approvals, responsibilities are all assigned into a user. This is very convenient and can fall within the category of virtual item class even if it has limited use in the scope of manufacturing. Their creation is not strictly necessary, the software would run just fine having just me as a user with full administrator credentials, but for this simulation, 5 users were created as listed below to represent different employees within the company. The following (Figure 29) is a screenshot of my user account item and its 'Asses Rights' followed by one of the fictional users being created for the company (Figure 30).

核准、責任都指派給一個使用者。這非常方便，即使在製造範圍內的使用有限，它也可以屬於虛擬項目類別。它們的創建並非絕對必要，軟件只需我一個使用者具有完整的管理員權限即可運行良好，但是為了這個模擬，創建了5個使用者，如下列舉的那樣，代表公司內不同的員工。下面（圖29）是我的用戶帳戶項目的屏幕截圖及其"評估權利"，隨後是為公司創建的一個虛構用戶的屏幕截圖（圖30）。

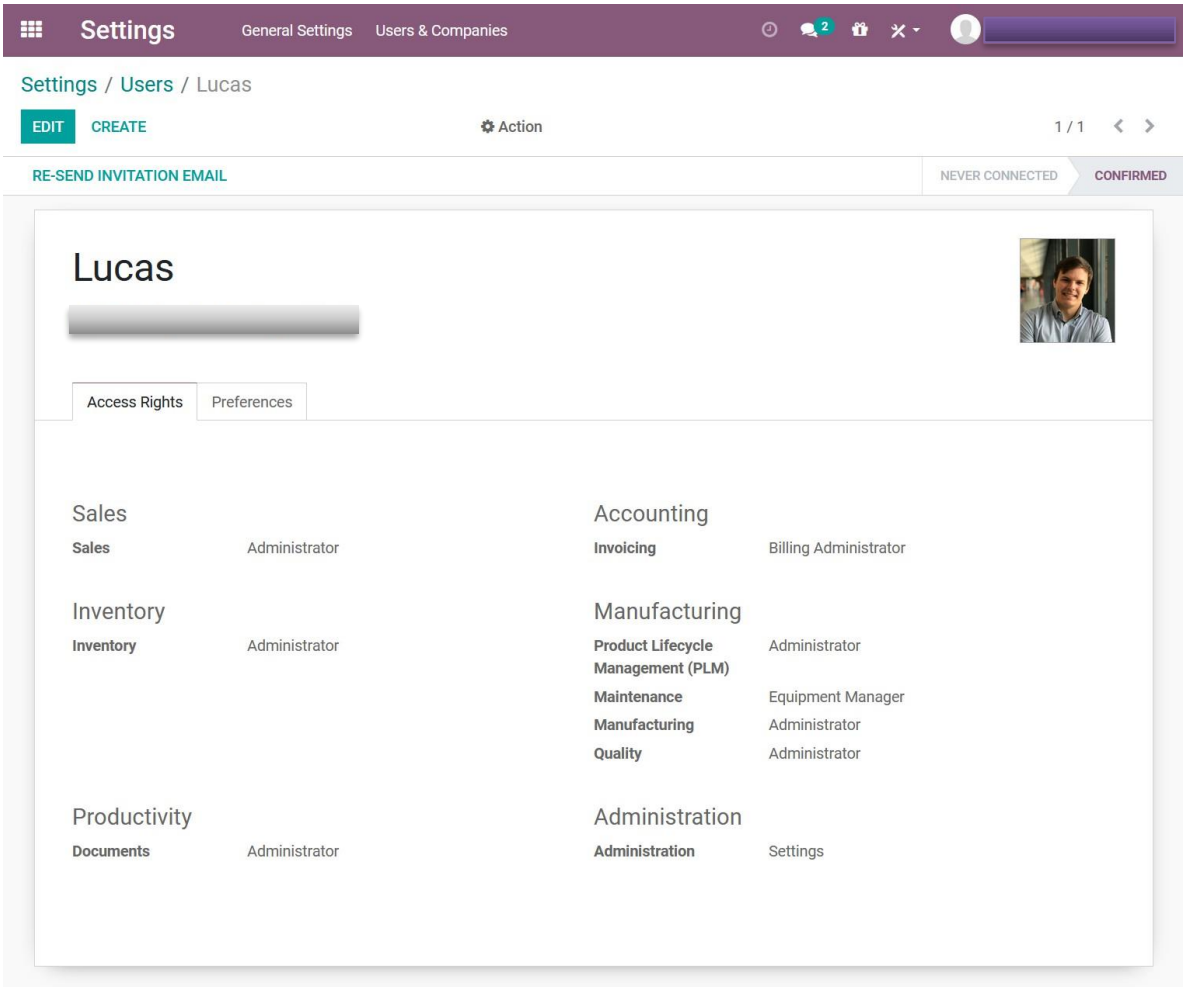

Figure 29 Screenshot of user account interface

圖29 用戶帳戶界面截圖

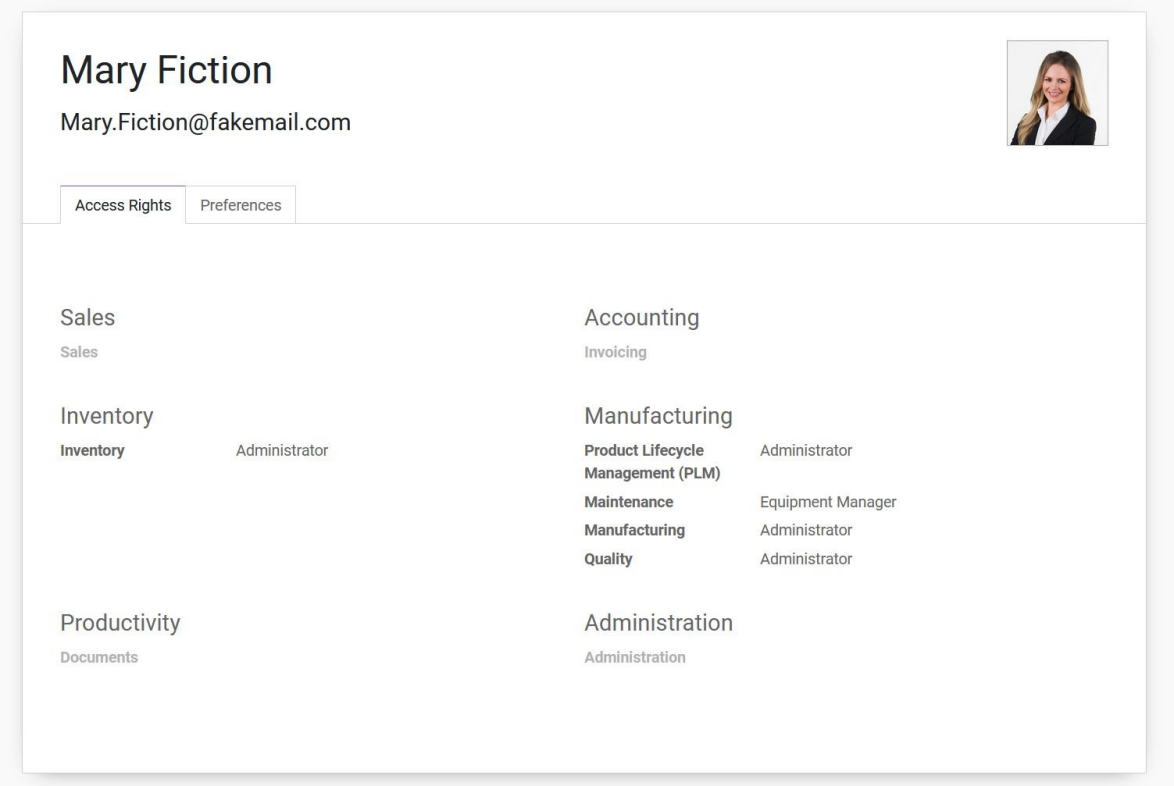

Figure 30 Screenshot of second user account interface

圖 30 第二個使用者介面截圖

It is nice to point out how the two differ in access rights. Mary Fiction has been created in this example as an engineer and therefore most of her permissions are around the manufacturing procedure while she is denied access to other parts like Sales or Accounting.

