

Figure 52 Sectioned diagram regarding Process development

圖 52：有關流程開發的剖面圖

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). 其他創建的產品項目是用於射出成型的原材料（這些是供給機器熔化和射出的塑料粒子）。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). 所有這些都以與我們創建原型產品時相同的方式進行，唯一的例外是 Alpha 案例（見圖 53）現在被標記為可銷售，其銷售成本現在是相關的（見圖 54）。



Figure 53 Render of how the final product should look like

圖 53：最終產品應該是什麼樣子的渲染效果

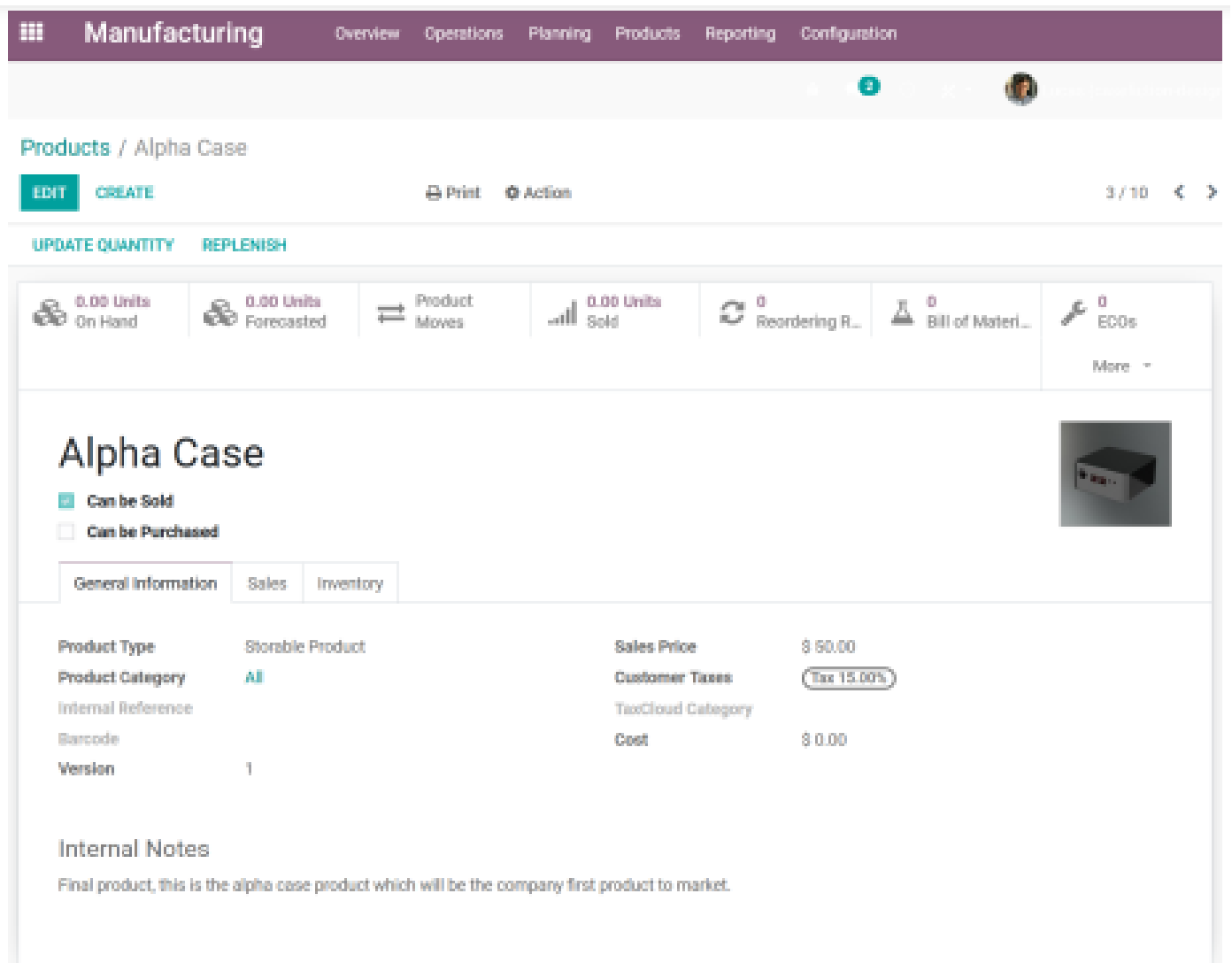


圖 54：Alpha Case 的產品項目

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. 一旦處理了產品項目，我們需要回到在這個模擬的上下文中將使用 Odoo 追蹤的流程的哪些方面。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. 正如之前提到的，當談論射出成型時，關於流程的關鍵變化之一是機器使用的模具來製造零件。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).對於這個模擬，考慮到模具開發將遵循與產品開發非常相似的程序，這將從以下圖表（圖 55）更清楚地呈現。

