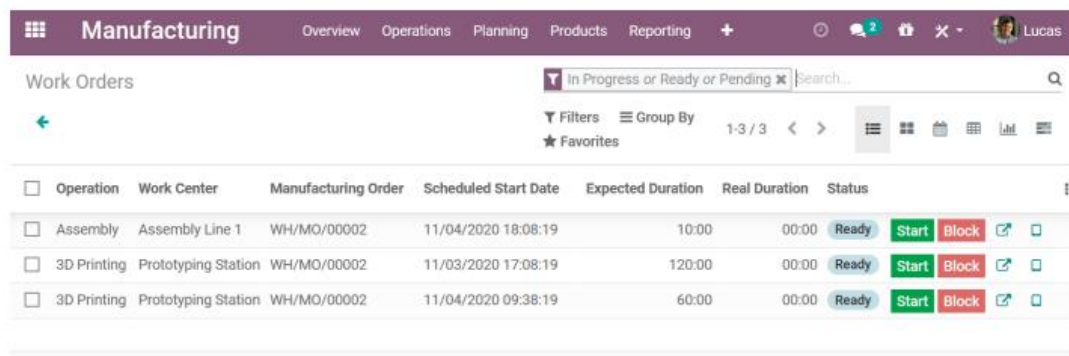only solution is to count on the awareness of the operators regarding the order of productionor manually scheduling the operations in the plan tab. During the period of research for thiswork (before Odoo V14) familiarization experiments were made in which there were noproblem of this nature. In addition, there are examples online even from Odoo websitedemonstrating the use of routes and how they are useful for this exact situation.

唯一的解決方案是依賴操作員對生產順序的認識，或者在計劃選項卡中手動安排操作。在進行此項研究期間（Odoo V14 之前），進行了熟悉化實驗，並未出現這種性質的問題。此外，甚至在 Odoo 網站上都有示例，展示了路線的使用以及它們對於這個確切情況的有用性。



**Figure 47 Overview of the resulted Work Orders**
圖 **47** 工作訂單結果概觀

The problem has been reported by other people (Figure 48) to the Odoo company and is been and hopefully it will be resolved shortly (this is after all a extremelly recent version of the software). That been said, it is a problem even if it is a minor one.

這個問題已被其他人（圖 48）報告給 Odoo 公司，希望它會很快得到解決（畢竟這是一個非常新的軟件版本）。儘管如此，即使它只是一個小問題，這仍然是一個問題。
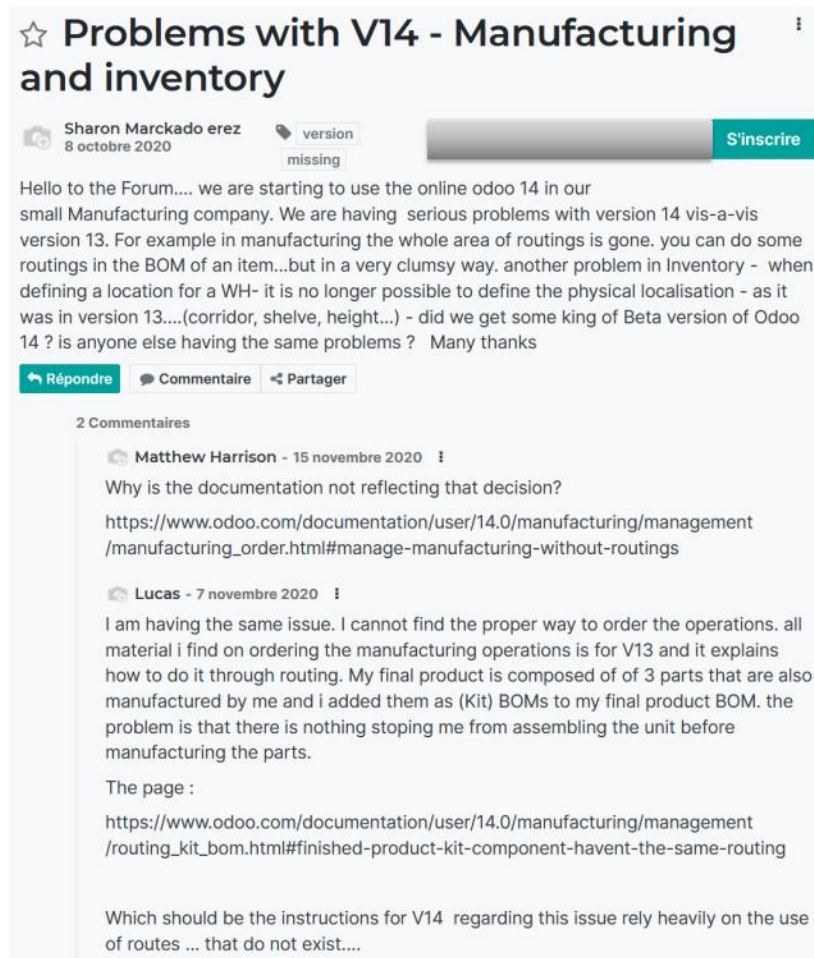
**Figure 48 Image of Odoo forum question regarding routes**
圖 48 Odoo 論壇有關路線問題的圖片

The manufacturing process was repeated 7 times (Figure 49) to simulate a small batch ofprototypes for testing and tolerance checking. It is rare to get a perfect prototype in the first batch, for this reason it was chosen to represent correction through the simulation. In this simulation this problem was a fit problem that resulted in a change of dimension of PROTO Part A.