很高興指出兩者在訪問權限上的差異。在此示例中，Mary Fiction 被創建為一名工程師，因此她的大部分權限都圍繞著製造程序，同時她被拒絕訪問其他部分，如銷售或會計。

1.1.1. Workcenters and Equipement
工作中心和設備

Workcenters are quite flexible within Odoo in the sense that they can be changed and expanded as needed. One could create the workcenters after creating the product items to allow for reorganization of the shop floor once you gained some perspective on what the products will be in the end. However, for most scenarios this seems unrealistic since the workcenters are more rigid structures in the real world - they don’t change as much as the products since they tend to hold heavy machinery.

工作中心在Odoo中非常靈活，因為它們可以根據需要進行更改和擴展。可以在創建產品項目之後創建工作中心，以便在獲得一些關於最終產品的遠景後重新組織車間。然而，對於大多數情況來說，這似乎不太現實，因為工作中心在現實世界中是比較固定的結構——它們不像產品那樣經常變化，因為它們往往容納著重型機械。

In this simulation it was considered that the company already has 3 workcenters from the get-go and therefore the workcenters and machinery were created beforehand. This is more useful for possible readers interested in implementing Odoo as well as saving sometime.

在這個模擬中，假設公司從一開始就已經擁有3個工作中心，因此工作中心和機械都是事先創建的。這對於有興趣將Odoo實施的可能讀者來說更有用，同時也節省了一些時間。

We begin by creating the equipment we have. This is an item class that emphasizes in maintenance organization. The application responsible for managing equipment is the Maintenance App. The following image is an example of how Odoo portrays a 3D printer equipment item (Figure 31).

我們首先創建我們擁有的設備。這是一個強調維護組織的項目類別。負責管理設備的應用程式是維護應用程式。下面的圖片是Odoo展示3D打印機設備項目的示例（圖31）。

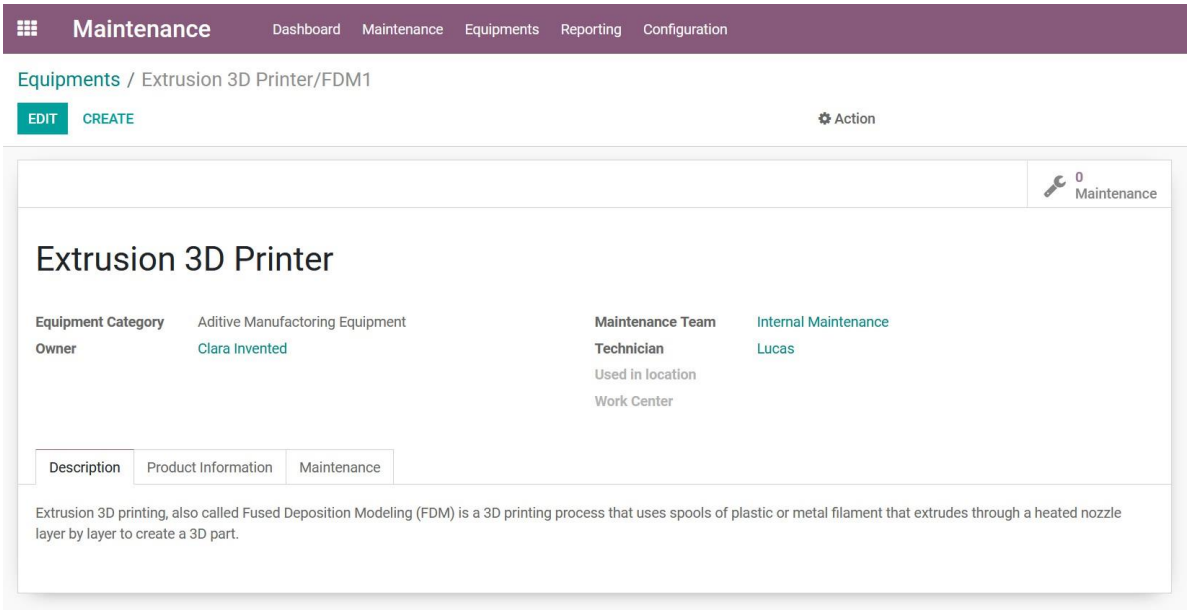

Figure 31 Odoo 3D printer equipment item
圖31 Odoo 3D打印機設備項目

In addition to this 3D printer the following equipment were created to be used throughout the development/production process (Figure 32):

除了這台3D打印機外，還創建了以下設備，用於整個開發/生產過程中的使用（圖32）：

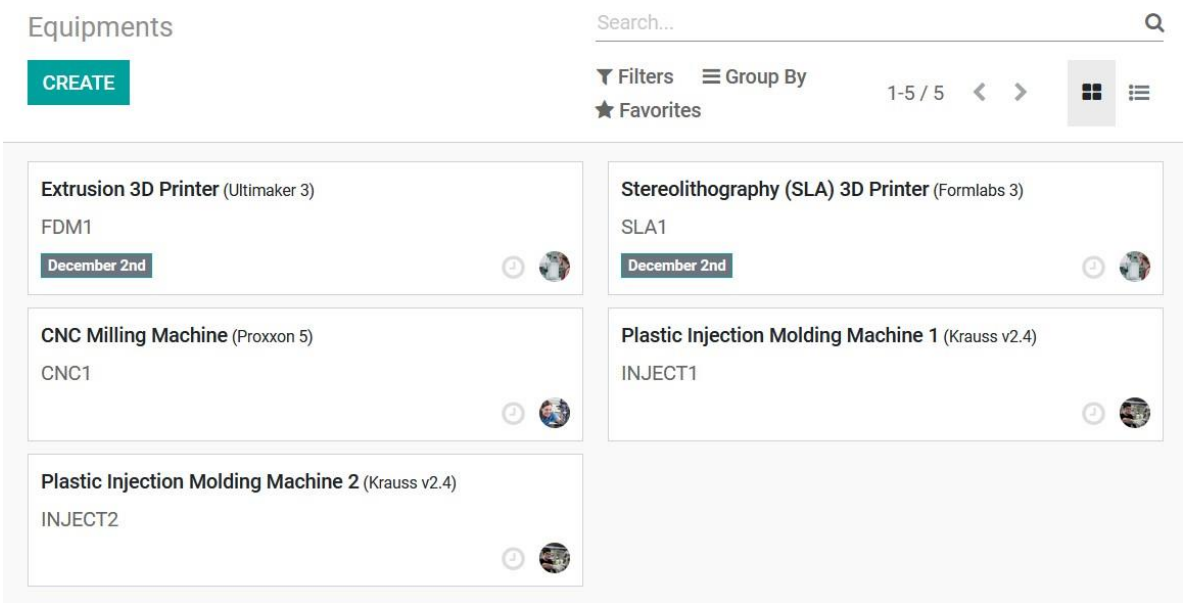

Figure 32 Overview of equipment items
圖32 設備項目概覽

This is where software limitations regarding PLM start to show. Although equipment items allow you some level of metadata (description text, responsible user, maintenance data

and vendor). It does not allow for the uploading of files of any kind to be attached to the item class (machine manuals, reports etc). This is a substantial weakness, since file management is something quite unanimously considered a main aspect of PLM. This will be a recurring subject of this simulation since the number of Items that allow upload of files directly to them is limited in Odoo.

