行政院國家科學委員會專題研究計畫 期末報告

限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究(I)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 101-2221-E-216-016-
執 行 期 間 ：101 年 08 月 01 日至 102 年 07 月 31 日
執 行 單 位 ：中華大學企業管理學系

計 畫 主 持 人 ：吳鴻輝

報 告 附 件 ：出席國際會議研究心得報告及發表論文

公 開 資 訊 ：本計畫可公開查詢

中 華 民 國 102 年 10 月 15 日

中 文 摘 要 ： LED 晶粒製造(LED-CM)為 LED 產業中重要的一環，晶粒製造過程由於製程技術的特殊性，容易造成晶粒光電性規格不均勻及良率不穩之問題，一般 LED 晶粒產出符合客戶需求規格的比率約只有 6~8 成左右。因而在接單式生產時，當一張訂單出現產出不足時，生管必須以補投料方式，補投該訂單所缺的不足量。雖然客戶能體諒 LED-CM 製程產出不穩之特性，但會要求補投單必須以急單的趕工方式生產，以減低該訂單產出不足的影響。因此 LED-CM 廠在大量補投單的趕工壓力下，如何確保這些補投單的如期出貨以及如何降低這些補投單對正常單交期的衝擊，即為 LED-CM 廠所面對的挑戰。
本研究提出了一套 DBR 的強化模式以改善 LED-CM 廠所面對的補投單挑戰。這套 DBR 強化模式主要強化了補投單在 DRUM 的合理插單及在投料計畫的立即投料需求。其次本計畫亦設計了模擬實驗，以驗證本模式的可行性及效益。實驗結果證明，不論在平均流程時間或補投單交期回覆誤差等績效，本模式都優於 EDD 及 EDD+補投單優先模式。

中文關鍵詞： 關鍵字：限制驅導式排程技術、LED 晶粒製造、補投單、趕工管理、插單模式

英 文 摘 要 ： The LED chip manufacturing (LED-CM) is an important process in the LED supply chain. The make-to-order production is a general model for the LED-DM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-CM plants, the effective order fulfillment is low and variety. Therefore, the production planner will thus confront the issue of an insufficient output of a manufacturing order (MO). Although material re-issued is allowed by the customers, this re-issued lot is required to be rush order. The LED-CM plant thus confront the issues of on-time delivery of those re-issued lots and the impact on the normal lots.
An enhanced models of Drum-Buffer-Rope (DBR) system for LED-CM plants is proposed in this project to improve those issues mentioned above. This model provides the hot lot schedule in DRUM and immediate material-issued in ROPE. A simulation and experiment model is also designed in this project to demonstrate the feasibility and effectiveness of this model.

Based on the simulation study, this model surpasses the traditional EDD model or EDD + hot lot first model in mean flow time or the deviation between forecast due-date and actual delivery.

英文關鍵詞： Key Words: Drum-Buffer-Rope(DBR), LED chip manufacturing (LED-CM), Re-issued lot, Expediting model, Hot lot scheduling

行政院國家科學委員會補助專題研究計畫 □期中進度報告

■期末報告

（計畫名稱）**限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究(I)**

Enhanced Models of Drum-Buffer-Rope (DBR) System for LED Chip Manufacturers(I)

計畫類別：■個別型計畫 □整合型計畫
計畫編號：NSC 101-2221-E-216-016-
執行期間： 101 年 08 月 01 日至 102 年 07 月 31 日

執行機構及系所：中華大學 企業管理學系

計畫主持人：吳鴻輝
計畫參與人員：

本計畫除繳交成果報告外，另須繳交以下出國報告：
□赴國外移地研究心得報告
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■出席國際學術會議心得報告及發表之論文
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中 華 民 國 102 年 10 月 1 日

中文摘要

LED 晶粒製造(LED-CM)為 LED 產業中重要的一環，晶粒製造過程由於製程技術的特殊性，容易造成晶粒光電性規格不均勻及良率不穩之問題，一般 LED 晶粒產出符合客戶需求規格的比率約只有 6~8 成左右。因而在接單式生產時，當一張訂單出現產出不足時，生管必須以補投料方式，補投該訂單所缺的不足量。雖然客戶能體諒 LED-CM 製程產出不穩之特性，但會要求補投單必須以急單的趕工方式生產，以減低該訂單產出不足的影響。因此 LED-CM 廠在大量補投單的趕工壓力下，如何確保這些補投單的如期出貨以及如何降低這些補投單對正常單交期的衝擊，即為 LED-CM 廠所面對的挑戰。