製造過程重複 7 次（圖 49），以模擬小批量原型進行測試和公差檢查。在第一批中獲得完美原型的情況很少見，因此選擇它來代表透過模擬進行修正。 在此模擬中，該問題是一個擬合問題，導致原型 A 部分的尺寸發生變化。
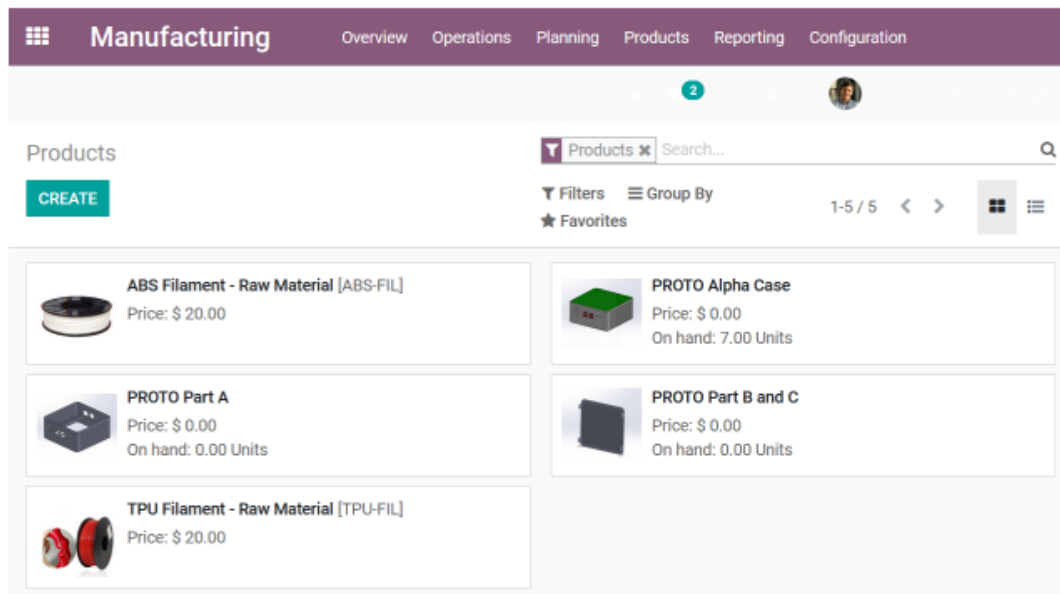
**Figure 49 Overview of the products after manufacturing**
圖 49 製造後的產品概覽

This give us the opportunity to use ECOs for their actual purpose, stablish and control a change to the product item. The changes to be carried out were on the CAD file regarding the product item. As before we can start the ECO and fill in the description, then the files are uploaded, and the ECO (Figure 50) goes through necessary validation before been made effective.

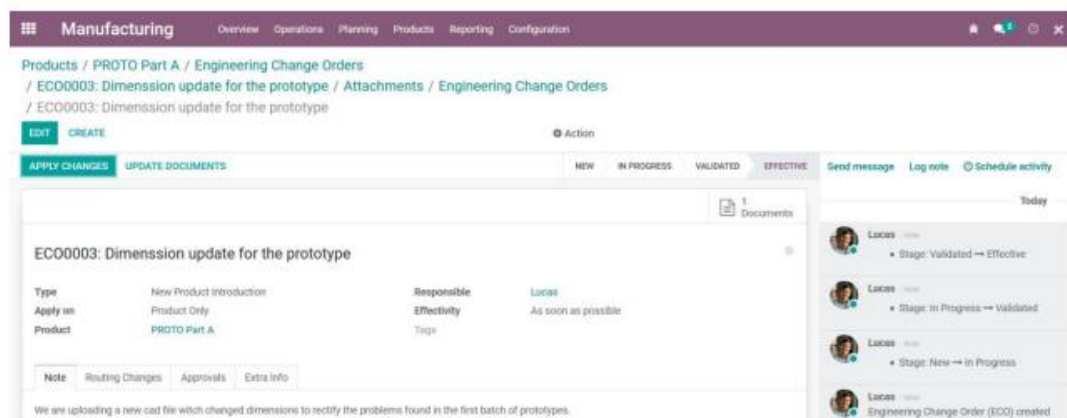這使我們有機會將 ECO 用於其實際目的、建立和控制產品項目的變更。要進行的變更是在有關產品項目的 CAD 檔案上進行的。 與之前一樣，我們可以啟動 ECO 並填寫描述，然後上傳文件，ECO（圖 50）經過必要的驗證後才會生效。