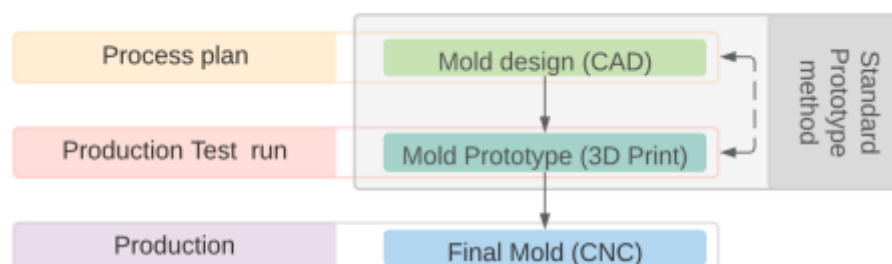


Figure 55 Diagram regarding process development for mold

圖 55：模具的流程開發圖解

The production of a prototype mold by 3D printing follows the same standard procedure for 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. 通過 3D 打印製作原型模具的生產遵循與產品原型化相同的標準程序。到目前為止，模具被視為與其他產品相同，這揭示了 Odoo 在代表整個流程的能力方面的另一個小弱點。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. 讀者會注意到，儘管模具被視為一種產品（因為它正在被製造），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. 儘管 Odoo 對設備和產品之間進行了區分，但它對於一個同時具有兩者身份的情況沒有集成。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. 此外，正如之前解釋的那樣，目前無法將 CAD 文件上傳到設備項目，或將設備與一系列工具相關聯。s. 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. 是的。也就是說，Odoo 沒有考慮到一個垂直鑽床搭配 x 個鑽頭來製作不同尺寸的孔。從設備/維護的角度來看，它最接近的做法是將垂直鑽床視為一個工作站，每個鑽頭尺寸視為工作站內的獨立設備，並分配一個設置時間。如果忽略鑽頭是一個產品的話，這是可以的。

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. 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，這並不理想，因為它顯示了應該代表相同事物的項目之間存在差距。In production from the manufacturing application what is set is the work center station not the equipment (see Figure 41). 在製造應用程序中，設置的是工作中心站而不是設備（參見圖 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. 在維護應用程序中，沒有考慮到工具是一種耗材產品的相關連接。你可以考慮一個維護計劃，甚至可以設置有用壽命參數，但因為它是一種設備，你無法像耗材一樣在庫存中保留鑽頭等工具。

The result is that it becomes very difficult to represent testing with a prototype mold. 結果就是很難用原型模具來表示測試。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). 如果按照軟件設計的方式操作，您需要為每個模具開發的不同迭代創建一個單獨的工程變更訂單（ECO），以將必要的操作應用到 BOM 中，然後進行測試運行（見圖 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. 在這一點上，考慮將模具作為一種工具的維護方面實際上是毫無意義的，因為這將意味著需要手動為每個原型模具迭代在維護應用程序中填寫元數據，而這一切都不會從製造的角度造成任何差異。The PROTO mold item ends up been used only for the sake of tracking material and holding files as the mold is improved. PROTOTYPE 模具項目最終僅僅用於跟踪材料並保存文件，因為模具逐步改進。