這是軟件在產品生命週期管理（PLM）方面的限制開始展示的地方。儘管設備項目允許您進行一定程度的元數據（描述文本、負責用戶、維護數據和供應商），但它不允許附加任何類型的文件到該項目類別（機器手冊、報告等）。這是一個重大的弱點，因為文件管理被普遍認為是PLM的主要方面之一。這將是這次模擬的一個反覆出現的主題，因為在Odoo中，允許直接上傳文件的項目數量有限。

Now that the equipment has been created, their workcenters can be created. It is interesting to remember that the main use of the workcenter item is management of time and cost per hour. The idea is that equipment assigned to a WC should not be used at the same time and that ideally equipment that have widely different running costs should also be in different workcenters to allow for better time/cost tracking.

現在設備已創建，可以創建它們的工作中心。值得記住的是，工作中心項目的主要用途是管理每小時的時間和成本。理念是分配給工作中心的設備不應該同時使用，並且理想情況下，運行成本差異很大的設備也應該位於不同的工作中心，以便更好地追蹤時間/成本。

The following (Figure 33) is a an example of a workcenter item made to represent the prototyping station that is used throughout the development of the product.

以下（圖33）是一個工作中心項目的示例，用於代表整個產品開發過程中使用的原型製作站。

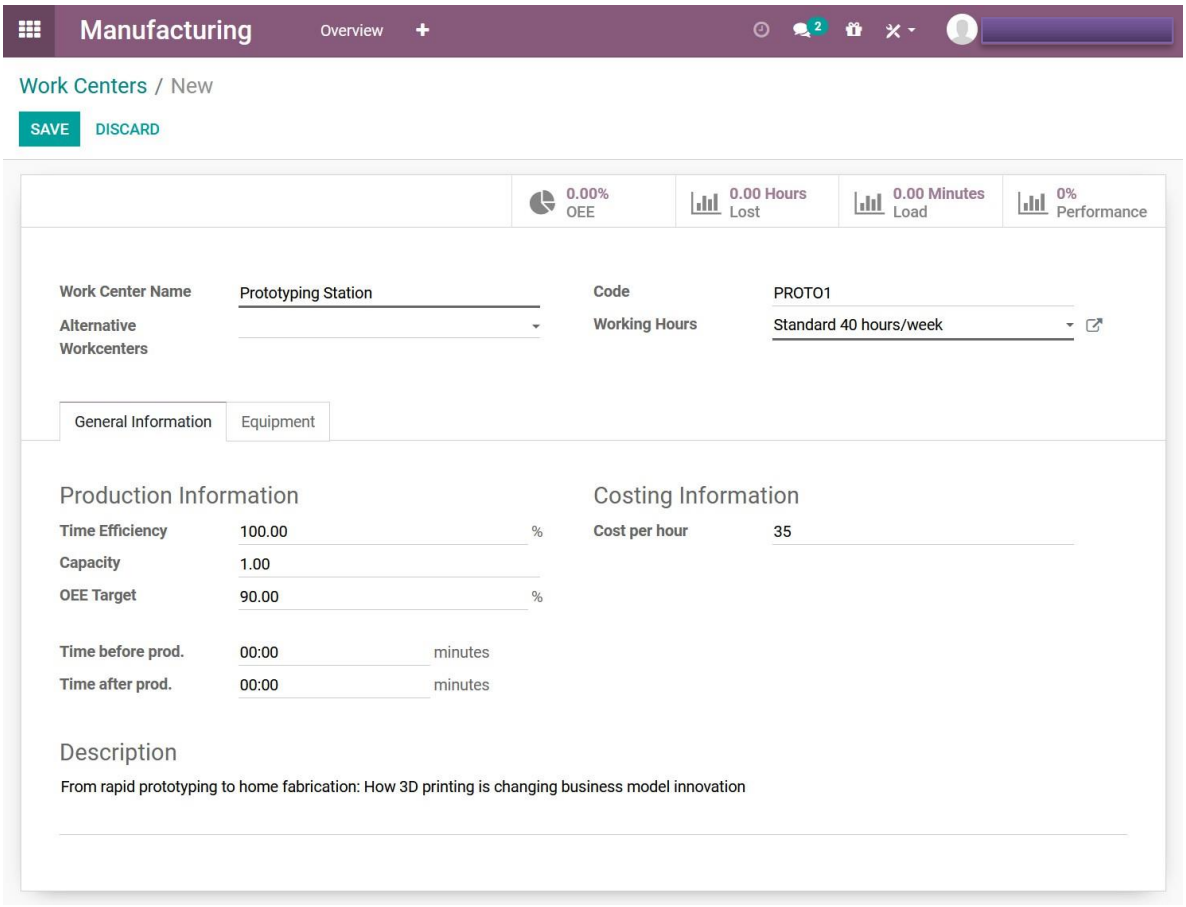

Figure 33 Odoo Prototyping Station item representation 1

Figure 33 Odoo原型製作站項目表示1

The reader will notice that this station (Figure 34) is where the 3D printers and CNC machine are located. Usually these machines would be separated in singular workcenters because of difference in operation costs and because they are for the most part independent however for the sake of this simulation this has been considered representative enough.

讀者會注意到這個站點（圖34）是3D打印機和CNC機床的所在地。通常，這些機器會因為操作成本的差異以及它們大部分是獨立的而被分開放在不同的工作中心中，但是為了這次模擬的目的，這被認為已經足夠代表性了。

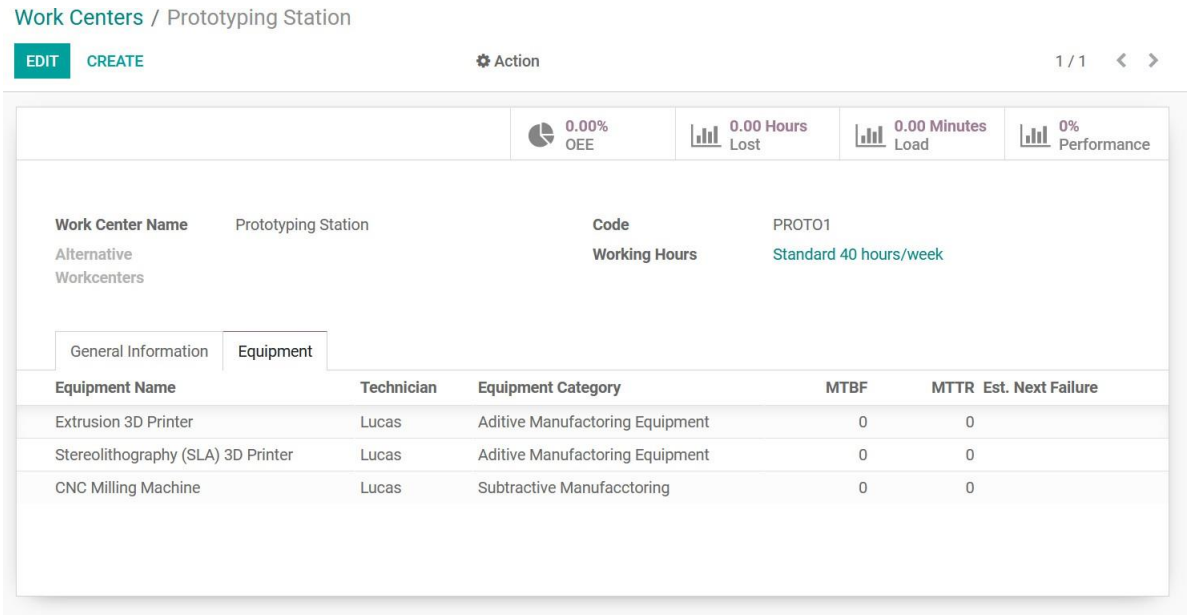

Figure 34 Prototyping Station item representation 2

Figure 34 原型製作站項目表示2

The following workcenters have been also created for the simulation and filed with the necessary equipment:

同時，以下工作中心也已經為模擬創建並裝備了必要的設備：

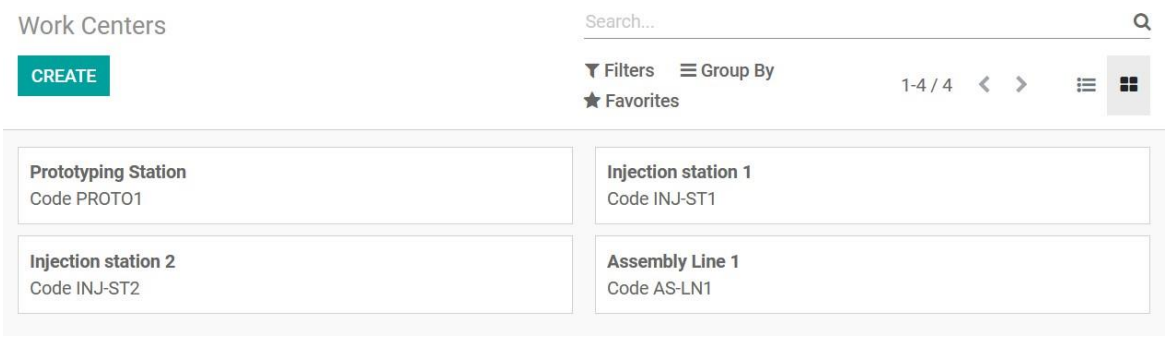

Figure 35 Overview of Workcenter items

圖35 工作中心項目概覽

1.2. Development
開發

Now that the basic structure of the company has been recreated in the software, it is

possible to commence the simulation process. At first, the focus is on the development aspect of a brand new product using Odoo (Figure 9) most noticeably, since this is the company first product to be created, a possible use of Odoo for organizing prototyping procedure is evaluated. This include the path from idea to design and prototype production. Then once the product has reached an acceptable result as a prototype, the work regarding the development of the production process will take place. The product development is considered successful once an official production run is done.

現在，公司的基本結構已經在軟件中重新建立，可以開始模擬過程。首先，重點放在使用Odoo進行全新產品開發的方面，特別是因為這是公司創建的第一個產品，因此對於組織原型製作程序的可能使用進行了評估。這包括從想法到設計和原型生產的過程。然後，一旦產品作為原型達到了可接受的結果，就會進行生產過程的開發工作。一旦完成正式生產運行，產品開發就被認為是成功的。

1.2.1. Idea - design - product prototype
想法 - 設計 - 產品原型

As explained in (Chapter 4) the idea for the product has already been stablished and initial design characteristics and basic product research have already been carried out. This is representative of an actual implementation of the Odoo software in the real world because although Odoo have good project management and communication applications, those are external to the inventory and manufacturing applications and, more importantly, share no integration with the engineering design CAD software. In this simulation, the idea has been put to paper and have been turned into a CAD design using the Solidworks software generating a CAD file locally stored in the engineer computer.

正如在（第4章）中所解釋的，產品的想法已經確立，初始設計特徵和基本產品研究已經進行。這代表了Odoo軟件在現實世界中的實際應用，因為儘管Odoo具有良好的項目管理和通訊應用程序，但這些應用程序是外部的庫存和製造應用程序，更重要的是，它們與工程設計CAD軟件沒有任何集成。在這個模擬中，想法已經被紀錄下來，並且已經被轉化為使用Solidworks軟件生成的CAD設計，將CAD文件存儲在工程師的計算機上。

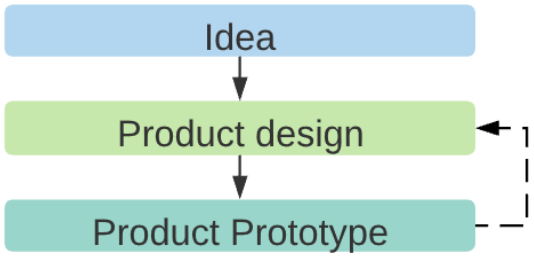

Figure 36 Sectioned diagram regarding product development
Figure 36 關於產品開發的分段圖示

It is at this point that the utilization of the Odoo software can officially take place. The first step is to understand what the subject of production is as far as product items are concerned. There are two takes in how to do this:

在這一點上，Odoo軟件的利用正式開始。第一步是了解就產品項目而言生產主題是什麼。有兩種方法來做到這一點：

- The first is to consider the prototype an early revision of the final product, that is the prototype item created in Odoo would be the same as the final product item with revisions been carried out during development. That would be the recommended if the prototype is achieved by identical means to the ones used in the final production. An example of this approach would be if the product is simple enough that product and production aspects of development can be carried

out together.

- The second one is to consider the prototype as a separate item from the final product - this is the path was taken in this simulation. The main reason for this decision was that the ways in which our prototype production were carried out differed from the final production since 3D printing was used for the prototypes.

- 第一種方法是將原型視為最終產品的早期版本，即在開發過程中對原型進行修訂的原型項目在Odoo中創建的將與最終產品項目相同。如果原型是通過與最終生產使用相同的方法來實現的，這將是推薦的方法。這種方法的一個例子是，如果產品足夠簡單，開發的產品和生產方面可以一起進行。

- 第二種方法是將原型視為與最終產品不同的單獨項目-這是此模擬中採取的路徑。做出這個決定的主要原因是，我們的原型生產方式與最終生產方式不同，因為原型使用了3D打印。

Starting from the root, a product item called PROTO Alpha Case (Figure 37) was created (Alpha Case being the name of the product). From this point on we will refer to prototype products as 'proto item'. As we can see, this allows for a nice representation of the proto item. Since it is a prototype, it will not be marked as something that can be sold or purchased, and sales price will be set to 0$ since it is unimportant. This proto item will be used to connect the different aspects of its development but for now it is left alone.

從根源開始，創建了一個名為PROTO Alpha Case（圖37）的產品項目（Alpha Case是產品的名稱）。從這一點開始，我們將將原型產品稱為"proto item"。正如我們所看到的，這允許對proto項目進行良好的表示。由於這是一個原型，因此它不會被標記為可以出售或購買的物品，銷售價格將設置為0美元，因為這不重要。這個proto項目將用於連接其開發的不同方面，但目前它被單獨留下。