**Figure 50 Depiction of the validation of the ECO**
圖 50 ECO 驗證描述

The validation procedure basically is set to ask for validation of someone with proper access permissions or specific personnel. In this case, the master account was used to validate and make effective as can be seen from the log in the right side of the image. Once the change is applied you can see that the product item version has been iterated to version 2 as well as a new ECO has been added to the list of ECOs linked to the item (Figure 51).

驗證程序基本上設定為要求具有適當存取權限的人員或特定人員進行驗證。 在本例中，主帳戶用於驗證並生效，從圖像右側的日誌可以看出。 套用變更後，您可以看到產品項目版本已迭代至版本 2，並且新的 ECO 已新增至連結至該專案的 ECO 清單（圖 51）。
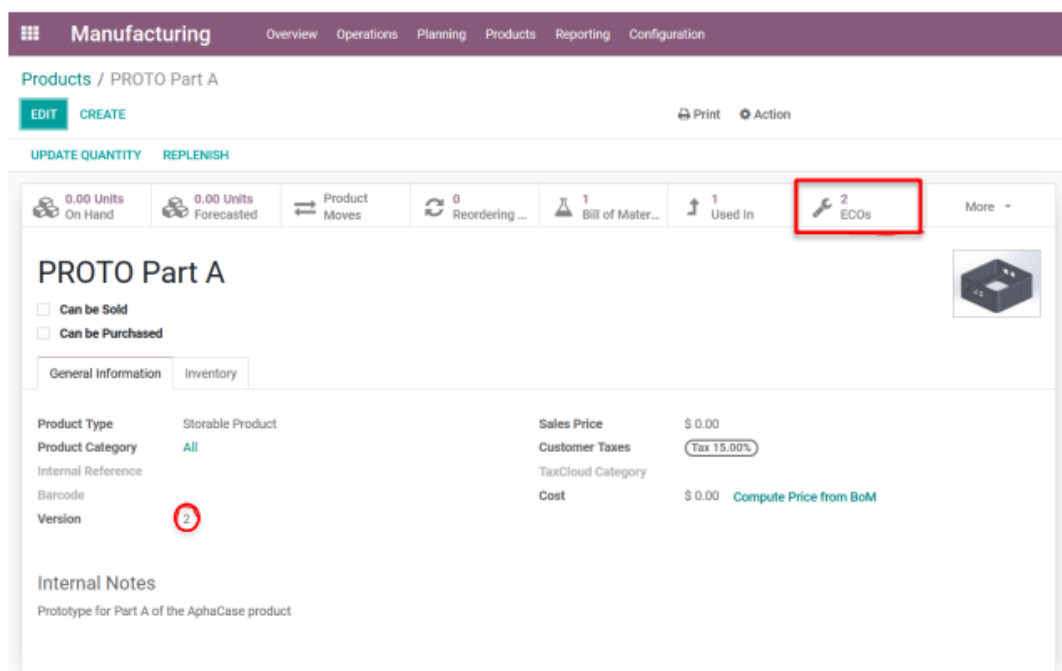


**Figure 51 Depiction of changes provoked by the ECO to product item**
圖 51 ECO 對產品項引起的變化的描述

That update is followed by another batch of prototypes, the cycle would continue until the prototypes produced satisfy the criteria stablished by the design team. In the case of this simulation it was assumed that one correction was representative enough of this process. This finalizes the development from idea to prototype.

更新之後是另一批原型，循環將繼續，直到生產的原型滿足設計團隊制定的標準。 在此模擬的情況下，假設一次校正足以代表該過程。 這就完成了從想法到原型的開發。

### 5.4.2. Process Plan - Production Test Run – Production
### 5.4.2. 製程計劃 - 生產 試運轉 - 生產

Now that the prototype phase is complete the focus will shift to the process. As stablished before, it was decided to separate the prototype products from the final product item to isolate the product from the production process during the development. This way many aspects of development of the product could be evaluated in an ordered manner. Now that the process is been developed it seems reasonable to create the product items that will represent the final products since the product of a successful run of the process will be the production ready samples of it (Figure 52).