The screenshot displays the SAP Manufacturing Engineering Change Order (ECO) interface. The top navigation bar includes 'Manufacturing' and various menu items like 'Overview', 'Operations', 'Planning', 'Products', 'Reporting', and 'Configuration'. The breadcrumb trail indicates the path: 'Products / PROTO Part A / Engineering Change Orders'. The specific ECO is identified as 'ECO0004: Update of process to test the prototype molds'. The interface shows the 'UPDATE BOM' tab selected, with a status bar indicating 'NOW', 'IN PROGRESS', 'VALIDATED', and 'EFFECTIVE'. The main content area displays the ECO details, including 'Type: New Product Introduction', 'Apply on: Bill of Materials', 'Product: PROTO Part A', and 'BOM of Materials: PROTO Part A'. The 'Responsible' field is set to 'LUC95' and 'Effectivity' is 'As soon as possible'. Below this, there are tabs for 'Note', 'Routing Changes', 'Approvals', and 'Extra Info'. The bottom section, titled 'Create Operations', shows the 'Operation' as 'Test injection with prototype mold part A', 'Work Center' as 'Injection station 1', and 'Sequence' as '101'. The 'Duration Computation' is set to 'Set duration manually' with a 'Default Duration' of '60:00 minutes'. The 'Work Sheet' section has 'Test' selected, and the 'Description' field contains the text: 'Make sure the 3D printed prototype mold is well installed to the plastic injection equipment then turn on the machine.' At the bottom, there are buttons for 'SAVE & CLOSE', 'SAVE & NEW', and 'DISCARD'.

Figure 56 ECO example of update procedure of BOM

Figure 56：BOM 更新程序的 ECO 示例

Taking this in consideration, in simulation it will be produced one 3D printed mold for each part of the alpha case. 考慮到這一點，在模擬中，將為 Alpha Case 的每個部件生產一個 3D 打印的模具。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. 然後，將為機箱的原型部件創建 ECO，以應用於部件 BOM，將操作從 3D 打印更新為射出成型測試運行使用原型模具。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 use the same items. We can do this because those prototypes have already served their purpose.

在這一點上，我們可以通過製作一個新的產品原型項目來區分產品原型和測試運行原型，但考慮到我們迅速增長的產品項目清單（見圖 57），結論是在這個工作中修改之前製作的產品原型（用 3D 打印製造）會更好使用相同的項目。我們可以這樣做，因為那些原型已經完成了它們的任務。。