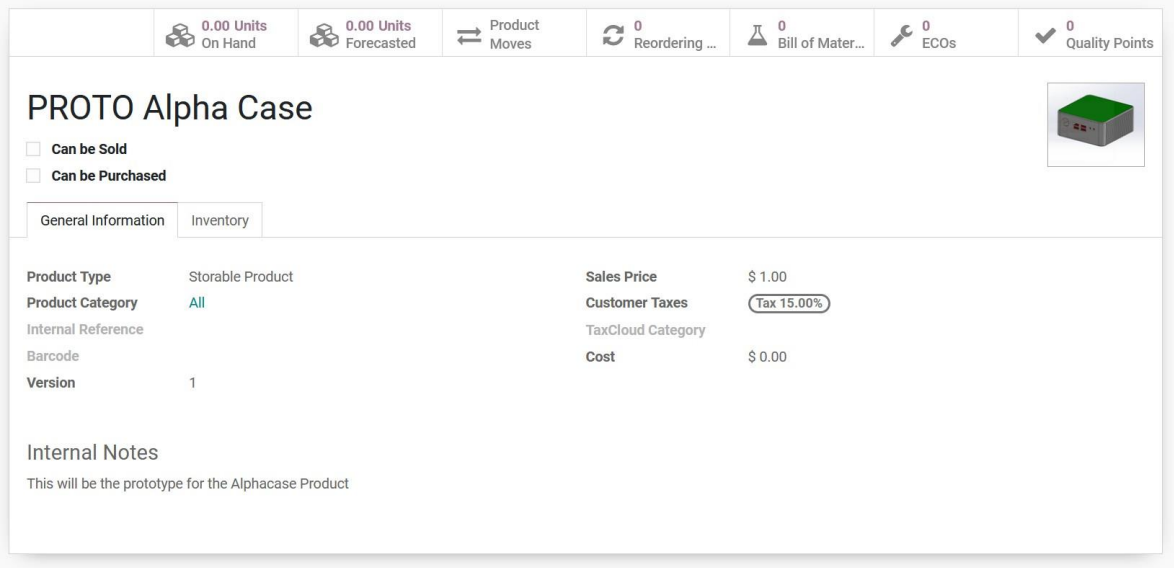

Figure 37 Image of the prototype product item
Figure 37 原型產品項目的圖片

As we have previously stablished in chapter 3, the product will consist of 3 pieces Part A, Part B and Part C. These need to be prototyped and created as products as well so that they can be added to the bill of materials of the PROTO Alpha Case. Finally, it was decided to use specific plastic filaments (see section 4.1.1) for the 3D printing of PROTO Part A and PROTO Part B and C and these need to be added as products as well (Figure 38).

正如我們在第3章中先前確定的，產品將由3個零件組成，即A零件、B零件和C零件。這些零件需要被製作成原型並作為產品創建，以便它們可以被添加到PROTO Alpha Case的物料清單中。最後，決定使用特定的塑料填充物（參見4.1.1節）來進行PROTO Part A和PROTO Part B和C的3D打印，這些也需要被添加為產品（圖38）。

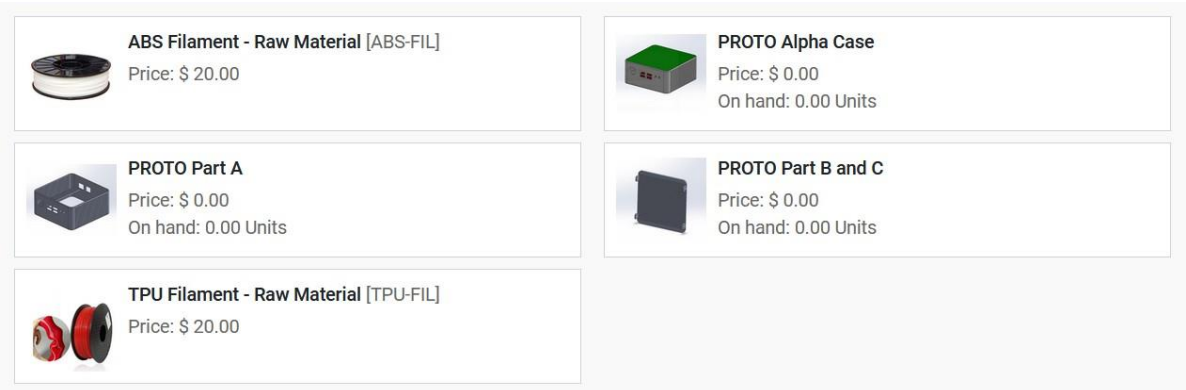

Figure 38 Overview of Product class items for prototype
Figure 38 原型產品類項目概覽

At this point, the relevant product items for the prototyping of the Alpha Case were finished, which makes possible the creation of the its relevant BOMs. There are 3 of them and they follow the structure in (Figure 39):

此時，用於Alpha Case原型的相關產品項目已經完成，這使得可以創建相應的物料清單。它們有3個，並且遵循如（圖39）中的結構：

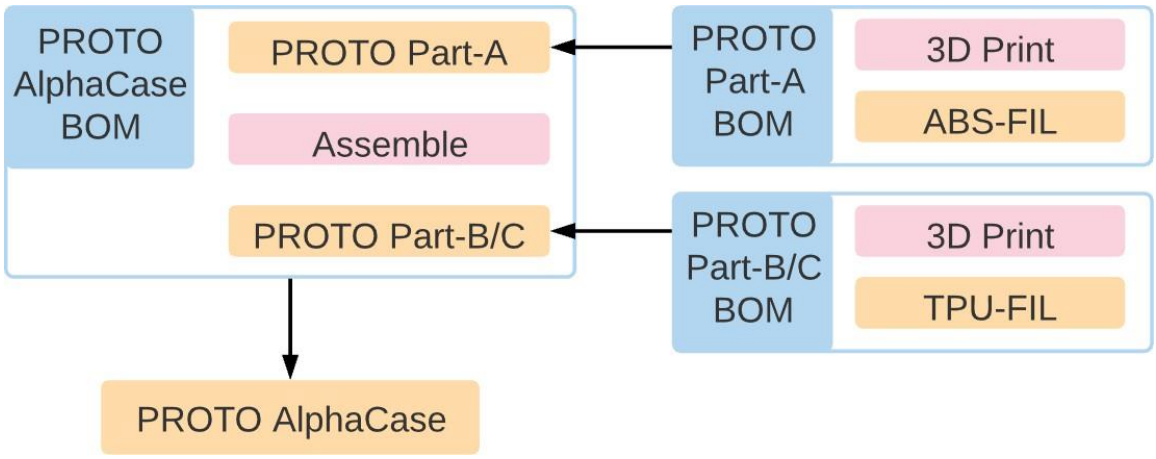

Figure 39 BOM diagrams for prototyping

Figure 39 用於原型的物料清單圖表

Something worth mentioning is that Odoo used the kit option (Figure 40) on the item to infer that this product is a component of another product. This is very interesting because it automatically creates dependencies between the product items for production.