現在原型階段已經完成，重點將轉移到流程。 如前所述，決定將原型產品與最終產品分開，以將產品與開發過程中的生產流程隔離。 這樣，產品開發的許多方面都可以按順序進行評估。 既然流程已經開發完畢，創建代表最終產品的產品專案似乎是合理的，因為流程成功運作的產品將是其生產就緒的樣品（圖 52）。
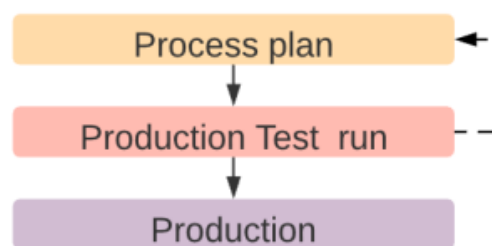


**Figure 52 Sectioned diagram regarding Process development**
**圖 52 製程開發剖面圖**

Other product items that created were the raw materials for the injection molding (which are plastic pellets that are fed into the machine to be melted and injected). All that was done in identical manner to when we create the prototype products with the exception that the Alpha case (Figure 53) now is marked as sellable and its sale costs are now relevant (Figure 54).

創建的其他產品項目是注塑成型的原料（這些塑膠顆粒被送入機器進行熔化和注射）。 所有這些都以與我們創建原型產品時相同的方式完成，除了 Alpha 案例（圖 53）現在被標記為可銷售並且其銷售成本現在是相關的（圖 54）。

**Figure 53 Render of how the final product should look like**
圖 53 最終產品的渲染圖



**Figure 54 Product Item of the Alpha Case**
圖 54 Alpha 案例的產品項目

Once the product items are taken care of, we need to go back to what aspect of the process will be tracked using Odoo in the context of this simulation. As it was hinted previously when talking about injection molding the key aspect of change regarding the process are the molds used by the machines to create the parts. For this simulation it was considered that the mold development will follow a very similar procedure of the development of the product, this should be more clear from the following diagram (Figure 55).

一旦處理完產品項目，我們需要回到在此模擬的背景下使用 Odoo 追蹤流程的哪些方面。 正如之前在談論注塑成型時所暗示的那樣，工藝變化的關鍵方面是機器用來製造零件的模具。 對於此模擬，我們認為模具開發將遵循與產品開發非常相似的程序，這一點從下圖中應該更清楚（圖 55）。
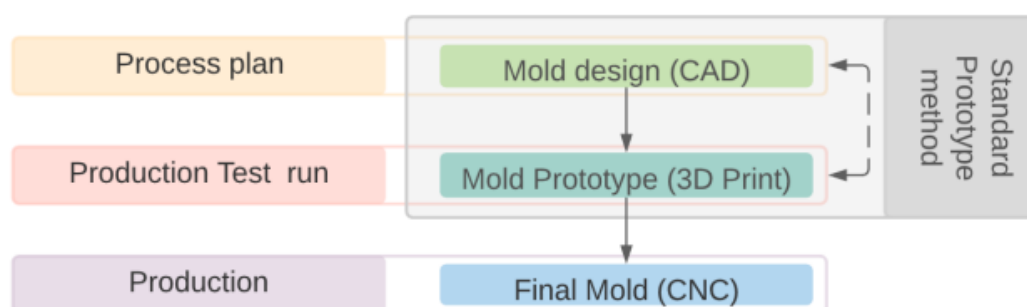


**Figure 55 Diagram regarding process development for mold**
**圖 55 模具製程開發圖**

The production of a prototype mold by 3D printing follows the same standard procedurefor prototyping used for the product. So far, the mold is considered a product like any other,this reveals another small weakness regarding Odoo ability to represent the totality of the process. The reader will notice that although the mold is been treated as a product (because it is been manufactured) it should in fact be considered a tool or piece of equipment as well.

透過 3D 列印生產原型模具遵循與產品原型製作相同的標準程序。 到目前為止，模具被認為是與任何其他產品一樣的產品，這揭示了 Odoo 代表整個過程的能力的另一個小弱點。 讀者會注意到，雖然模具被視為一種產品（因為它是製造出來的），但實際上它也應該被視為一種工具或設備。

Although Odoo does makes this distinction between equipment and products, it has no integration regarding the situations where one is both. In addition, as explained before, there is no way of uploading CAD files to an equipment item or linking an equipment to a range of tools. I.e. Odoo does not consider a vertical drill with x number of drill bits to make different size holes. The closest it can do from the

perspective of equipment/maintenance is consider the vertical drill a workstation and each drill size a separate equipment within the station with an assigned set up time. This is ok if you ignore that the drill bit is a product.

儘管 Odoo 確實對設備和產品進行了區分，但對於兩者兼而有之的情況，它沒有進行整合。 此外，如前所述，無法將 CAD 檔案上傳到裝置項目或將裝置連結到一系列工具。 IE。 Odoo 不考慮使用具有 x 個鑽頭的垂直鑽頭來製作不同尺寸的孔。 從設備/維護的角度來看，它可以做的最接近的事情是將立式鑽機視為工作站，並且每個鑽機尺寸都是工作站內的單獨設備，並具有指定的設置時間。 如果你忽略了鑽頭是一種產品，這也沒關係。

All of this is reasonable from the perspective of an ERP system but not ideal from the perspective of PLM because it shows gaps in between items that should represent the same thing. In production from the manufacturing application what is set is the work center station not the equipment (see Figure 41). In the maintenance app there is no connection to the fact that the tool is a consumable product, you can consider a maintenance schedule and even make a useful life parameters but because it is an equipment you can't have reserve tools like drill bits in inventory like consumables.