本研究提出了一套 DBR 的強化模式以改善 LED-CM 廠所面對的補投單挑戰。這套 DBR 強化模式主要強化了補投單在 DRUM 的合理插單及在投料計畫的立即投料需求。其次本計畫亦設計了模擬實驗以驗證本模式的可行性及效益。實驗結果證明，不論在平均流程時間或補投單交期回覆誤差等績效，本模式都優於 EDD 及 EDD+補投單優先模式。

關鍵字：限制驅導式排程技術、LED晶粒製造、補投單、趕工管理、插單模式

Abstract

The LED chip manufacturing (LED-CM) is an important process in the LED supply chain. The make-to-order production is a general model for the LED-DM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-CM plants, the effective order fulfillment is low and variety. Therefore, the production planner will thus confront the issue of an insufficient output of a manufacturing order (MO). Although material re-issued is allowed by the customers, this re-issued lot is required to be rush order. The LED-CM plant thus confront the issues of on-time delivery of those re-issued lots and the impact on the normal lots.

An enhanced models of Drum-Buffer-Rope (DBR) system for LED-CM plants is proposed in this project to improve those issues mentioned above. This model provides the hot lot schedule in DRUM and immediate material-issued in ROPE. A simulation and experiment model is also designed in this project to demonstrate the feasibility and effectiveness of this model. Based on the simulation study, this model surpasses the traditional EDD model or EDD + hot lot first model in mean flow time or the deviation between forecast due-date and actual delivery.

Key Words: Drum-Buffer-Rope(DBR), LED chip manufacturing (LED-CM), Re-issued lot, Expediting model, Hot lot scheduling

一. 前言

LED 晶粒製造(LED-CM)為 LED 產業中重要的一環，晶粒製造過程由於製程技術關係，容易造成晶粒光電性規格不均勻及良率不穩，加上市場上客戶應用差異對電性規格的要求多元，因此在接單式生產型態下的 LED-CM 廠中生產與銷售之間的管理是相當有挑戰性的[1,2]。一般 LED 晶粒產出符合客戶需求規格的比率約只有 6~8 成左右。生產管理者(以下稱生管)則是這產銷協調的重要橋梁。圖 1 為 LED-CM 廠之訂單履約管理流程，生管經由訂單得知客戶需要的品名、光電性規格、數量與需求日等資訊，生管必須先確認庫存是否能滿足客戶需求，如否則須參考產品的”產出分布”及”良率”安排投產計畫，並回覆客戶交期。當計畫擬定完成，則建立工單並確認投產產能限制及安排適合磊晶片投料。投料完成後則需監控生產線產出符合工單狀況，以確保客戶需求能如期達交[2,5,16]。

晶粒製造的前段製為蒸鍍、顯影、蝕刻、熔合及研磨等加工，為決定電性的重要製程，但電性資料卻是要到點測後才能得知，此時生管必須確認產出規格是否有符合當初所預期的產出分佈，進而確認是否會影響達交數量。

