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. 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. 通過 3D 打印生產原型模具遵循與產品原型相同的標準流程。到目前為止,模具被視 為與其他產品一樣的產品,這揭示了 Odoo 在表示整個過程方面的另一個小弱點。讀者 將注意到,雖然模具被視為產品(因為它正在製造),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. 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,但對於同時屬於兩者的情況,它並沒 有相應的整合。此外,如前所述,無法將 CAD 文件上傳到設備項目,也無法將設備 與一系列工具進行關聯。換句話說,Odoo 並不考慮具有 x 個鑽頭的立式鑽床可以鑽 不同尺寸的孔。從設備/維護的角度來看,它所能做的最接近的做法是將立式鑽床視 為工作站,然後將每個鑽頭尺寸視為該站點內的單獨設備,並分配設置時間。如果 忽略鑽頭是產品的事實,這是可以接受的。 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. 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,這一切都是合理的,但從 PLM 的角度來看,並不理想, 因為它顯示了應該代表相同事物的項目之間存在差距。在製造應用程序的生產過程 中,設定的是工作中心站,而不是設備(見圖 41)。在維護應用程式中,與工具是消

耗性產品的事實之間沒有任何聯繫,您可以考慮維護計劃,甚至可以設置使用壽命 參數,但由於它是設備,您無法像消耗品那樣在庫存中保留備用工具,比如鑽頭。 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. 結果是要用原型模具進行測試變得非常困難。如果按照軟件的設計進行操作,您 需要為每個模具開發的不同迭代創建單獨的工程變更訂單(ECO),並將其應用到必 要的物料清單(BOM),然後進行測試運行(見圖 56)。在這一點上,考慮模具作為 工具的維護方面就沒有意義了,因為這將意味著為每個原型模具迭代在維護應用程 序中手動填寫元數據,而從製造角度來看並不會產生任何差異。PROTO 模具項目最 終僅用於跟蹤材料並保存文件,以便改進模具。