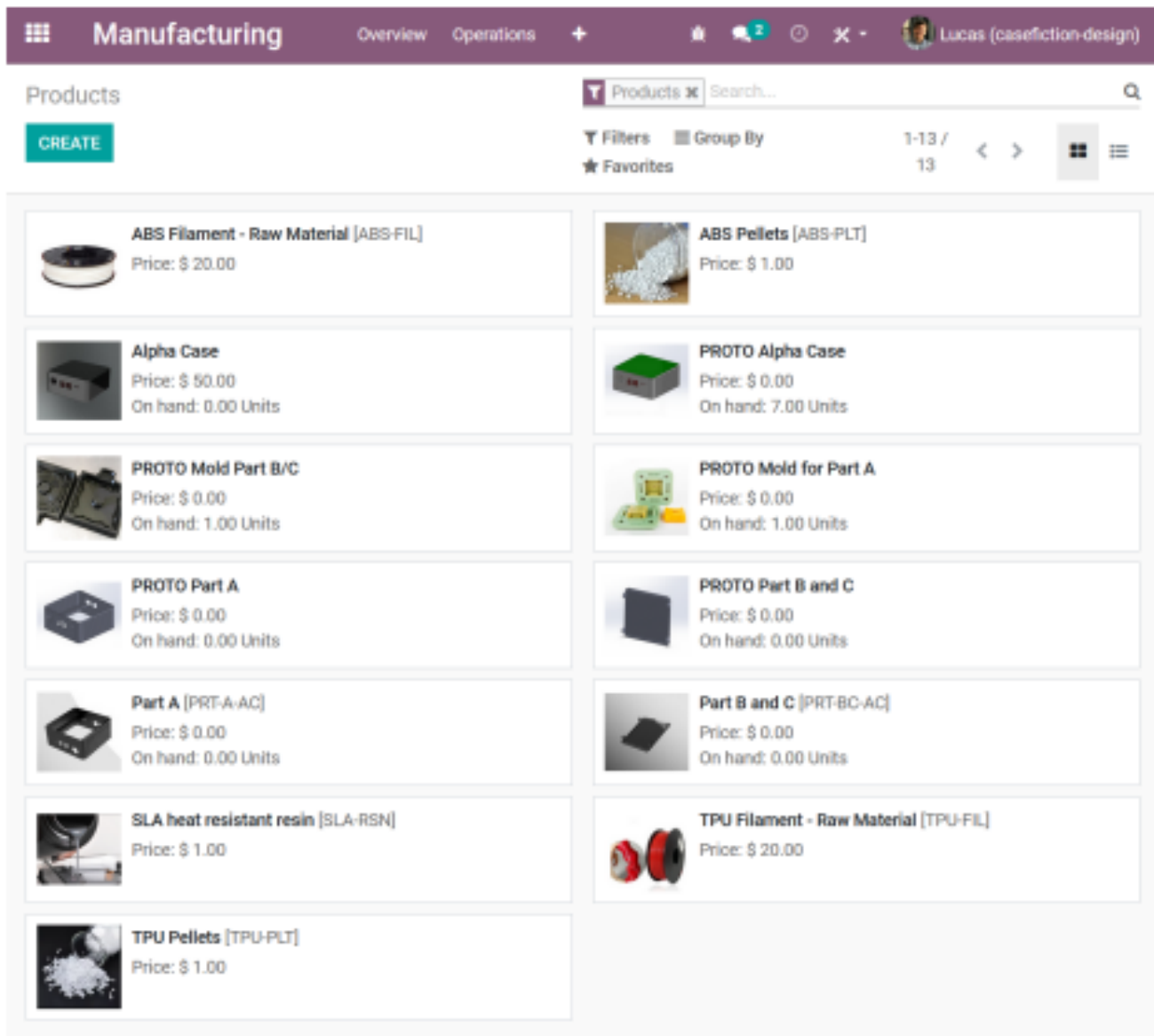


Figure 57 Overview of product items at this stage of the simulation

Figure 57 模擬目前階段的產品項目概覽

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. 在模具已經製造完成並且原型的 BOM 已經更新以包括射出站和正確的操作（指定模具的使用）之後，下一步是進行原型的生產測試運行。Again that is done by emitting the MO completing the generated WOs (see Figure 46 and Figure 47 of previous section). 再次通過發出製造訂單（MO）來完成生成的工單（WO），詳見上一節的圖 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. 生產的結果用於檢查尺寸和配合，如果需要進行校正，則再次發出 ECO，如圖 56 所示，然後進行新的生產和測試迭代。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. 這個過程將重複進行，直到產品足夠令人滿意，可以證明生產數控機床加工模具以進行大量生產是合理的。

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. 由於在這個模擬中選擇了最終模具（由鋁製成）也將在內部生產，這是開發的下一步。程序基本上與之前相同，唯一的不同在於需要在製造之前為原材料（鋁方塊）和 CNC 模具創建產品項目。Creating BOMs and uploading relevant files. 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，新模具的實際生產可以開始。為了表示這一點，創建了 100 個 Alpha Case 的生產訂單。這標誌著從構想到生產的主要發展路徑的結束（見圖 58）。

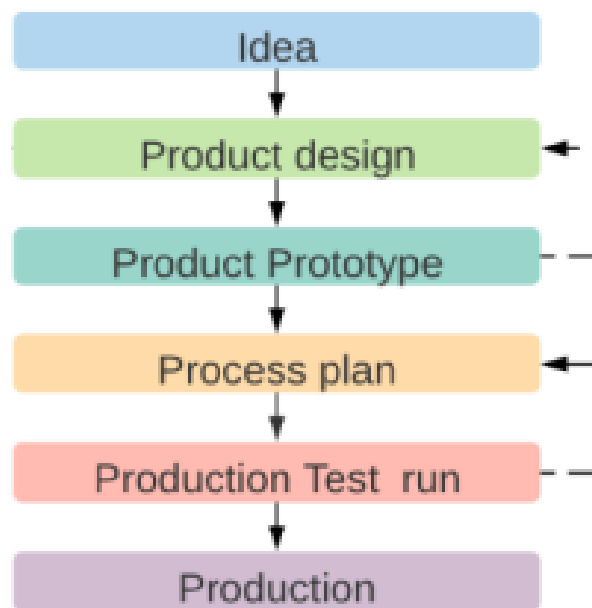


Figure 58 Main path of development from idea to production

Figure 58: 從構想到生產的主要發展路徑

5.4.3. Process upgrade procedure 5.4.3. 流程升級程序

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. 前面的章節是關於在產品主要開發過程中使用 Odoo 軟件跟踪變更所需的程序。As such, most of what was described focused in the use of PLM and the standard procedure of creating and utilizing items 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). 因此，大部分描述集中在使用 PLM 以及創建和利用產品、BOM、ECO、MO、WO 和操作等項目的標準程序上。這一部分將有所不同，因為現在我們正在進行生產，並且想要測試 Odoo 在進行升級方面的能力（見圖 59 和圖 60）。In other words, performance and feedback of information (and of course MES) becomes the main subject. 換句話說，性能和信息反饋（當然還有 MES）成為主要的主題。

