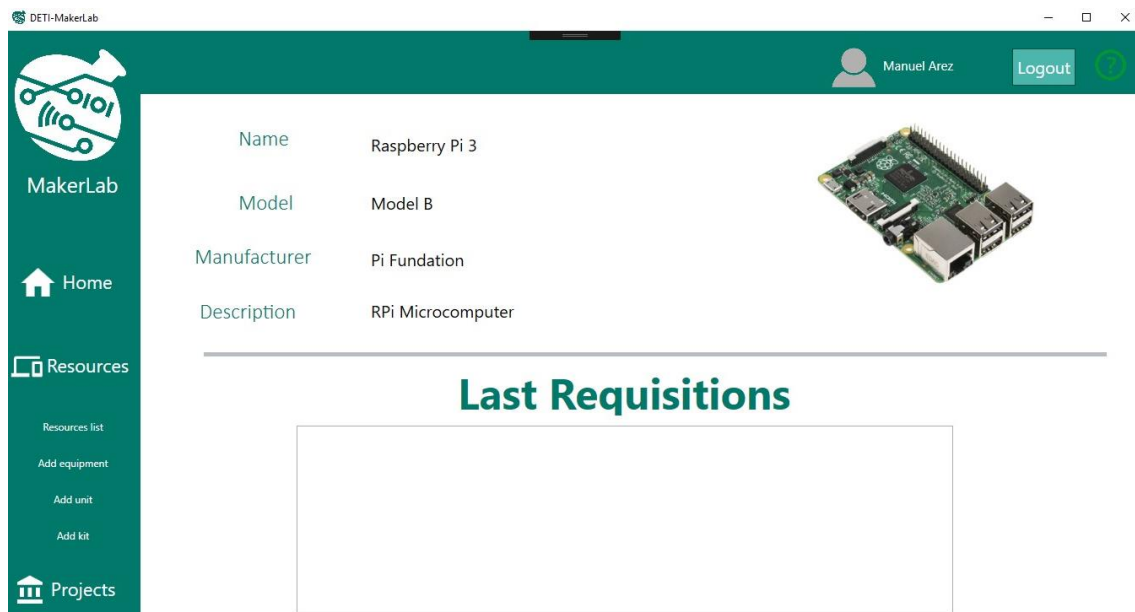
Requisition Page

The requisition page is where the users of the platform can get a more precise information about an already performed requisition. They can check its ID, the units and kits that were requested, which user and to which project it is associated to and finally the request date.



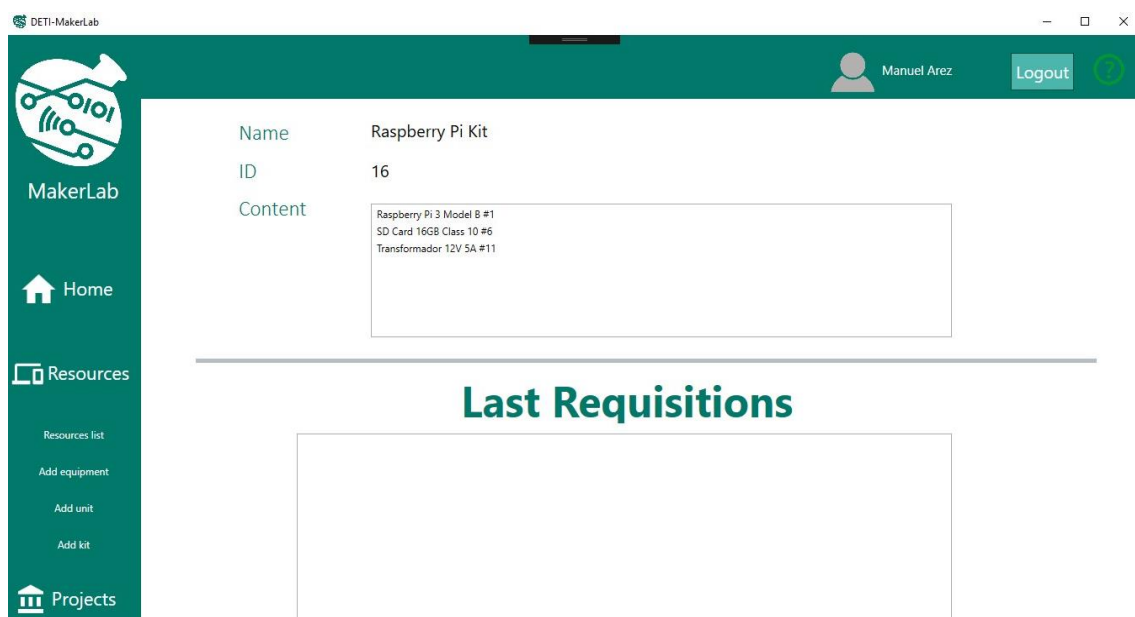
Electronic Equipment Page

This page allows the user to access all the details related to an equipment, may they be its name, model, manufacturer, a description/more detailed information about it and, at last, all the recent requisitions, which include that equipment.



Kit Page

The Kit Page allows the user to essentially see the items that make part of a kit and their last requisitions.



Conclusions

The developed platform ended up matching all the usability goals and requirements, even when using almost exclusively WPF toolkit.

Although the system is, as planned, intuitive, simple and usable, we would like to have implemented a lot more features, such as integrating it with the real DML API. However, due to time restraints, we have decided just to create the user interface.

Moreover, taking into account the feedback given by the users, it seems that our platform is functional and effective. That was a positive achievement, since the subjects of the tests were our main targeted public.

At last, we would like thank our college Leonardo Oliveira for allowing us to use the DETI MakerLab logo he has designed.

Attachments

The attachments are all in the same folder as the document.

- Paper prototype
- Usability tests forms
- User usability tests

References

- <https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/index>
- [https://msdn.microsoft.com/en-us/library/ms754130\(v=vs.110\).aspx](https://msdn.microsoft.com/en-us/library/ms754130(v=vs.110).aspx)
- <http://wpftoolkit.codeplex.com/documentation>
- <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/usability-evaluation>
- Peter Mitchell - Step by Step Usability testing chap 3-12 (on E-Learning)