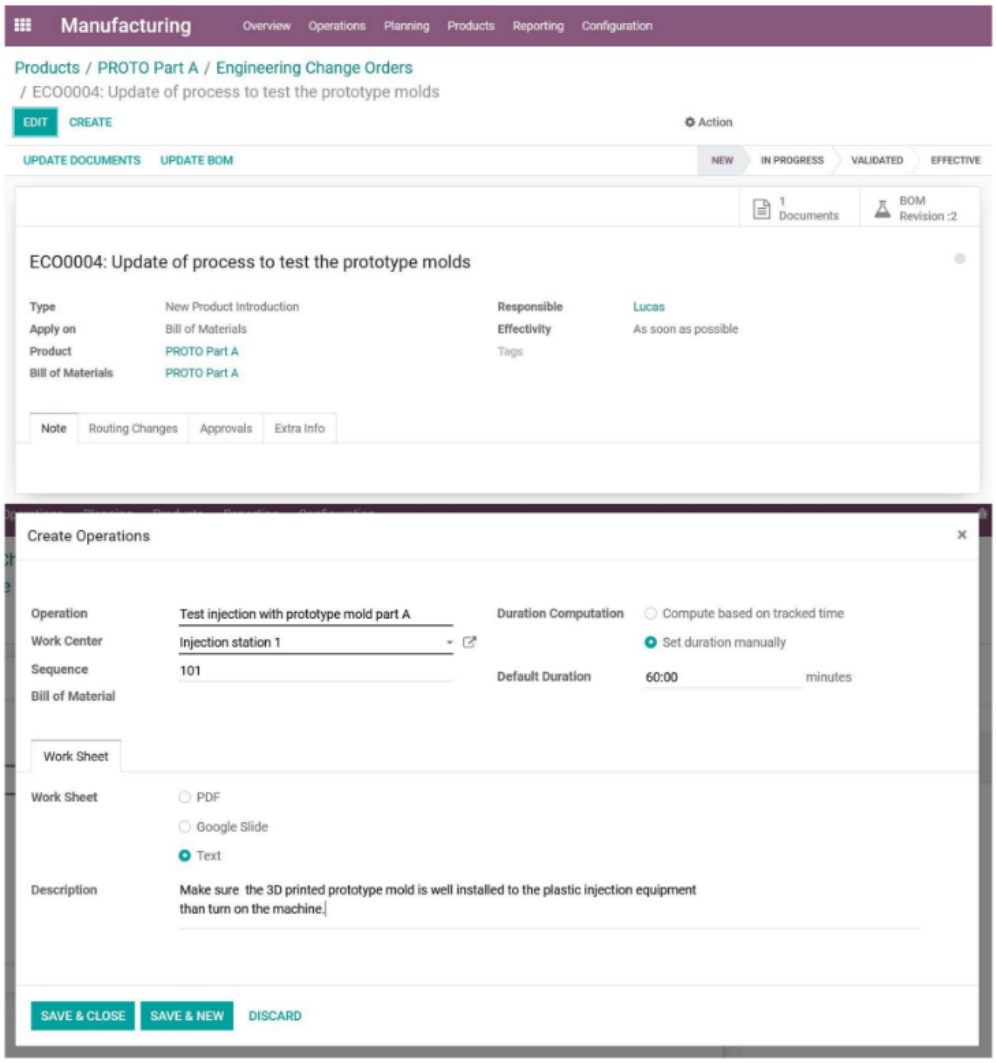

Figure 56 ECO example of update procedure of BOM

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 機殼的每個部分製作一個 3D 打印模具。然後,

將為機殼原型部件創建工程變更訂單(ECOs),以應用於部件 BOM,從而將操作從 3D 打印更新為注塑模具測試運行。 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,我們可以通過創建一個新的原型產品項目來區分產品原型和測試運 行原型,但考慮到我們快速增長的產品項目清單(見圖 57),我們得出結論,更好的 方法是在本文中修改先前製作的產品原型(使用 3D 打印),然後只使用相同的項目。 我們之所以能夠這樣做,是因為這些原型已經完成了它們的任務。