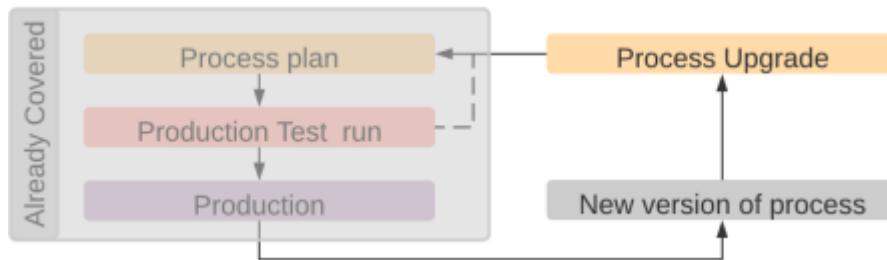


Figure 59 Sectioned diagram regarding Process upgrade procedure

Figure 59: 流程升級程序的剖面圖

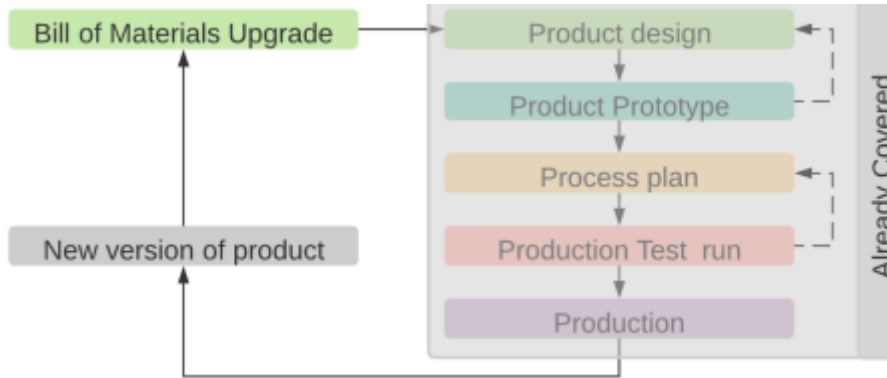


Figure 60 Sectioned diagram regarding Process development

Figure 60: 流程發展的剖面圖

Change is always enacted using the ECO functionality even in this case. 即使在這種情況下，變更始終使用 ECO 功能來執行。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). 提醒讀者，這種變更將應用的情況（見圖 61）是相關產品項目的產品概覽。在該列表中的每個產品項目（不是原材料）都至少具有一個 BOM 和兩個已應用於其上的 ECO，以表示每個產品項目的初始狀態（見圖 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. 每個項目的第一個 ECO 影響產品，它包含了相關的初始文件；第二個 ECO 應用於產品的 BOM，以保存與流程的初始狀態相關的文件，並記錄 BOM 的初始狀態。Without these ECOs (Figure 62), when we ever applied an improvement, the initial state of the product files or BOMs would be lost. 如果沒有這些 ECO（見圖 62），當我們應用改進時，產品文件或 BOM 的初始狀態將會丟失。