從 ERP 系統的角度來看，所有這些都是合理的，但從 PLM 的角度來看並不理想，因為它顯示了應該代表同一件事的項目之間的差距。 在製造應用程式的生產中，設置的是工作中心站而不是設備（見圖 41）。 在維護應用程式中，與該工具是消耗品這一事實無關，您可以考慮維護計劃，甚至可以製定使用壽命參數，但因為它是設備，所以您不能在庫存中保留鑽頭等工具像消耗品。

The result is that it becomes very difficult to represent testing with a prototype mold. If you do as the software is designed for you need to create a separate ECO to apply every operation for each different iteration of the mold development to the necessary BOMs and make a test run (Figure 56). At this point, considering the maintenance aspect of the mold as a tool just does not make sense because it would entails filing in metadata in the maintenance App by hand for every prototype mold iteration all without causing any difference from the manufacturing perspective. The PROTO mold item ends up been used only for the sake of tracking material and holding files as the mold is improved.

結果是用原型模具來表示測試變得非常困難。 如果您按照軟體設計的方式進行操作，則需要建立一個單獨的 ECO，將模具開發的每個不同迭代的每個操作應用到必要的 BOM 並進行測試運行（圖 56）。 在這一點上，將模具的維護方面視為一種工具是沒有意義的，因為這需要為每個原型模具迭代手動在維護應用程式中歸檔元數據，而從製造角度來看，這不會造成任何差異。 隨著模具

的改進，原型模具專案最終僅用於追蹤材料和保存文件。



**Figure 56 ECO example of update procedure of BOM**
**圖 56 BOM 更新流程 ECO 範例**

Taking this in consideration, in simulation it will be produced one 3D printed mold for each part of the alpha case. Then ECOs for the prototype parts of the case will be created to be applied to the parts BOMs updating the operation from 3D printing to injection molding test run with prototype molds

考慮到這一點，在模擬中將為 alpha 外殼的每個部分製作 3D 列印模具。然後，將創建案例原型零件的 ECO，並將其應用於零件 BOM，更新從 3D 列印到原型模具注塑試運行的操作。

At this point we could differentiate the product prototype from the test run prototype by making a new prototype product item, however considering our rapidly growing list of product items (Figure 57) it was concluded that it would be just better for depiction in this work to modify the previously produced product prototypes (made with 3D printing) and just 60 use the same items. We can do this because those prototypes have already served their purpose.

此時，我們可以透過製作新的原型產品項目來區分產品原型與測試運行原型，但是考慮到我們快速增長的產品項目清單（圖 57），我們得出的結論是，在本工作中進行描述會更好修改先前生產的產品原型（透過 3D 列印製作），只有 60 個使用相同的物品。 我們可以做到這一點，因為這些原型已經達到了它們的目的。
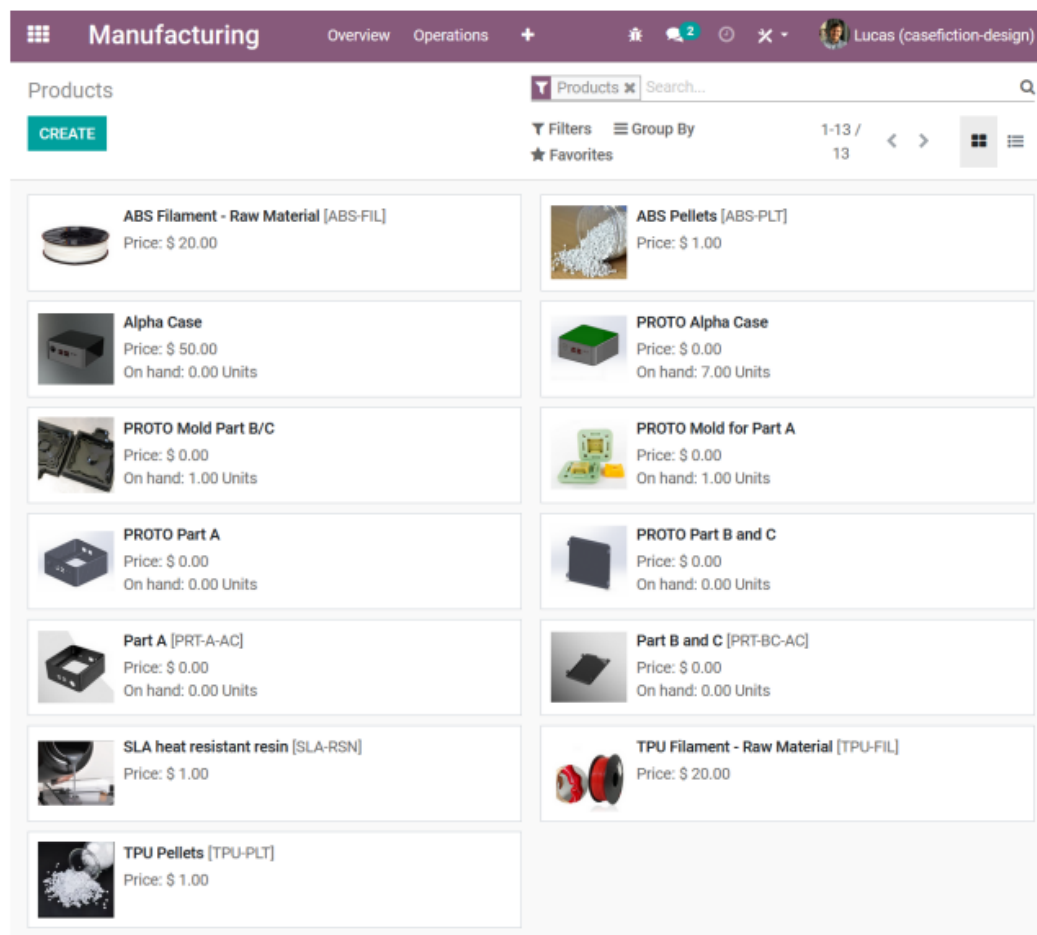