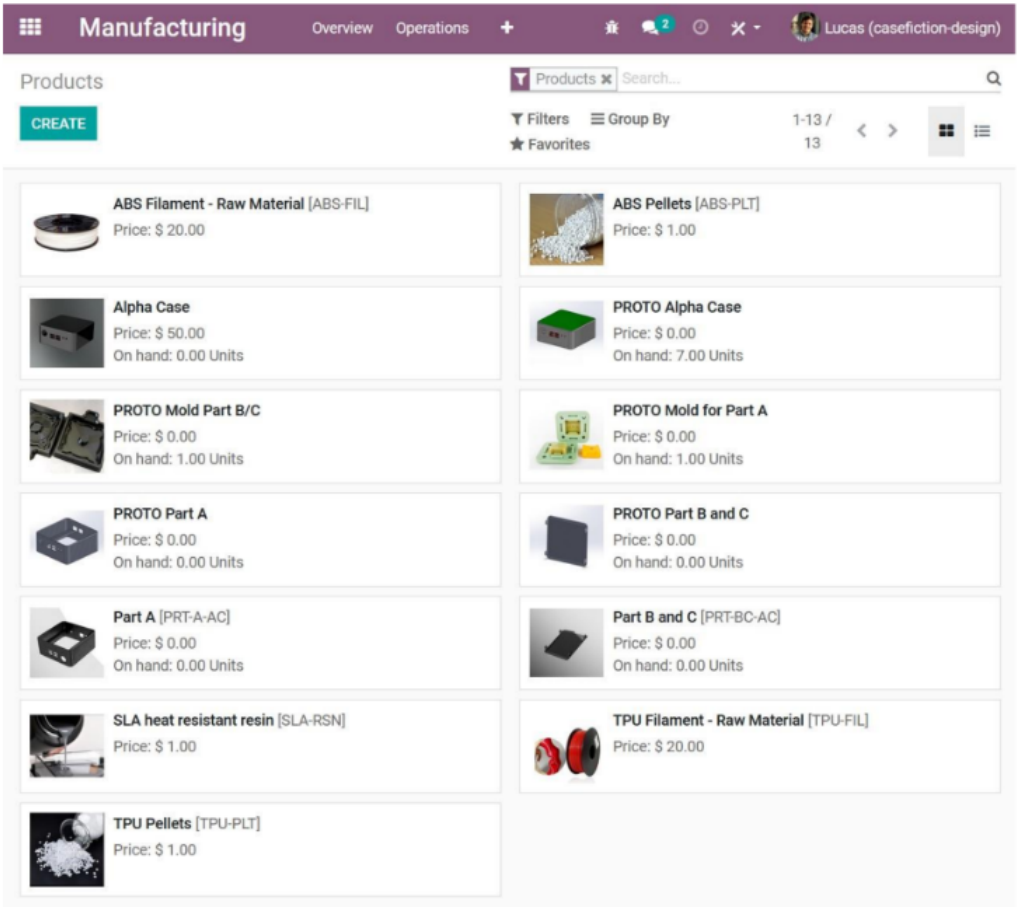

Figure 57 Overview of product items at this stage of the simulation

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). 在模具已經建立並且用於原型的 BOM 已更新以包括注射站和正確的操作(指定 模具的使用)之後,下一步是進行原型的生產測試運行。再次透過發出 MO 來完成 生成的 WO(參見前一部分的圖 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. 生產的結果用於檢查尺寸和配合度,如果需要進行更正,則再次發出ECOs,如圖 56 所示,並進行新的生產和測試迭代。這個過程將重複進行,直到產品足夠滿意,可以正式進行 CNC 機加工模具的生產,以用於大批量生產。 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了最終模具(由鋁製成)也將在公司內部生產,這是發展的 下一步。程序基本上與之前相同,只是需要在其製造之前為原材料(鋁塊)和 CNC 模具創建產品項目。創建 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,可以開始對新模具進行實際生產。代表著製作了 100 個 Alpha 機殼的製造訂 單。這標誌著從構想到生產的主要開發過程的結束(見圖 58)。

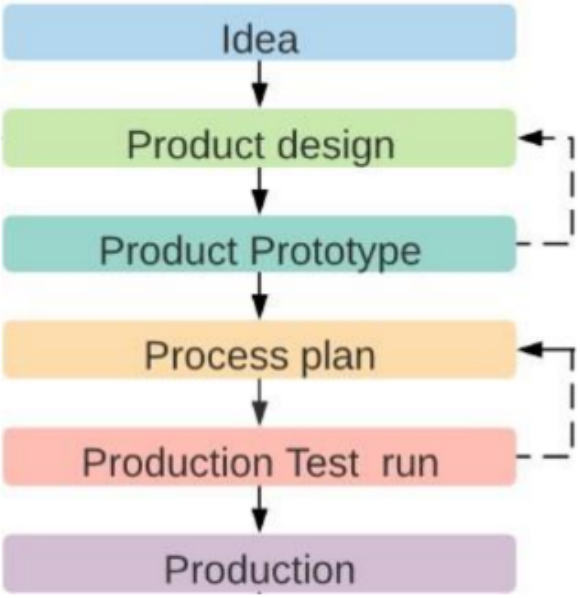

Figure 58 Main path of development from idea to production 5.4.3. Process upgrade procedure The previous sections were about the procedure that would be necessary to use the Odoo software to track change during the main development of product. As such, most of what was described focused in the use of PLM and the standard procedure of creating and 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). In other words, performance and feedback of information (and of course MES) becomes the main subject. 前幾節談到了使用 Odoo 軟件來追蹤產品主要開發過程中所需的程序。因此,大部分描述的重點都集中在使用 PLM 和創建和利用產品、BOM、ECOs、MOs、WOs 和操 作等項目的標準程序上。這一節將不同,因為現在正在進行生產,我們的想法是測 試Odoo在進行升級方面的能力(見圖59和圖60)。換句話說,性能和信息反饋(當 然還有 MES)成為主要的主題。