值得一提的是，Odoo在該項目上使用了套件選項（圖40），以推斷該產品是另一個產品的組件。這非常有趣，因為它自動在產品項目之間創建了生產依賴關係。

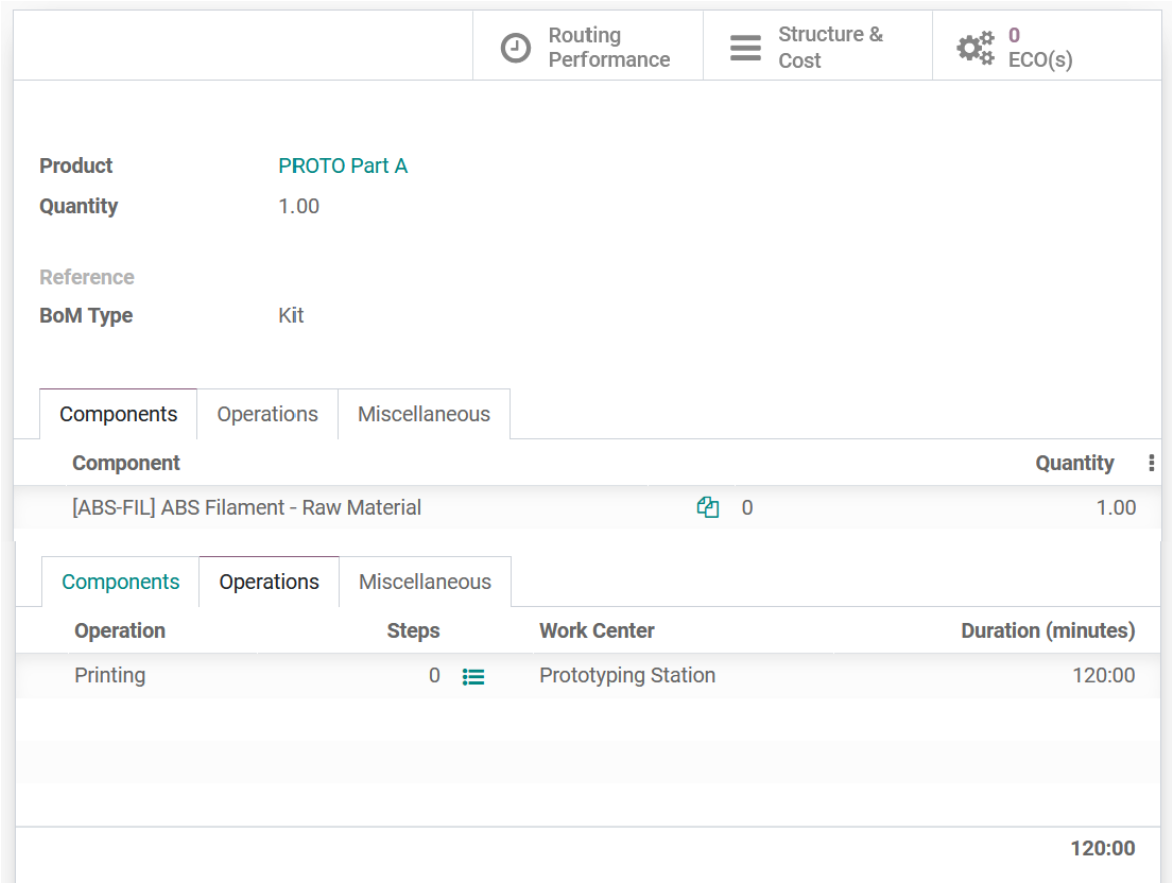

Figure 40 Image of the prototype product BOM (Part-A)
Figure 40 原型產品BOM的圖片（Part-A）

As the reader can see (Figure 41), while making the BOMs it is simple to create the specific operation items necessary for the manufacturing procedure and specify its work center. One of the best functionalities regarding MES in Odoo is the ability to track the time of operations based on default duration. This can be dynamically changed based on tracked time or set manually. It is also in the operation item that we can add instruction files for the operation. Even though it is limited to PDF text or a link to a google slides file, this is one of the few opportunities presented by Odoo for file management connected directly to an item.

如讀者所見（圖41），在製作物料清單時，可以輕鬆地創建必要的製造過程的具體操作項目並指定其工作中心。Odoo中關於MES的最佳功能之一是根據默認持續時間跟踪操作時間的能力。這可以根據跟踪的時間動態更改，也可以手動設置。同時，在操作項目中，我們可以添加操作的指示文件。儘管它僅限於PDF文本或鏈接到Google幻燈片文件，但這是Odoo為與項目直接相連的文件管理提供的少數機會之一。

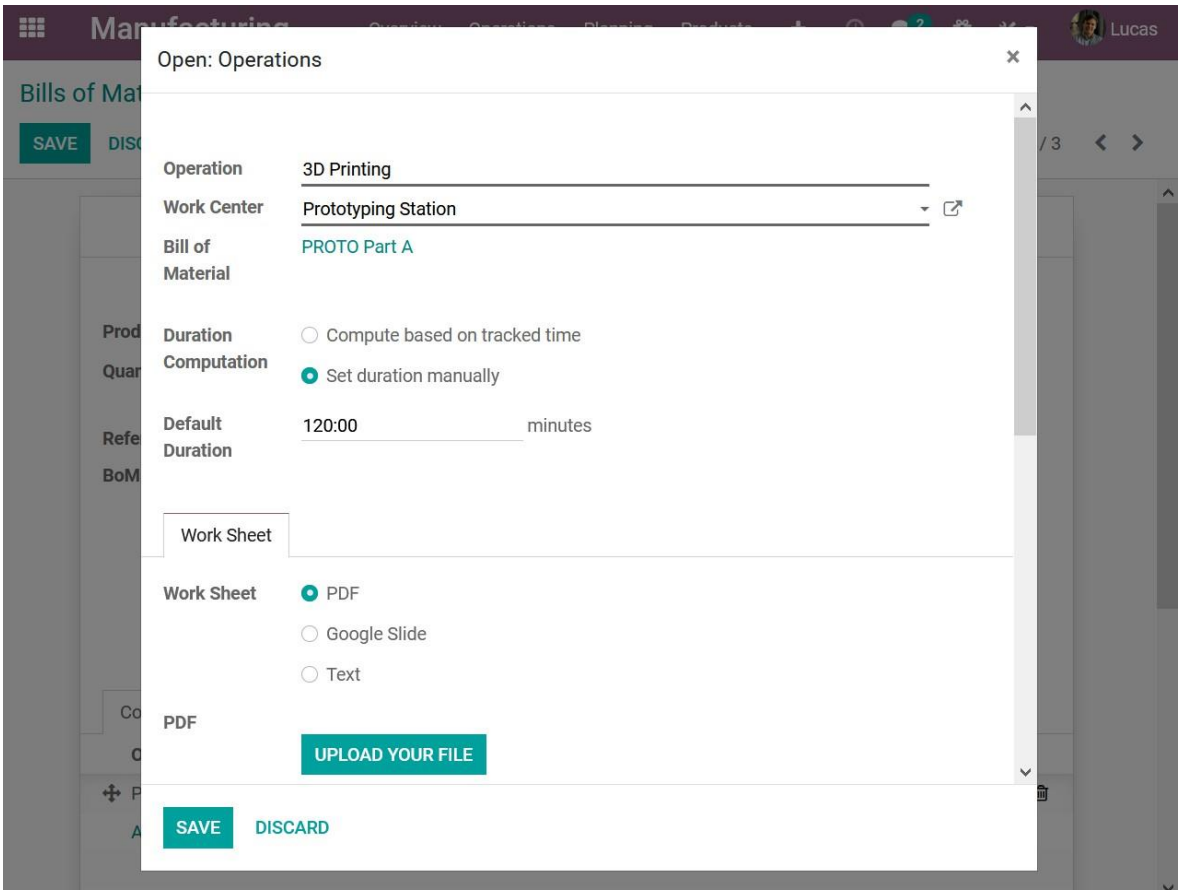

Figure 41 Image of operation item as presented by Odoo (BOM Part-A)
Odoo呈現的操作項目圖片（BOM Part-A）。

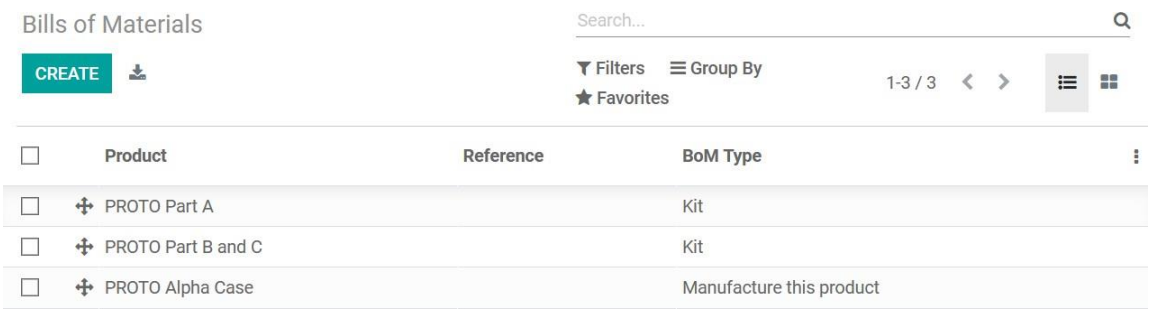

Figure 42 Overview of BOMs created for prototyping

Figure 42 原型製作的物料清單概覽

Speaking of this lack of upload opportunities, we can notice that while making the product item there was no way to directly upload files regarding the product to the item. In our case, we have the CAD files regarding the parts that we are prototyping, to not be able to upload these files in any way would be a complete failure from a PLM perspective. Thankfully there is a workaround. As explained in section 5.1.3.5, the ECO is an item that is linked to either product items or BOMs and allow uploaded files to be attached to it. It is a minor workaround but basically means that if we want to upload our CAD files to the items in any significative manner, we need to emit an ECO even if there is no “change” being made.