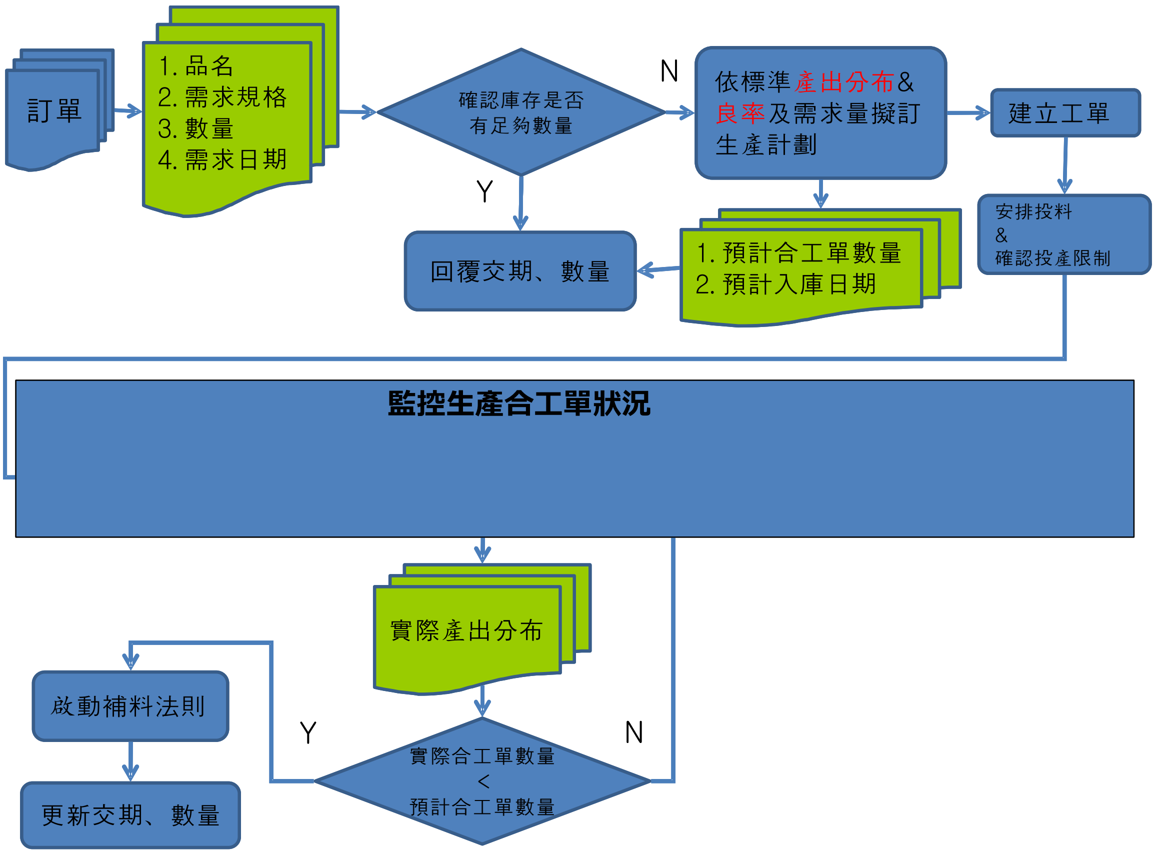


圖 1 LED-CM 廠之訂單履約管理流程

LED 晶粒生產過程中會造成光電性規格的不均勻，圖 2 為磊晶加工成 LED 晶粒時的亮度電性分佈示意圖，通常磊晶的內部的晶粒均勻性較高，也愈能符合預期的規格。以圖 2 為例，目標是要打 Grade4 及 Grade5，因此中心區域 Grade4、Grade5 的比例會較高，愈往外圍亮度愈暗，產出數量也較少，以規格等級與數量的分布看來，較接近常態分配關係，如圖 3 所示，同時也會製程的不穩定而造成分配峰形的改變或產出平均(μ)的偏移。