**Figure 57 Overview of product items at this stage of the simulation**
圖 57 模擬此階段的產品專案概覽

After the mold have been created and the BOMs for the prototypes are updated to include the injection stations and the proper operations (specifying the use of the molds) the next step is to do a production test run of prototype. Again that is done by emitting the MO completing the generated WOs (see Figure 46 and Figure 47 of previous section).

創建模具並更新原型的 BOM 以包括注射站和正確的操作（指定模具的使用）後，下一步是對原型進行生產測試運行。 這也是透過發出完成生成的 WO 的 MO 來完成的（參見上一節的圖 46 和圖 47）。

The result of the production is used to check for dimension and fitting, if correction is needed the ECOs would be emitted again as seen in Figure 56, and a new iteration of production and testing would be carried out. This process would repeat until the product is satisfactory enough to justify the production of the CNC machined molds that would be used in mass production.

生產結果用於檢查尺寸和裝配，如果需要修正，將再次發出 ECO，如圖 56 所示，並且將進行新的生產和測試迭代。 這個過程將重複進行，直到產品足夠令人滿意，足以證明用於大規模生產的 CNC 加工模具的生產是合理的。

Since in this simulation it was chosen that the final mold (made of aluminum) would also be produced in house, this is the next step of development. Procedure is basically the same as before except that it is needed to create product items for both the raw material (aluminum block) and the CNC molds prior to their manufacturing. Creating BOMs and uploading relevant files.

由於在此模擬中選擇最終模具（由鋁製成）也將在內部生產，因此這是開發的下一步。 程序與以前基本相同，只是需要在製造之前為原材料（鋁塊）和 CNC 模具創建產品項目。 建立 BOM 並上傳相關文件。

Finally, the actual production on the new molds can begin. To represent that a manufacturing order of 100 Alpha Cases were created. This marks the end of the main path of development from idea to production (Figure 58).

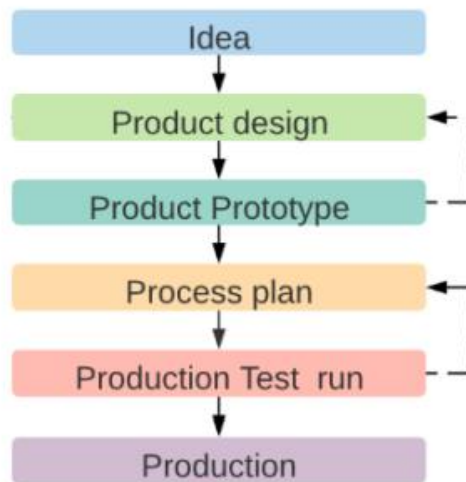最後，新模具可以開始實際生產。 表示創建了 100 個 Alpha Case 的製造訂單。 這標誌著從創意到生產的主要發展路徑的結束（圖 58）。

**Figure 58 Main path of development from idea to production**
圖 **58** 從創意到生產的主要發展路徑

## 5.4.3. Process upgrade procedure

## 5.4.3. 製程升級流程

The previous sections were about the procedure that would be necessary to use the Odoo software to track change during the main development of product. As such, most of what was described focused in the use of PLM and the standard procedure of creating and utilizingitems like Products, BOMs, ECOs, MOs, WOs and Operations. This section will be different in the sense that now we have a production being carried out and the idea is to test Odoo in its capabilities of performing upgrades (Figure 59 and Figure 60). In other words,performance and feedback of information (and of course MES) becomes the main subject.