提到這種缺乏上傳機會，我們可以注意到，在製作產品項目時，沒有直接上傳與產品相關的文件的方式。在我們的情況下，我們有關於我們正在原型的部件的CAD文件，無法以任何方式上傳這些文件將從PLM的角度來看會是完全失敗的。幸運的是，有一個解決方法。正如在第5.1.3.5節中所解釋的，ECO是與產品項目或物料清單相關聯的項目，並允許上傳文件附加到它。這是一個小的解決方法，但基本上意味著如果我們想以任何重要的方式上傳我們的CAD文件到項目中，即使沒有進行“更改”，我們也需要發出一個ECO。

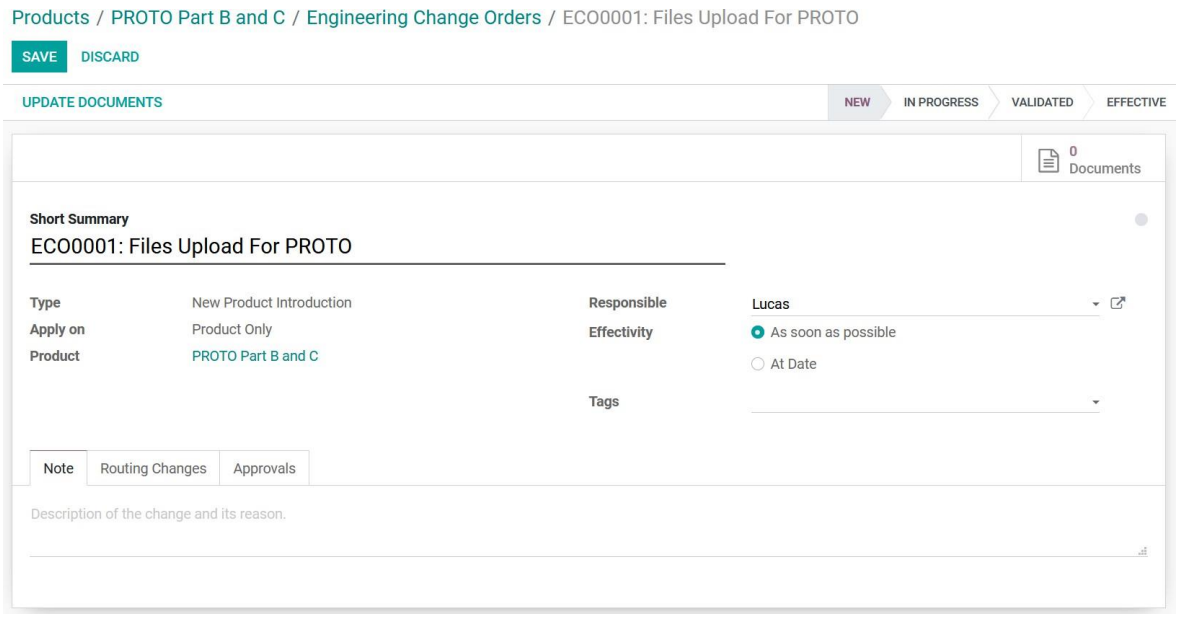

Figure 43 ECO example

Figure 43 ECO範例

It can only be assumed that this was part of Odoo’s team strategy to implement PLM as an external application in its ERP base. It is reasonable, but still, this is one of the few aspects of this software interface that is not as straightforward. It is an extremely valuable feature, but it is somewhat hidden. The documents icon appears in the top right corner (Figure 43) only after the ECO is created and saved.

可以假設這是Odoo團隊在實施PLM作為其ERP基礎的外部應用程序時的策略之一。這是合理的，但是，這仍然是這個軟件界面中少數不太直觀的方面之一。這是一個非常有價值的功能，但它有些隱藏。只有在創建和保存ECO之後，文檔圖標才會出現在右上角（圖43）。

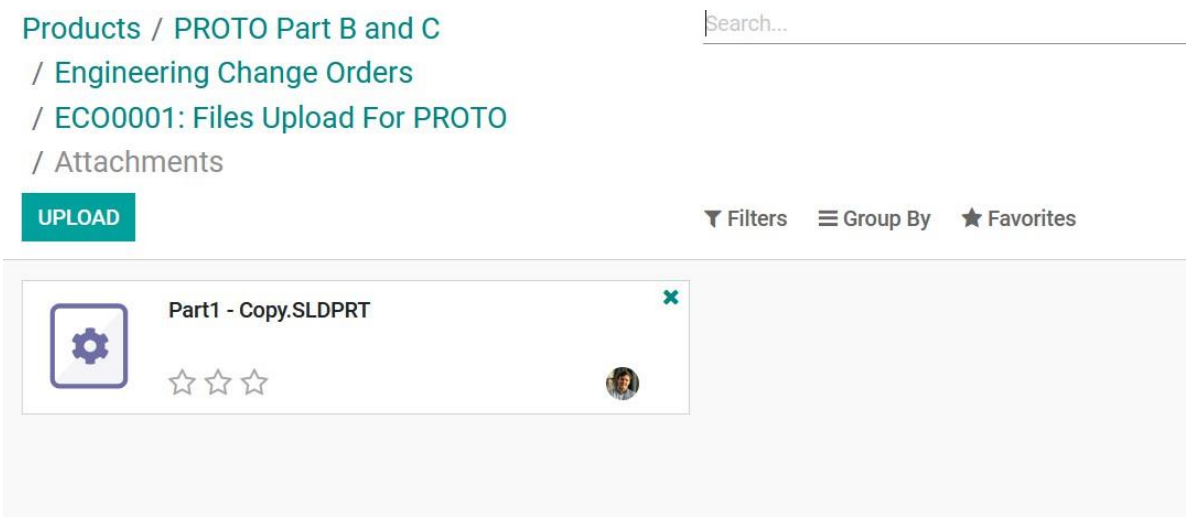

Figure 44 Overview of attached files to ECO
Figure 44 附加到ECO的文件概覽

Since there is no direct integration between Odoo and the CAD software, uploading the file do not cause any automatic change to the product metadata. This is not ideal from the PLM perspective, still, it is a well implemented feature. By allowing product items to link directly to not only one existing ECO but to the list of all ECOs ever applied to the item, the software does well in tracking version control and development.

由於Odoo與CAD軟件之間沒有直接集成，因此上傳文件不會導致產品元數據的自動更改。從PLM的角度來看，這並不理想，但它是一個實現良好的功能。通過允許產品項目直接鏈接到不僅是一個現有的ECO，而且是產品項目曾經應用過的所有ECO的列表，軟件在跟踪版本控制和開發方面表現良好。

Something interesting that can be done for the sake of process control is adding quality control points to operations. This allows the responsible personnel to give feedback during the production regarding concerning points to the engineering team. In our case, we are concerned about 3D printing warping. This is something that happens when temperature varies to much during the 3D printing procedure. To this end a Quality Control Point item will be created (Figure 45) that will enquire with the operator to check if there is warping in the piece and mark pass or fail.