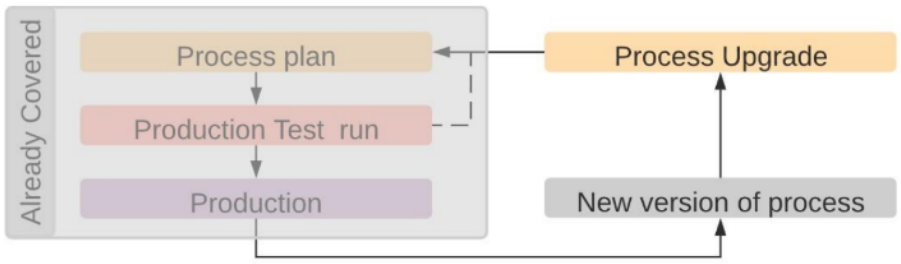

Figure 59 Sectioned diagram regarding Process upgrade procedure

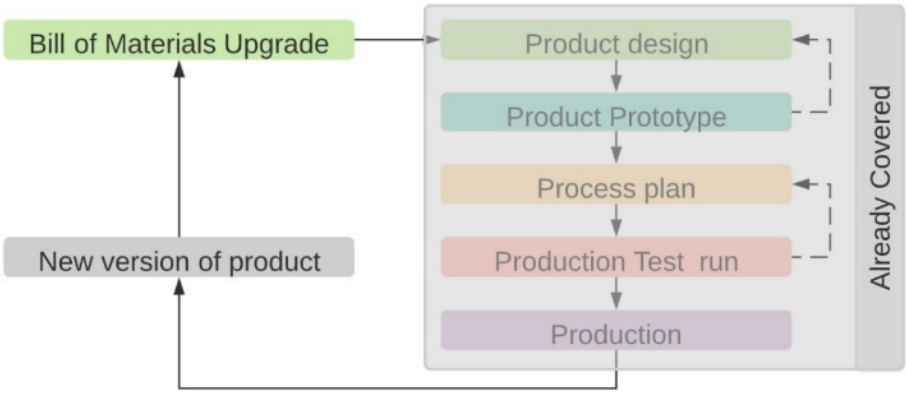

Figure 60 Sectioned diagram regarding Process development

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,變更也始終使用 ECO 功能來實施。為了提醒讀者,這種變更將應 用於的情況(見圖 61)是相關產品項目的產品概述。該列表中的每個產品項目(不是 原材料)都至少具有一個 BOM 和兩個已應用的 ECO,以表示每個產品項目的初始狀態

8 (見圖 62)。每個項目的第一個 ECO 影響產品,它包含了初始相關文件,第二個應用於 產品的 BOM,以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(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。