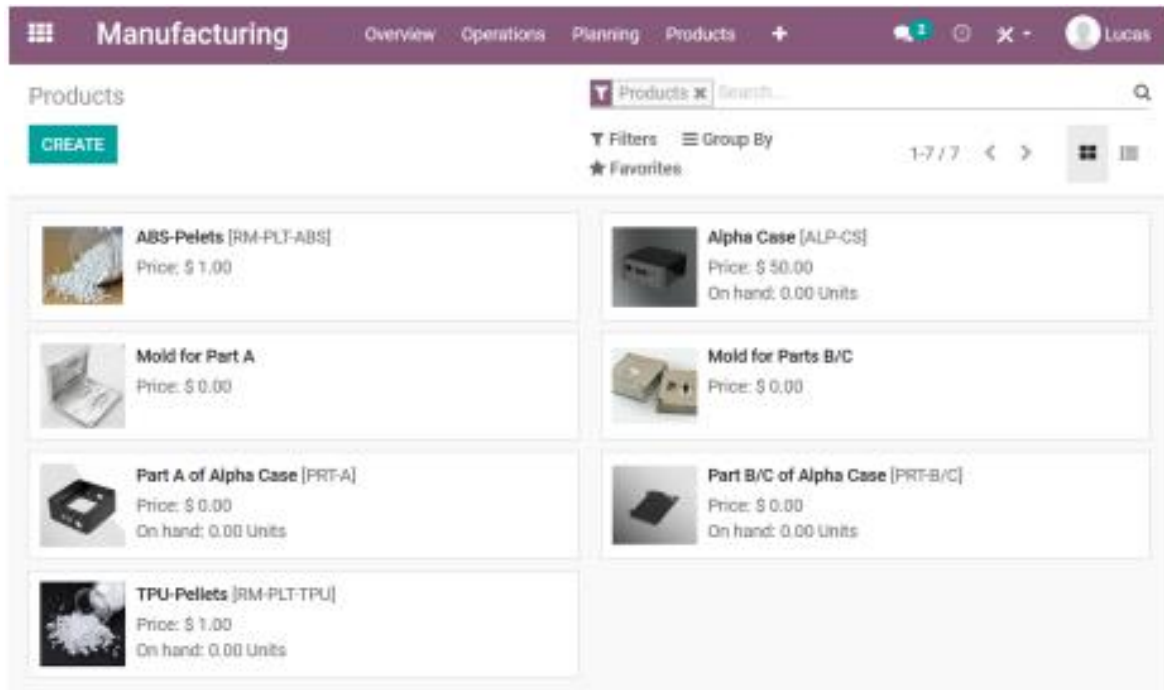


Figure 61 Relevant product items overview

Figure 61 相關產品項目概觀

The screenshot shows the 'Engineering Change Orders' page for the 'Alpha Case' product. The page includes a search bar, filters, and a table of ECOs. The table has columns for Reference, Bill of Materials, Responsible, Effectivity Date, and Stage.

Reference	Bill of Materials	Responsible	Effectivity Date	Stage
<input type="checkbox"/> ECO0001: Files Upload		Lucas		Effective
<input type="checkbox"/> ECO0006: Initial BOM	[ALP-CS] Alpha Case	Lucas		Effective

Figure 62 Example of ECOs of a product item

Figure 62 產品項目的 ECO 示例

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). 這一次，生產持續時間和流程的預估持續時間是需要考慮的因素，這樣我們就可以知道應用在流程上的變更如何影響生產。為此，將創建一個 50 個 Alpha Case 單位的 MO，每個操作預計需要 30 秒（由於需要 2 個部件 B/C，因此部件 B/C 的預計時間為 15 秒）。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). 這意味著在理想情況下，總長度將為 50 分鐘（25 分鐘用於平行進行的射出生產，另外 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. 在這個模擬的製造過程中，選擇了射出操作需要稍微更長的時間來完成，以代表次優性能。這是為了看看 Odoo 如何在實時中反應並通知當前的情況。

The first phase of the production in the injection process that is carried out in parallel for parts A and B/C on the injection stations 1 and 2. 在射出工序中的第一階段，即在射出工站 1 和 2 上並行進行的部件 A 和 B/C 的製造。The following (Figure 64) shows how in the beginning of the process the overview of the productions stations indicate with green circles. 以下（見圖 64）顯示了在流程開始時，生產站點的概觀指示為綠色圓圈。These circular signaling is known as Andon and although it is not always considered part of MES it is commonly an integrated feature in many MES systems. 這些信號圓圈被稱為安東（Andon），雖然它不總是被認為是 MES 的一部分，但在許多 MES 系統中通常是一個集成的功能。After the production process have been carried out with a little delay the circle turned gray and overall efficiency has been marked red on the station tabs (Figure 64). 在生產過程中有一些延遲後，圓圈變成了灰色，並且在工站標籤上標記了整體效率為紅色（見圖 64）。