前面的部分介紹了在產品主要開發過程中使用 Odoo 軟體追蹤變更所需的程序。 因此，所描述的大部分內容都集中在 PLM 的使用以及創建和利用產品、BOM、ECO、MO、WO 和營運等專案的標準程序。 本節將有所不同，因為現在我們正在進行生產，目的是測試 Odoo 執行升級的能力（圖 59 和圖 60）。 換句話說，訊息（當然還有 MES）的表現和回饋成為主要課題。
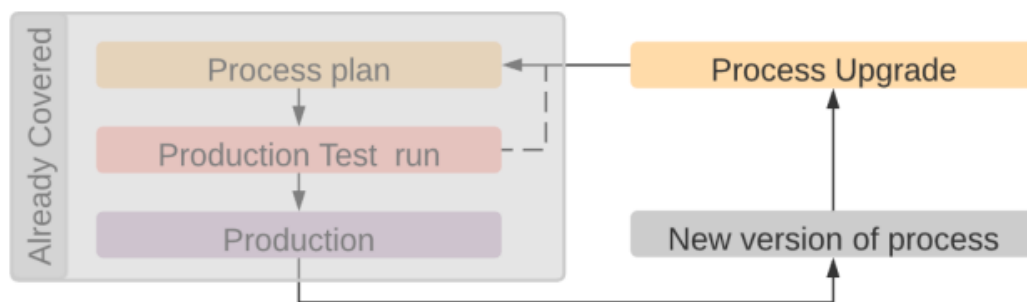
**Figure 59 Sectioned diagram regarding Process upgrade procedure**
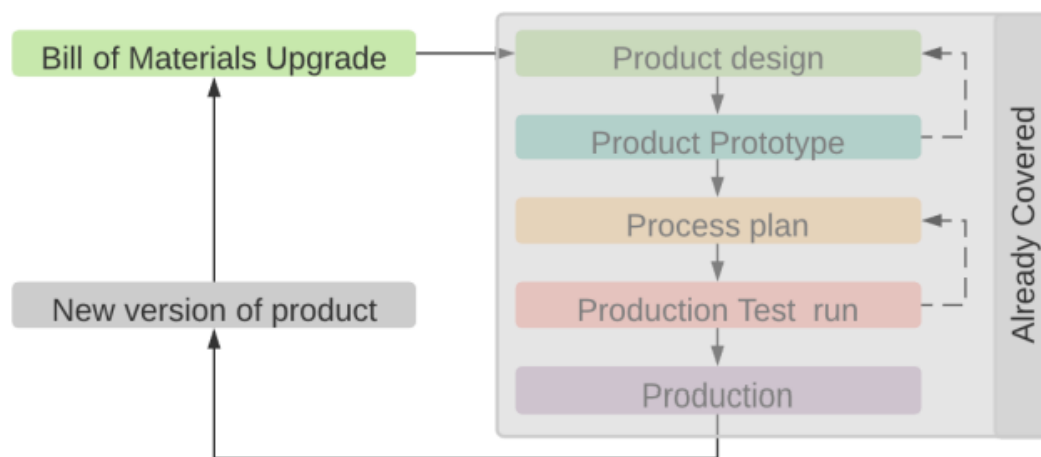圖 59 製程升級流程剖面圖



**Figure 60 Sectioned diagram regarding Process development**
圖 60 製程開發剖面圖

Change is always enacted using the ECO functionality even in this case. To remind the reader the situation in which this change will be applied (Figure 61) is the product overview of the relevant product items. Every product item in that list (that is not a raw material) poses at least one BOM and two ECOs already applied to them in order to signify the initial state of every product item (Figure 62). The first ECO of every item affects the product and it holds the initial related files, the second is applied to the BOM of the product in order to hold files related to the initial state of the process as well as record the initial state of the BOM. Without these ECOs (Figure 62), when we ever applied an improvement, the initial state of the product files or BOMs would be lost.