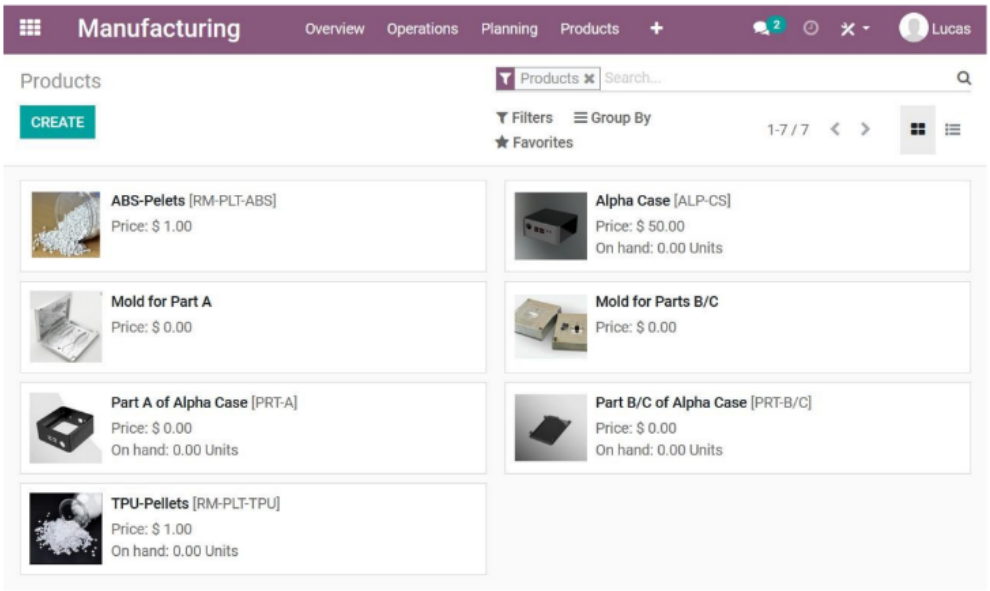

Figure 61 Relevant product items overview

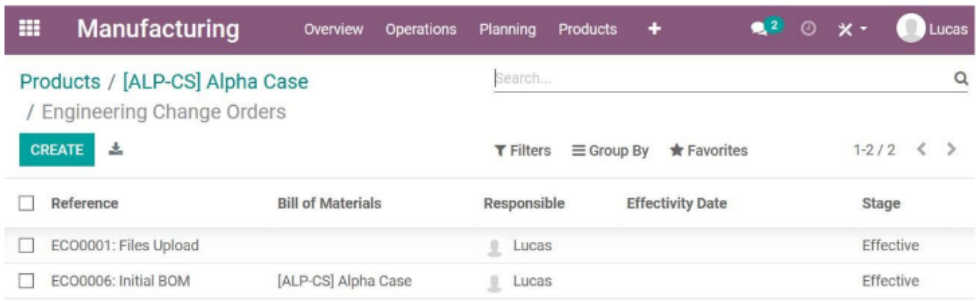

Figure 62 Example of ECOs of a product item

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,這樣我們才能 知道應用在流程上的變更如何影響生產。為此,將創建 50 個 Alpha 機殼的 MO,每 個操作預估需要 30 秒(因為需要 2 個零件 B/C,所以每個零件預計需要 15 秒)。這 意味著在理想情況下,總持續時間將為 50 分鐘(25

分鐘用於並行進行的注塑生產, 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. 在這次模擬的製造過程中,選擇讓注塑操作花費稍微更多的時間來完成,以代表 不太理想的表現。這樣做是為了看看 Odoo 如何在實時情況下反應並提供信息。 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. The following (Figure 64) shows how in the beginning of the process the overview of the productions stations indicate with green circles. These circulars signaling in known as Andon and although it is not always considered part of MES it is commonly an integrated feature in many MES systems. 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). 生產的第一階段是在注塑站 1 和 2 上進行的注塑過程,同時為零件 A 和 B/C 進 行。下圖(見圖 64)顯示了在過程開始時,生產站的概覽以綠色圓圈標示。這些圓 圈信號被稱為安敦,儘管它不總是被視為 MES 的一部分,但在許多 MES 系統中通常 是一個集成功能。在生產過程稍微延遲後,圓圈變成了灰色,並且在站點標籤上標 記了整體效率為紅色(見圖 64)。

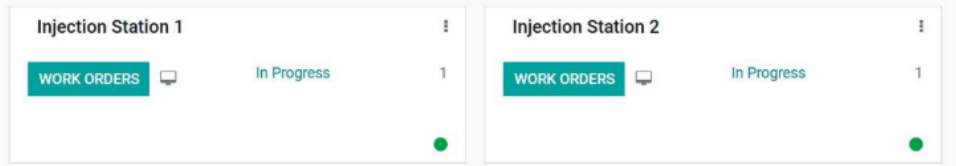

Figure 63 Workcenter overview 1

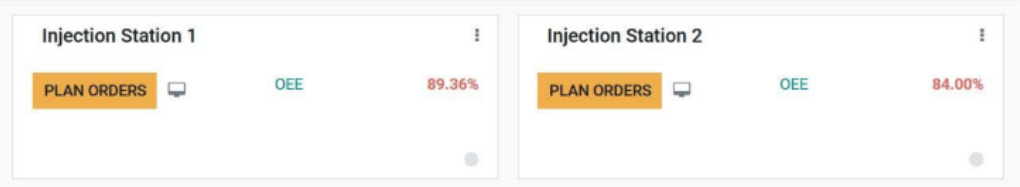

Figure 64 Workcenter overview 2

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. 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). 在進行任何改進之前,生產已經進行了兩次。要進行的第一項改進是在操作和使 用的原材料的生產過程上進行的。更具體地說,是對注塑機進行設備升級的新操作, 以及替換注塑過程中使用的塑料顆粒品牌(見圖 65)。