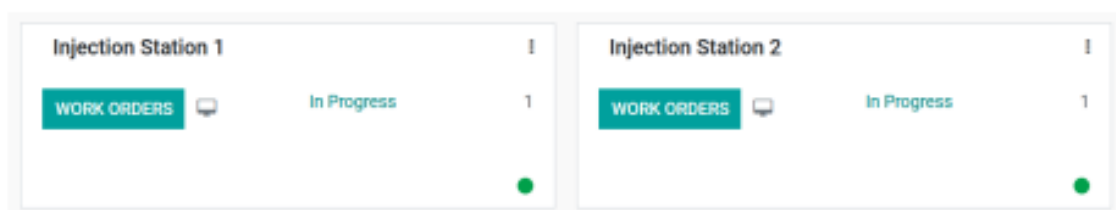


Figure 63 Workcenter overview 1

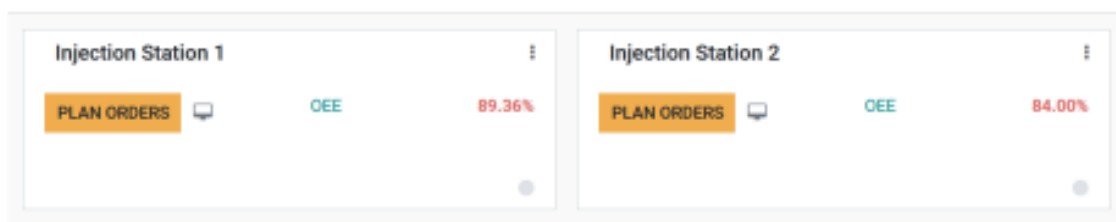


Figure 64 Workcenter overview 2

Figure 64 工作中心概覽 2

The production was carried out twice before any improvement was applied. The first improvement to be carried out were on the production process on the operation and the raw materials used. 在進行任何改進之前，生產已經進行了兩次。首先要進行的改進是對操作和使用的原材料進行生產過程的改進。More specifically, a new operation representative of an equipment upgrades on the injection machines and the replacement of the brand of plastic pellets use in the injection process (Figure 65). 更具體地說，是對射出機進行設備升級的新操作，以及更換射出過程中使用的塑料顆粒的品牌（見圖 65）。

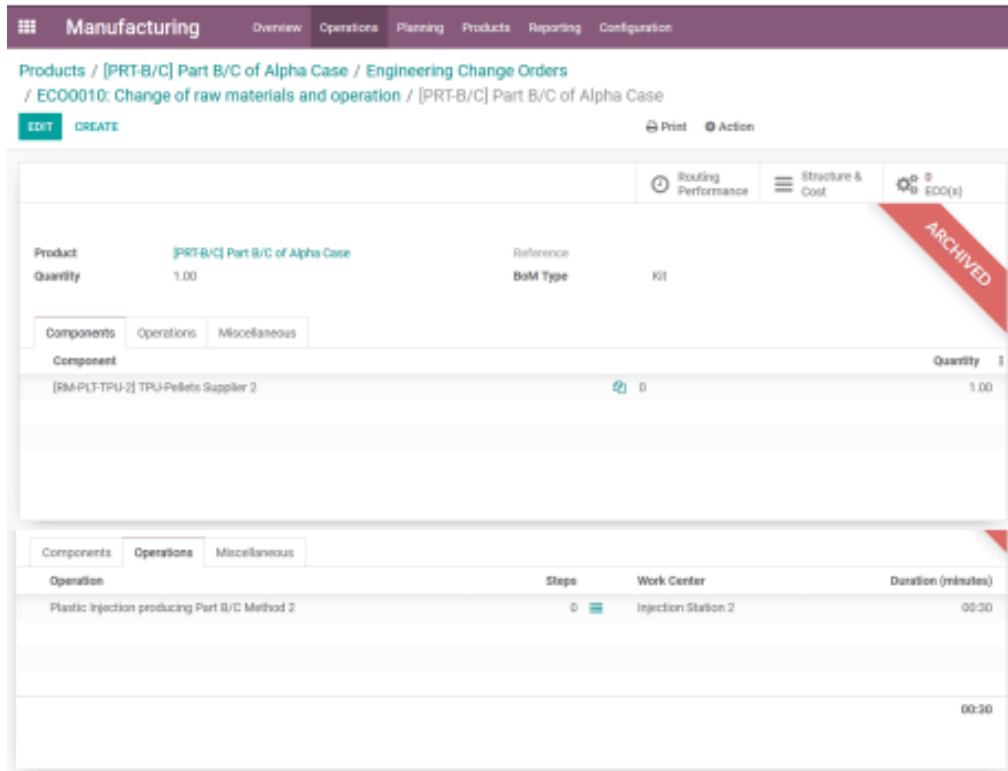


Figure 65 ECO applied to BOM
Figure 65: 應用於 BOM 的 ECO

These upgrades were applied to the BOMs of parts A and B of the Alpha case and production recommenced. After two other MOs producing 50 products each simulating an improvement to the process the following types of data were automatically made available by Odoo (Table 3): 這些升級已應用到 Alpha Case 的部件 A 和部件 B 的 BOM 中，並重新開始生產。在進行了另外兩個生產 50 個產品的 MO 來模擬流程改進之後，Odoo 自動提供了以下類型的數據（見表 3）：