即使在這種情況下，也始終使用 ECO 功能來實施變更。 為了提醒讀者將套用此變更的情況（圖 61）是相關產品項目的產品概述。 此清單中的每個產品項目（不是原材料）至少包含一個 BOM 和兩個已應用於它們的 ECO，以表示每個產品項目的初始狀態（圖 62）。 每個專案的第一個 ECO 影響產品並保存初始相關文件，第二個 ECO 應用於產品的 BOM，以便保存與流程初始狀態

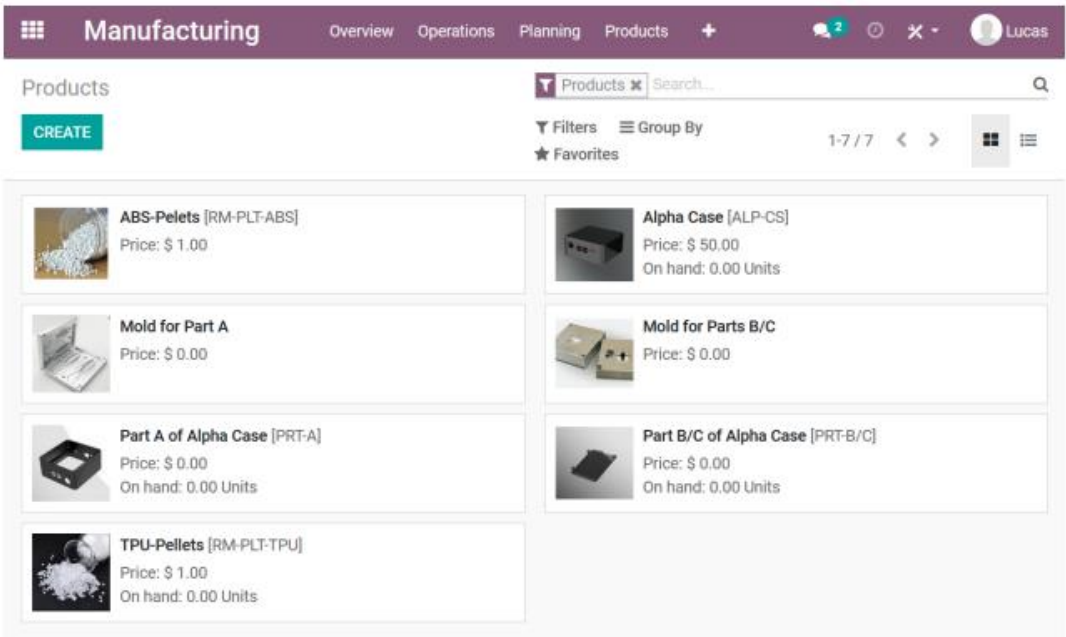相關的文件並記錄 BOM 的初始狀態。 如果沒有這些 ECO（圖 62），當我們應用改進時，產品檔案或 BOM 的初始狀態將會遺失。



**Figure 61 Relevant product items overview**
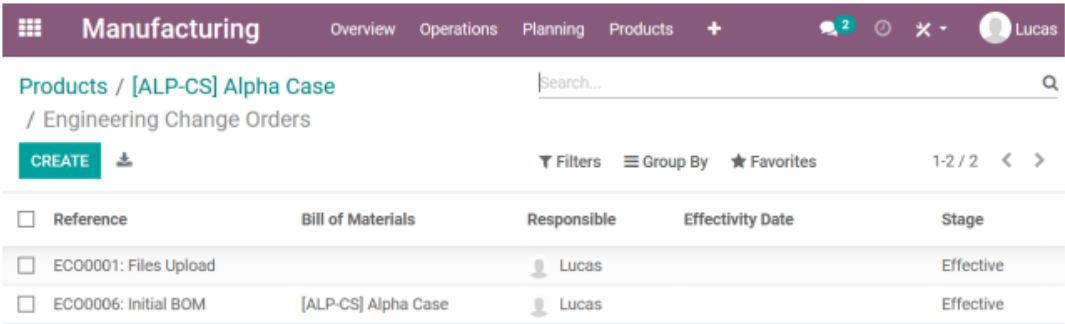**圖 61 相關產品項目概覽**



**Figure 62 Example of ECOs of a product item**
**圖 62 產品項的 ECO 範例**

This time around the production duration and the estimated duration of the process is something that need to be taken in consideration so we can perceive how that applied change on the process affect production. To this end a MO of 50 units of Alpha Case will be created with each operation being estimated to take 30 seconds (15s for parts B/C because there is the need for 2 of them). Meaning that in an ideal situation the total length would be 50 minutes (25 of injection production being done in parallel and 25 for final assembly).

這次需要考慮生產持續時間和流程的估計持續時間，以便我們能夠了解流程中應用的變更如何影響生產。 為此，將建立 50 個 Alpha Case 單元的 MO，每個操作預計需要 30 秒（B/C 部分需要 15 秒，因為需要其中 2 個）。這意味著在理想情況下，總長度為 50 分鐘（25 分鐘的注射生產並行完成，25 分鐘用於最終組裝）。

　　In this simulated manufacturing run it was chosen that the injection operations would take slightly more time to complete to be representative of a suboptimal performance. This is been done to see how Odoo reacts and informs in real time the situation in hand.

　　在此模擬製造運行中，選擇注射操作需要稍長的時間才能完成，以代表次優性能。 這樣做是為了了解 Odoo 如何反應並即時告知當前情況。