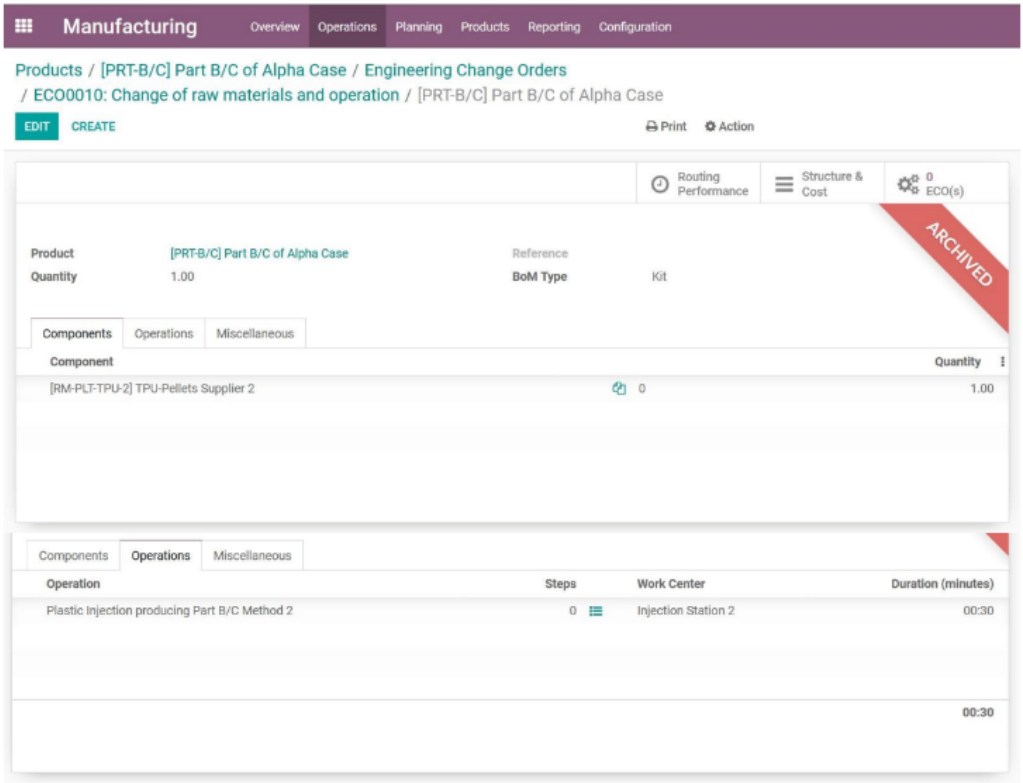

Figure 65 ECO applied to BOM

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): 這些升級已應用於 Alpha 機殼的零件 A 和 B 的 BOM,並重新開始生產。在另外兩個製 造 50 個產品的 MO 之後,模擬了對流程進行改進,Odoo 自動提供了以下類型的數據(見表 3):

Table 3 Types of data output

Regarding WOs:	Regarding MOs:	Overall Equipment Effectiveness:
-Duration deviation -Duration per unit -Expected duration -Quantity -Real duration	-Backorder sequence -Extra cost -Quantity to produce -Total quantity	-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. 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). 應該注意到,關於 MO 的數據不幸地是以每月為基礎捕獲的,而不是其他兩個類 別,它們以執行的每個訂單來處理數據。這意味著,由於這個模擬使用的是一個只 持續 14 天的軟件試用版,該數據的圖形表示將提供一個單點或單列的不令人印象深 刻的視圖。從長遠來看,這是一種很好的方法來顯示隨時間變化的性能,但在這個 模擬案例中則不太適用(見圖 66)。

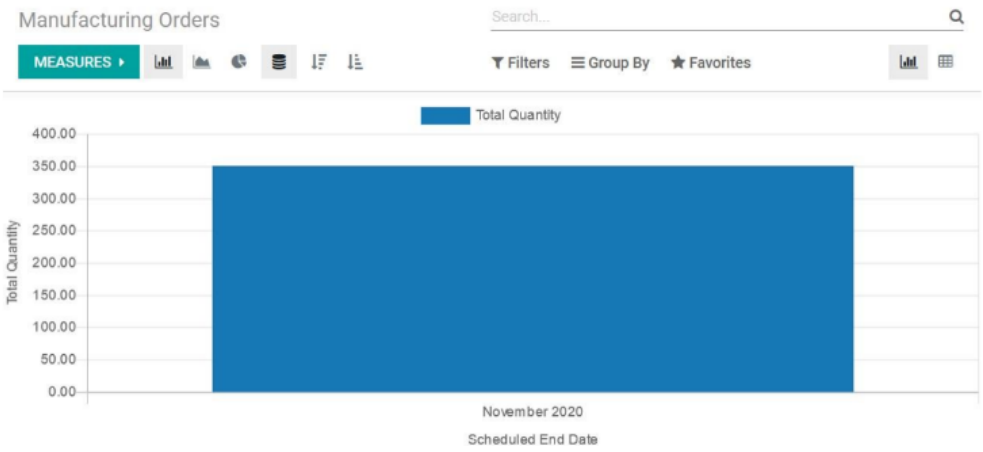

Figure 66 Total quantity regarding MO

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). Figure 67, Figure 68 and Figure 69 are examples of the results of the 5 production runs: 所有可用的數據都可以以條形圖、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(這發生在對工作訂單執行任何操作時)。圖 67、圖 68 和 圖 69 是 5 次生產運行的結果的示例:

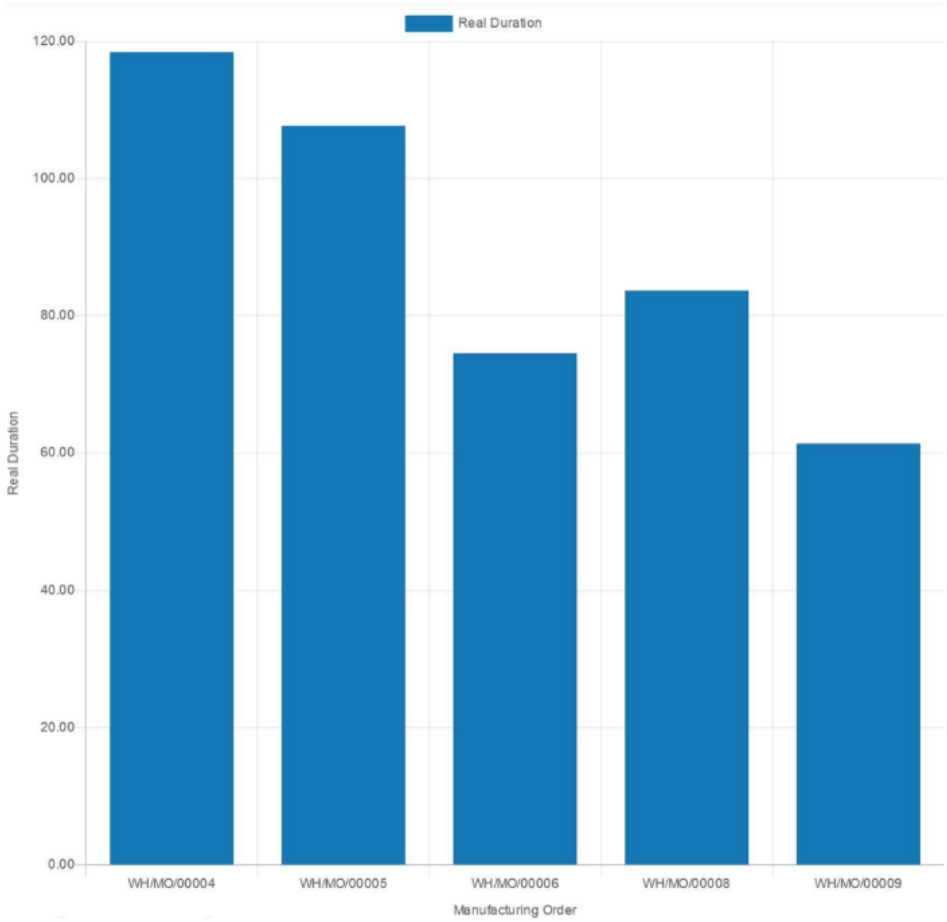

Figure 67 Real duration regarding work orders

Something worth mentioning here is that whenever Odoo mentions quantity or duration it is referring to amount per workorder summed (the system does not care if the operations are being carried in parallel). So, on our simulation, making 50 units using 3 operations that should take 30 seconds each the estimated “duration” to be recorded ideally here is 75 minutes per MO. 在這裡值得一提的是,每當 Odoo 提到數量或持續時間時,它指的是每個工作訂 單加總的數量或持續時間(系統不會在意操作是否並行進行)。因此,在我們的模擬 中,如果使用 3 個每個應該花費 30 秒的操作來製作 50 個單位,理想情況下應該記 錄的“持續時間”為每個 MO 75 分鐘。