Table 3 Types of data output
Table 3: 數據輸出類型

Regarding WOs:	Regarding MOs:	Overall Effectiveness:	Equipment
<ul style="list-style-type: none"> -Duration deviation -Duration per unit -Expected duration -Quantity -Real duration 	<ul style="list-style-type: none"> -Backorder sequence -Extra cost -Quantity to produce -Total quantity 	<ul style="list-style-type: none"> -Quantity 	

It should be commented that the data regarding MOs is unfortunately captured in a monthly basis as opposed to the other two categories that process data per order executed. 需要注意的是，關於 MO 的數據不幸地是以月度的方式捕獲，而不是像其他兩個類別那樣以執行的訂單為單位的。This means that since this simulation is using a trial version of the software that lasts only 14 days the graphical representation of that data offers an unimpressive view of a single point or a single column. In the long run this is a great way to display performance over time but in the case of this simulation not so much (Figure 66). 這意味著由於這個模擬使用的軟件試用版本僅持續 14 天，因此該數據的圖形表示將提供單一點或單一系列的印象不大的觀點。從長遠來看，這是一種展示隨著時間推移性能的好方法，但在這個模擬的情況下，效果並不太明顯（見圖 66）。

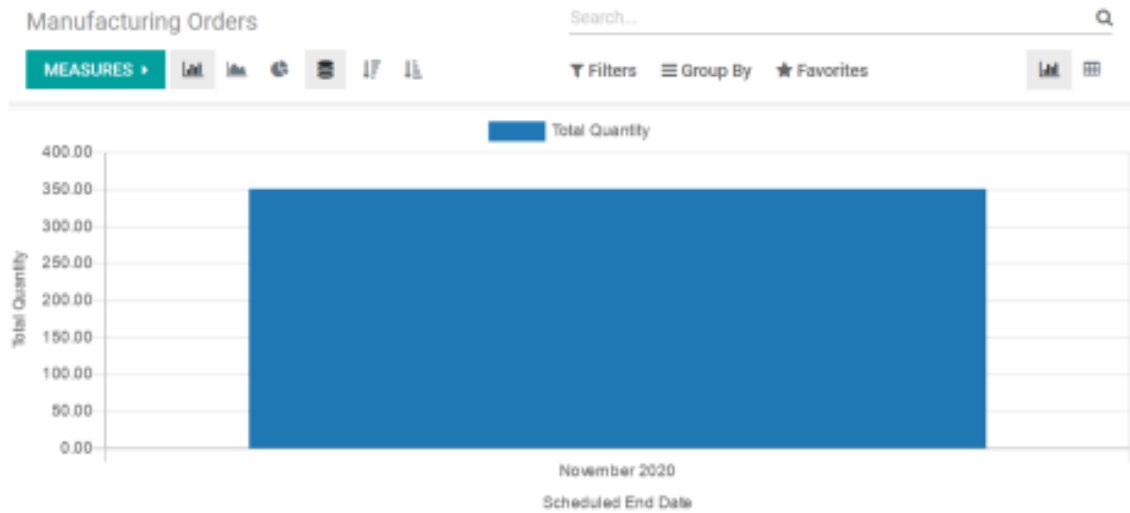


Figure 66 Total quantity regarding MO

Figure 66: 關於 MO 的總數量

All the data available can be seen in the form of bar charts, line charts or pie charts automatically generated after the time performance is registered (which happens at any moment an action is performed in a work order). 所有可用的數據可以以柱狀圖、折線圖或餅圖的形式看到，這些圖表是在時間性能被記錄後自動生成的（這發生在執行工單中的任何動作時）。 Figure 67, Figure 68 and Figure 69 are examples of the results of the 5 production runs:

Figure 67、Figure 68 和 Figure 69 是 5 次生產運行結果的示例：