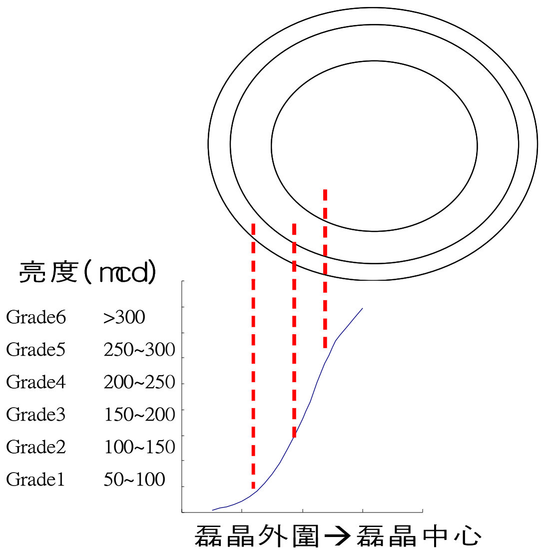


圖 2 LED 晶粒亮度分佈示意圖

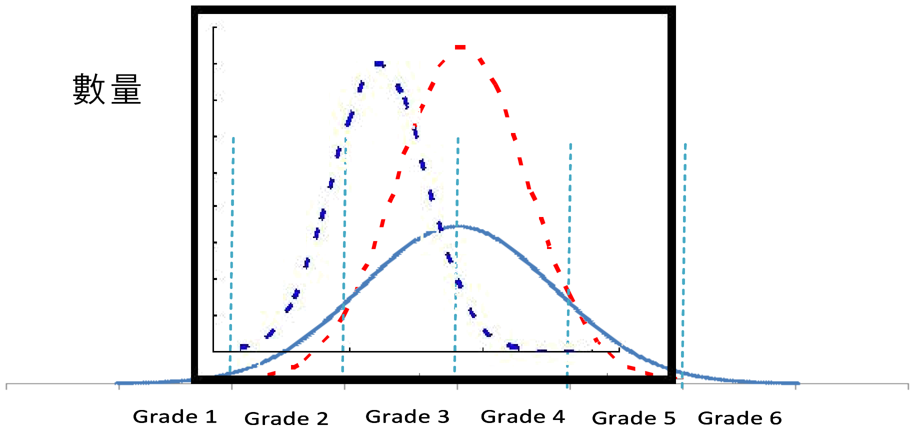


圖 3 LED 亮度規格產出分佈

由於此產出特性，生管在監控產出時所面臨的問題，除了製程良率外還需確認規格、數量是否如計畫所預期的分佈。當產出分布符合預期分佈時，工單將能順利進行接下來的製程，如過產出分佈不如預期，導至目標規格數量不足時，生管必需進行補投計畫並更新交期。此特性引申出的另一個問題是庫存容易因產出不符工單規格，無法出貨導致庫存上升，因此庫存的調配對於產銷平衡是相當重要的。

現有 LED-CM 廠的生管都是以其經驗在運作，在排程機制上常常會以交期法則(EDD)來決定投產先後，針對上述問題較難有顯然的改善。例如吳與李[2]從生產管理的角度，歸納了四點實務上可能面臨的問題：1. 產出分布不穩定與客戶需求多變，易造成庫存上升與未能順利達交的風險。2. 庫存與 WIP 管理的重要，必須靈活的調度庫存與 WIP，減少不必要的浪費是很重要的。3.逐批 WIP 確認達交狀況困難，生管必須有良好的管理方法來確保交期的順利達交。4.. 生管人才訓練困難，生管面對問題總是依經驗處理，對新人來說是需要時間培養的。

因此 LED-CM 廠若要輔助生管克服上述問題，進而提升整廠的合單率、訂單達交率、縮短製造時間以及降低存貨水準等，勢必要引進先進有效的管理方法或系統。在業界有許多可用來改善接單式生產交期品質的方法，例如及時化生產(JIT)、先進生產排程系統(Advanced Production Scheduling System)或限制理論(TOC)等。但其中以架構在 TOC 上的限制驅導式排程技術(Drum-Buffer-Rope, DBR)[3,12]是為最可行方法之一，是本計畫所要探討的管理方法。

DBR 是由高瑞博士(Dr. E. M. Goldratt)於 1986 年所提出的現場排程與管理技術[11,12]，是一套建立在 TOC 管理哲學上的生產管理方法或解決方案。這套技術已成功的應用在愈來愈多的國內外產業

[4,6-10,12-14]，而且改善成效非常的快且大[10]。

雖然已有愈來愈多的文獻探討 DBR 成功在產業的應用，其次為了在不同複雜工廠的應用，亦提出了不少的 DBR 改善或強化模式，然而並無在類似 LED-CM 廠這種製程不穩定且兼具迴流複雜性之應用。本研究將針對 LED-CM 廠不穩定製程及經常需要補投工單等特性以 DBR 排程平台為基礎，來建立上述 LED-CM 廠問題的解決模式。

本研究因此提出了一套 DBR 的強化模式以改善 LED-CM 廠所面對的補投單挑戰。這套 DBR 強化模式主要強化了補投單在 DRUM 的合理插單及在投料計畫的立即投料需求。其次本計畫亦設計了模擬實驗，以驗證本模式的可行性及效益。

二. DBR 的強化模式

LED 晶粒生產過程中的由於光電特性產出容易呈現不均勻分布，及良率的不穩，導致合訂單規格的中 BIN 率容易降低，這時如果庫存無法彌補損失的數量，這時即需立即補投訂單並以急件方式趕工[16]。如圖 4 所示，點測站常常會形成 LED-CM 廠的瓶頸站，此站同時也是得知合工單量是否足夠的重要站別。透過 DBR 排程機制，將工單依瓶頸站的節奏排出 DRUM 順序，在回推 CCR Buffer，排出投料節奏(RPOE)，瓶頸站按 DRUM 順序進行加工，而非瓶頸站亦配合 DURM 節奏指派加工順序。當工單完成瓶頸站加工，即判斷所點測出的光電性是否符合預期之工單規格，如果能滿則工單預成量，則繼續接下來的制程，反之如果不能滿足工單預成量，即馬上補投工單。本研究針對此特性所提出 DBR 排程機制，假如捕投單 x 已產生，則將補投單 x 與原來 DRUM 中未生產的工單做比較，來決定補投單的順序，如果補投單 $_x$ 產生時間點+急件工單 BUFFER 小於工單 $_y$ 瓶頸站開始加工時間，即將補投單 $_X$ 安插工單 $_y$ 前面順序，補投單 $_X$ 投單時間即為補投單 $_x$ 產生時間點。