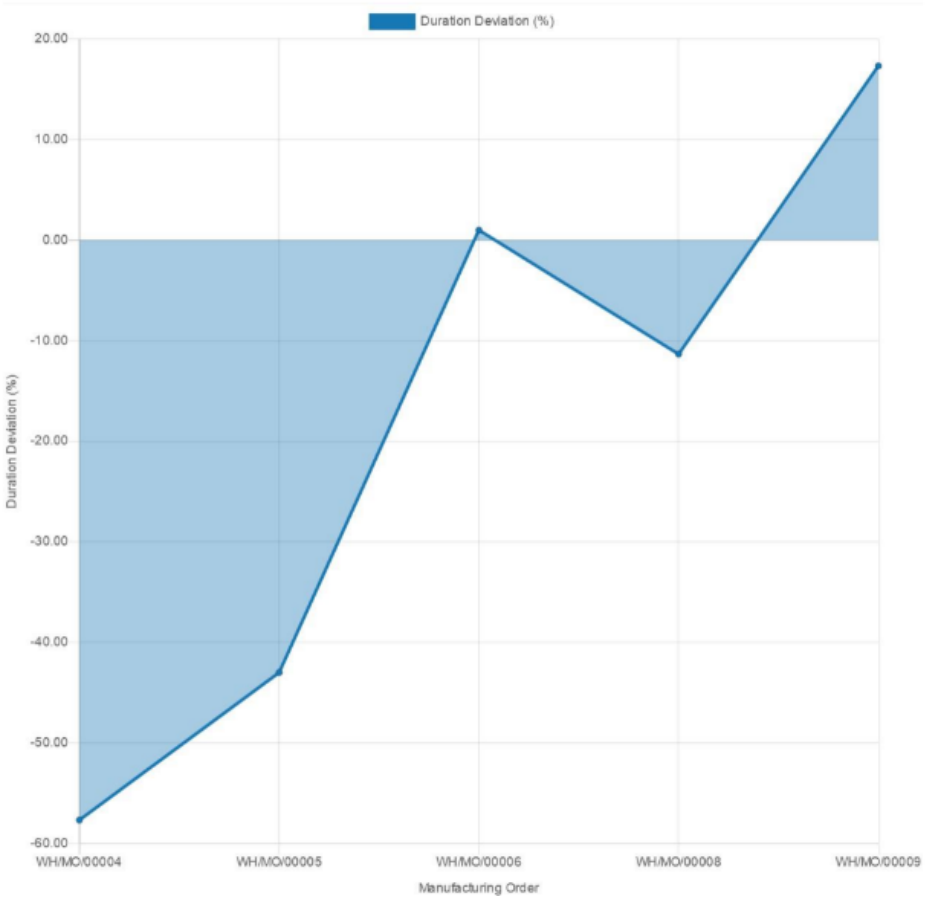

Figure 68 Duration variation regarding work orders

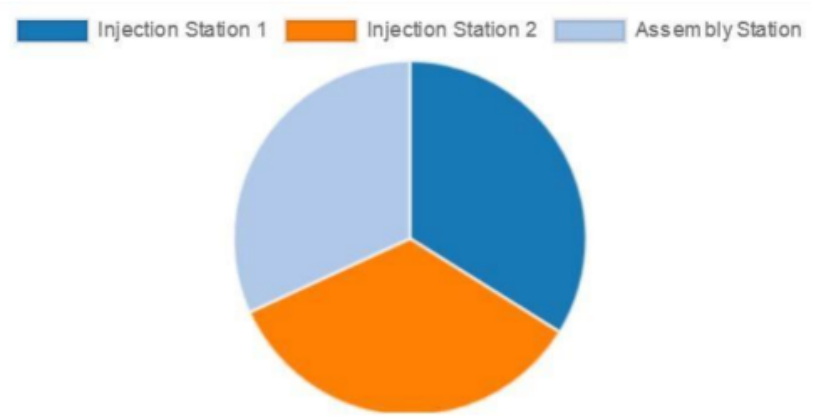

Figure 69 Overall equipment effectiveness

The astute reader will notice that all the data mentioned so far is derived from the time to completion of the operations been carried out, the related amount to the MO and the workcenter utilized. Even so it is impressive how much information can be drawn especially considering that it is all generated automatically.

細心的讀者會注意到,到目前為止提到的所有數據都是從正在進行的操作完成所花費的時間、相關的 MO 數量以及使用的工作中心派生出來的。即便如此,令人印象深刻的是,可以獲得多少信息,特別是考慮到這一切都是自動生成的。