為了流程控制的目的，可以做一些有趣的事情是在操作中添加質量控制點。這使得負責人員可以在生產過程中就工程團隊關注的問題提供反饋。在我們的案例中，我們關注的是3D打印扭曲。這是在3D打印過程中溫度變化太大時發生的情況。為此，將創建一個質量控制點項目（圖45），該項目將要求操作員檢查零件是否扭曲並標記通過或失敗。

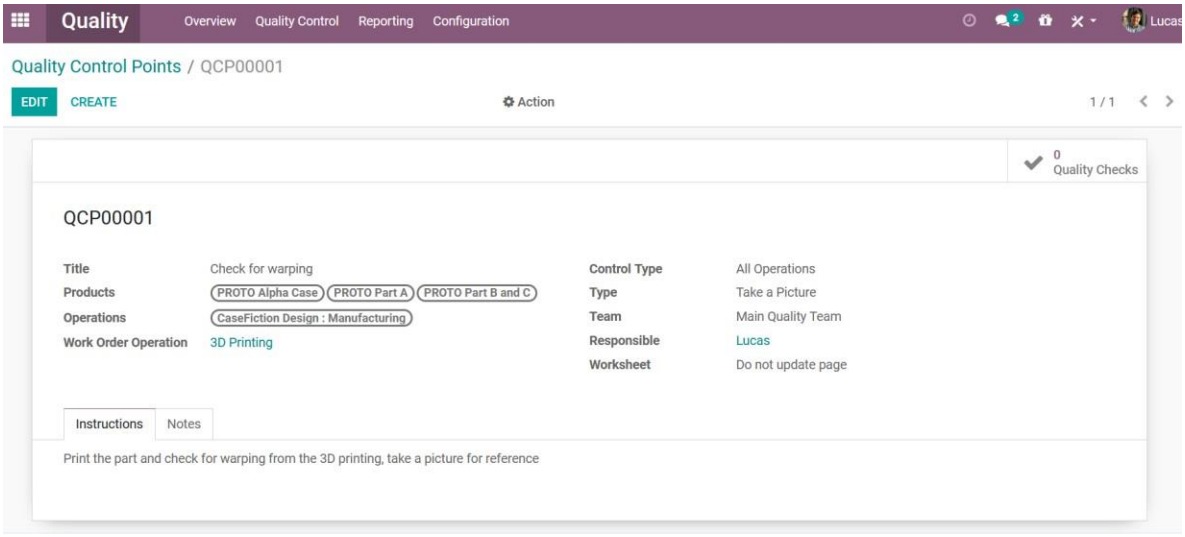

Figure 45 Quality Control Point item for the prototype production

Figure 45 原型生產的質量控制點項目

The last step of a prototype cycle would be the production of prototypes for testing and evaluation. Production is something quite straightforward in Odoo and really the point where everything we have done before come together. The metadata and the items that have been created allow us to start the Manufacturing Order (MO) (Figure 46). This, in turn, pull the necessary workorders from the operations and components listed in the BOM. The workorders appear for manufacturing operators and production can commence/be tracked.

原型循環的最後一步將是生產用於測試和評估的原型。在Odoo中，生產是一個非常直觀的過程，也是我們之前所做的一切集合的地方。已經創建的元數據和項目使我們能夠開始製造訂單（MO）（圖46）。這反過來從BOM中列出的操作和組件中拉出必要的工單。工單出現在製造操作員的工作中，生產可以開始/被跟蹤。

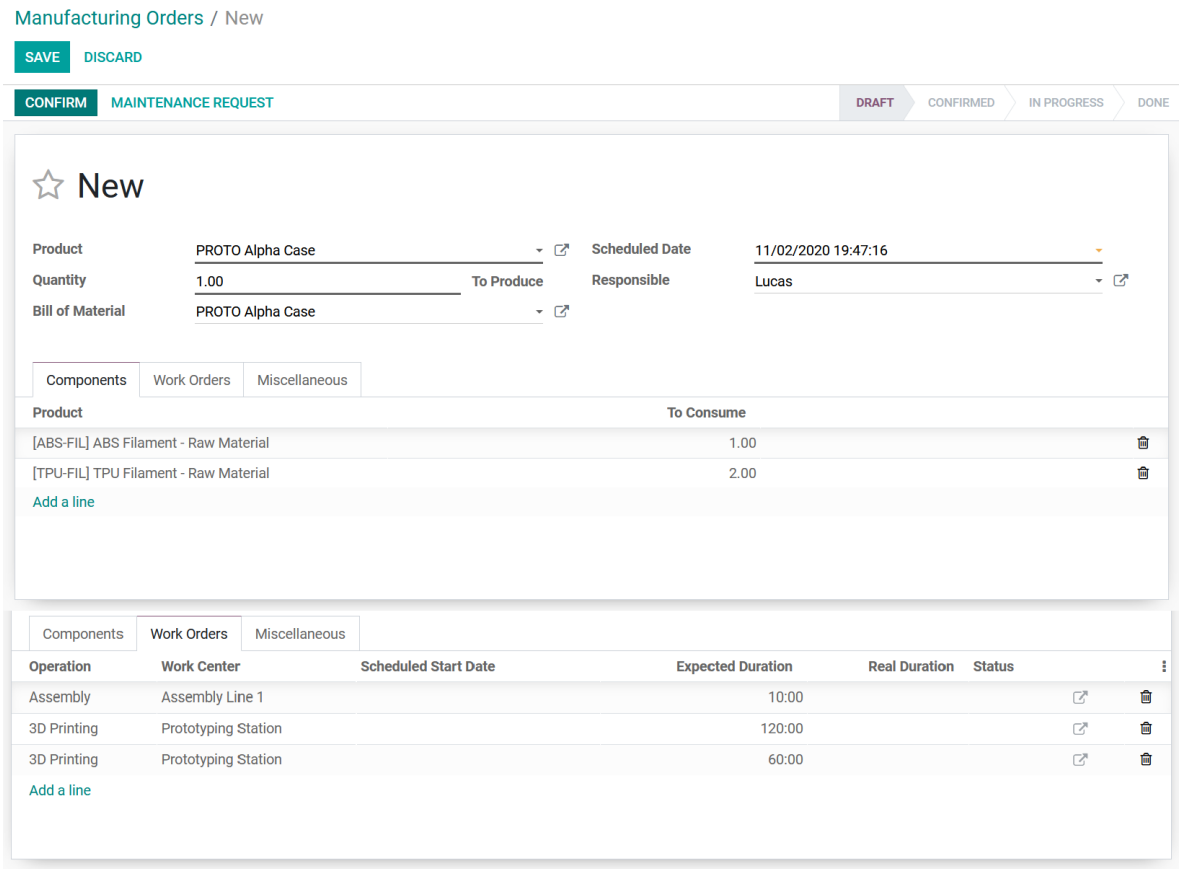

Figure 46 Depiction of the manufacturing order

Figure 46 製造訂單的描述

For the most part this operation is very well automated and clear. There are however a few problems that are result of structural changes from Odoo V13 to Odoo V14. For a long time, the software ordered the operations to be carried out using an extra item class called ‘Route’. These were a fundamental part of how the product moved within the inventory and

manufacturing, but for some reason, was dropped in the manufacturing aspect of the new version in favor of a simplified sequence data built into the BOM. As of the writing of this work, there have been reports of problems and confusions regarding how that works, which are aggravated by the fact that material explaining the use of this functionality are either nonexistent or still referencing old versions of the software (in which ‘routes’ are still in use).

在很大程度上，這個操作非常自動化和清晰。然而，由於從Odoo V13到Odoo V14的結構性變化，存在一些問題。很長一段時間以來，軟件使用了一個名為“路線”的額外項目類來指定要執行的操作。這些是產品在庫存和製造中移動的基本部分，但出於某種原因，在新版本的製造方面放棄了這一功能，而是改為在BOM中內置了簡化的順序數據。截至撰寫本文時，有報告稱對此功能的使用存在問題和困惑，這些問題更加惡化的原因是解釋這一功能的資料要麼不存在，要麼仍然在參考舊版本的軟件（在這些版本中，“路線”仍然在使用）。

The avid reader will notice in Figure 47 that the order in which operations are being made available are not in the correct sequence. This is due to exactly this problem and for now the

熱心的讀者將會注意到在圖47中，操作的提供順序並不正確。這正是由於這個問題，目前