三. 模擬和實驗

為了分析本研究所提 DBR 排程機制使用在 LED-CM 廠的優劣，因此將使用 VB 來模擬 LED-CM 廠製程，與現行實務常使用的法則來做比較，分別為 EDD 排程機制(如圖 5)及補投單優先之 EDD 排程機制(如圖 6)，比較三種法則在不同的補投水準下所影響工單流程時間及補投單交期回覆之準確度情況。

LED-CM 模擬廠有八個主要站點，分別為前段的蝕刻、蒸鍍、顯影、黏合、切割，後段的點測、分類、目檢，其代號如圖 7 所示。

機台的產能狀況及各站加工時間如表一所示，E、D、P、B 為 EPI 狀態作業，作業時間是以整批來計算，C、Po、S、I 為 CHIP 狀態作業，因此作業時間以 chip 顆粒數來計算，每一機台一次只能針對一批工單作業。

同時模擬三種產品分別為 A、B、C，每種產品有三種規格例如 A 產品有 A1、A2、A3 等三種規格，產品的製程分別如表二，不同規格有不同的中 BIN 率。

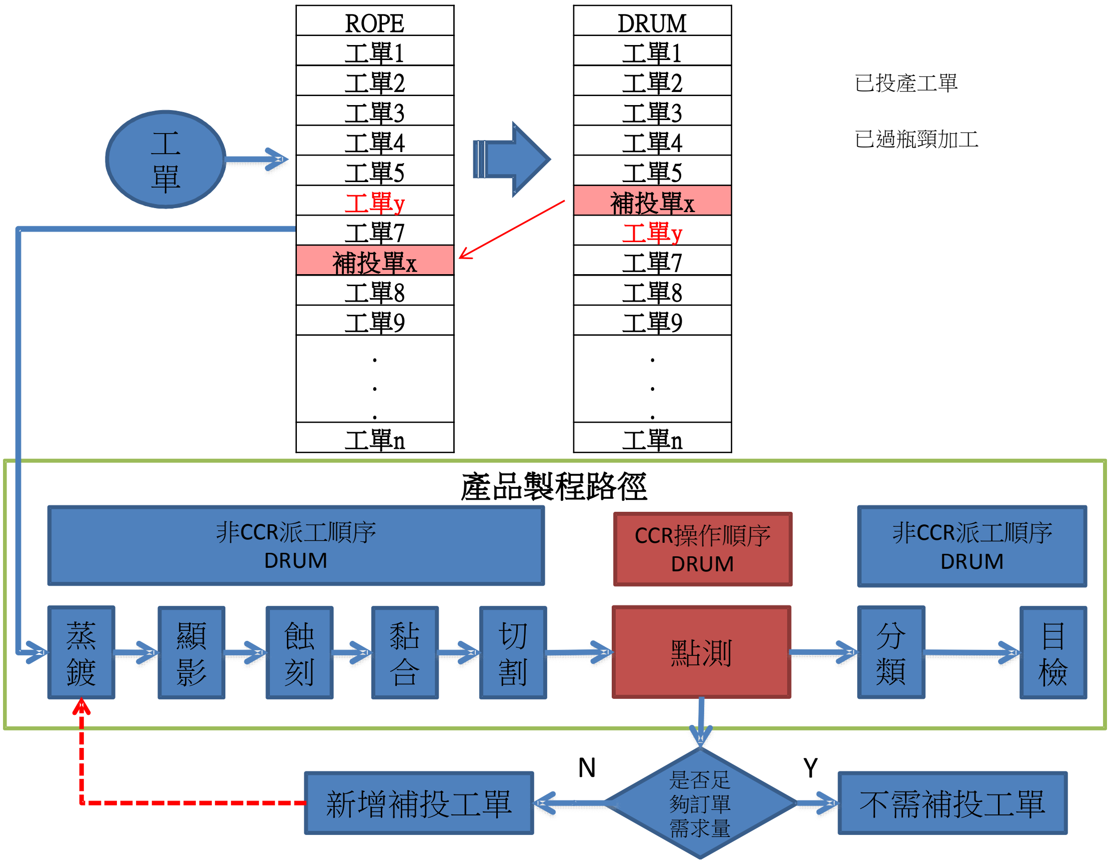


圖 4 DBR 的強化排程機制

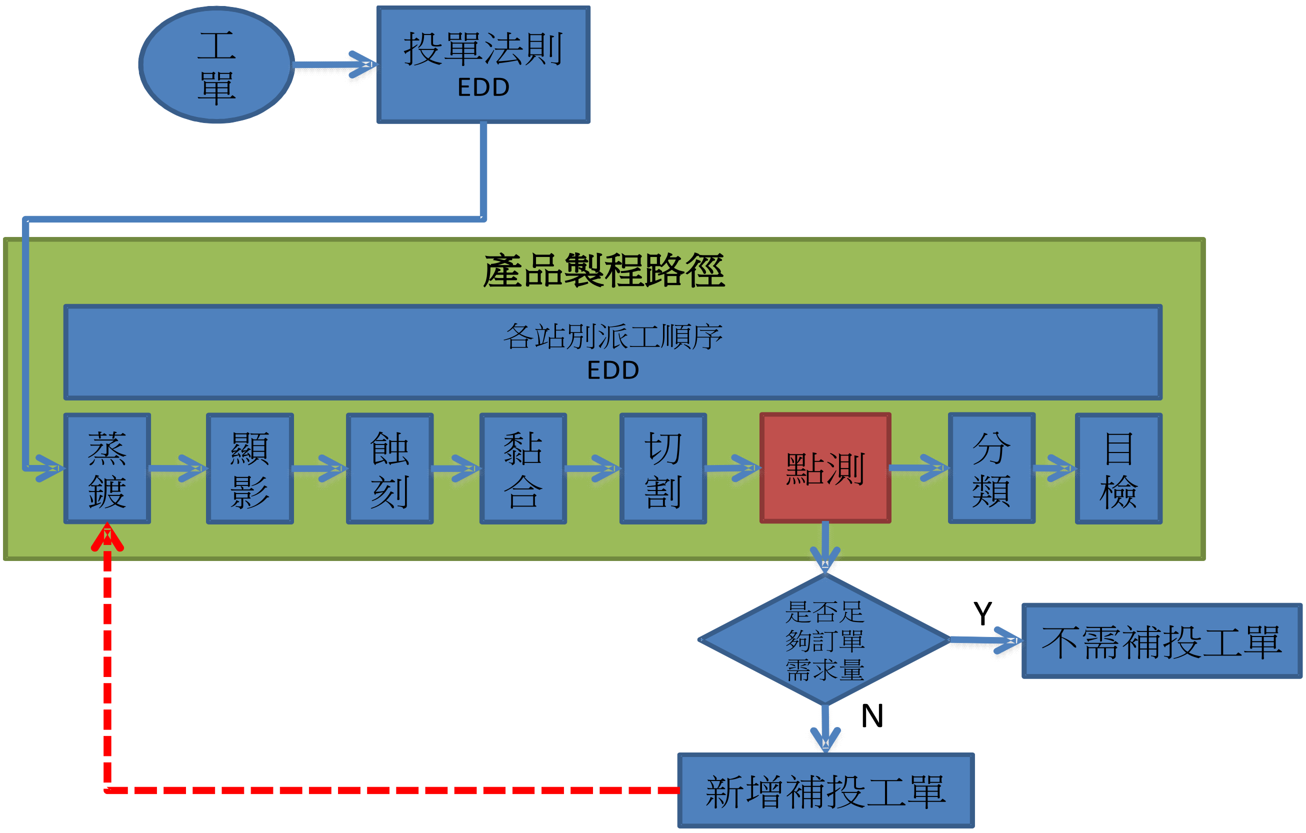


圖 5 EDD 排程機制

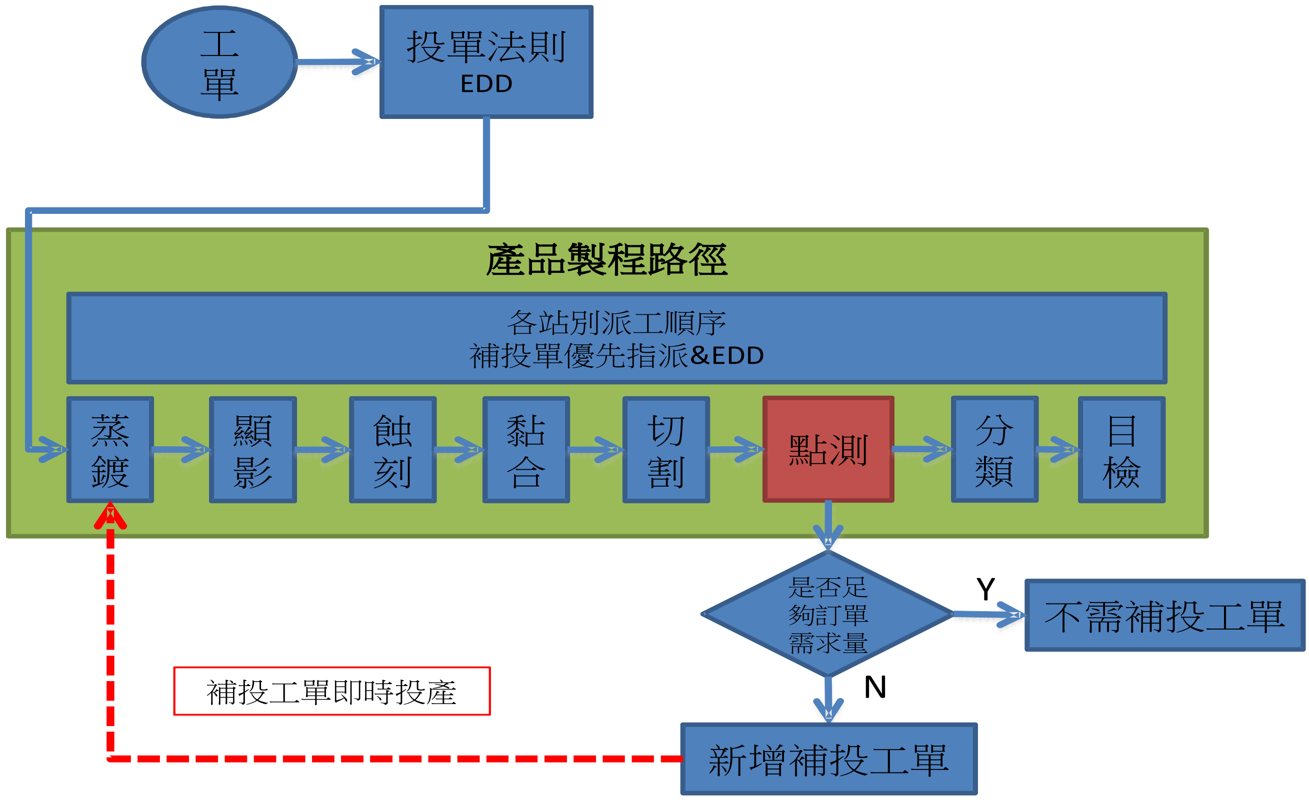


圖 6 補投單優先之 EDD 排程機制

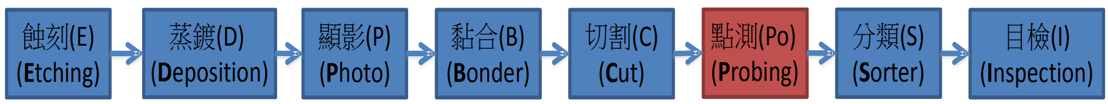


圖 7 **LED-CM 廠製程與代碼說明**

表一 站別產能

站別	E	D	P	B	C	Po	S	I
機台數	3	2	3	2	1	1	2	2
整批作業時間(天)	2.5	2	2.5	2	-	-	-	-
每粒chip作業(天)	-	-	-	-	0.025	0.042	0.035	0.035

表二 產品製程

產品	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12
A	E	D	P	B	C	Po	S	I	-	-	-	-
B	E	D	P	E	D	P	B	C	Po	S	I	-
C	E	D	P	B	E	D	P	B	C	Po	S	I

圖 8 為 LED-CM 廠之模擬架構，工單隨機產生並同時產生六種資訊，來單時間、品名、需求量、交期、製程、規格，再將工單依不同排程法則排出投料順序且按順序進行投料，而各站的加工順序則依不同的機台派工法則的決定工單的加工順序，其中當工單通過點測站(Po)加工完成時，立即判斷該工單數量是否能滿足預期的需求量，如不能滿足則立即產生補投訂單，再透過排程法則安排補投單順序。

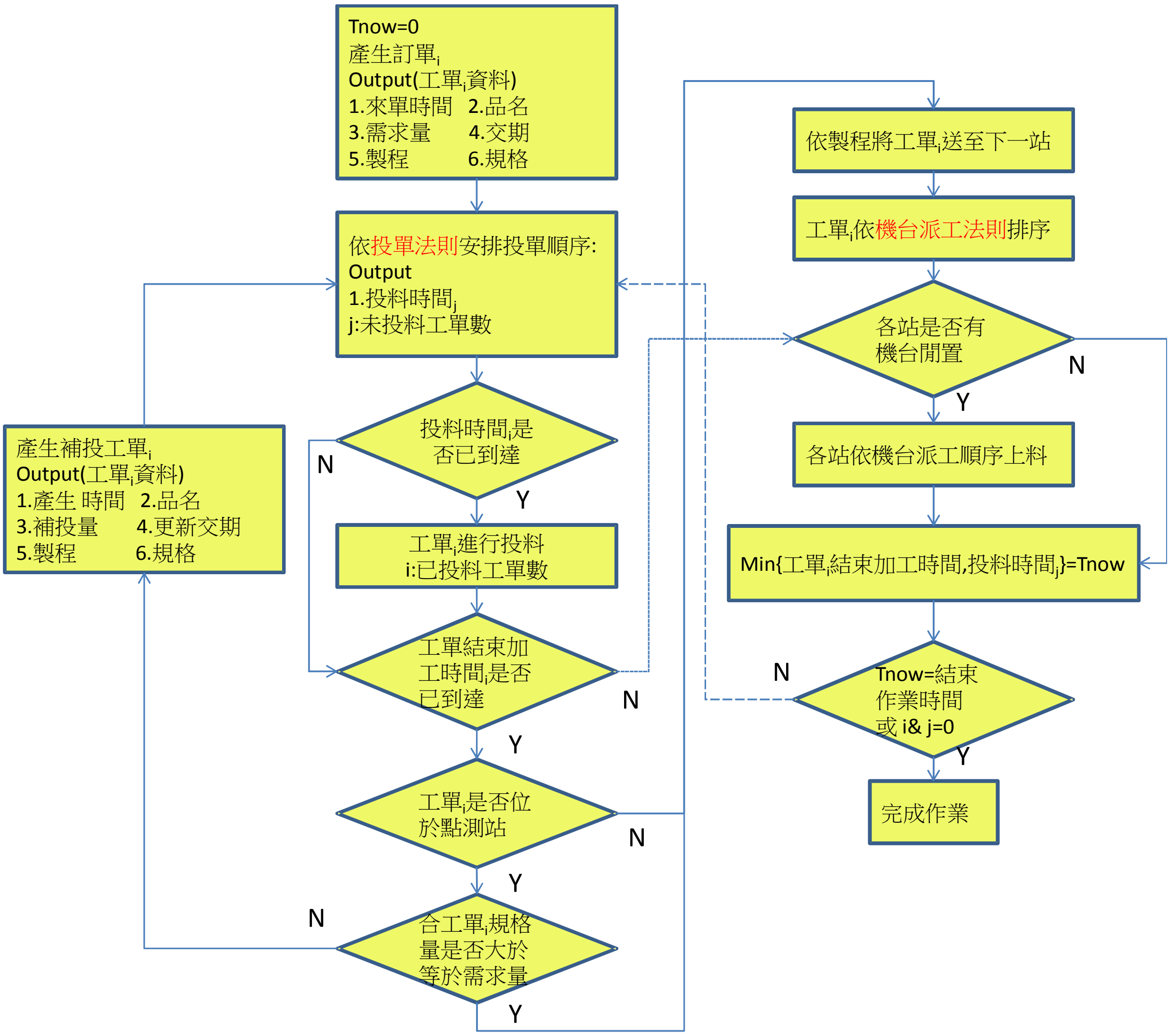


圖 8 LED-CM 廠之模擬架構

四. 實驗設計

為了確定有效實驗的長度，工單產生頻率在不同水準的指數分配下(λ=0.2、λ=0.21、λ=0.22、λ=0.23)，3000 天內隨機以指數分配產生工單，分別產生 665、699、725、775 張工單，以 EDD 排程機制作先前測試實驗，得到的 CCR 平均使用率如圖 9，圖中可看出時間點在 250~2900 天期間系統是較穩定的，因此可以判定當產生訂單天數為 3000 天時，統計 250~2900 天的資料是有效益的。

為了比較排程機制對於 LED-CM 廠常態補投特性的優劣，本實驗將設計不同補投單比例來測試三種排程機制，但為了建立在公平的水準下，必需要讓瓶頸站使用率在同一水準下做測試。表三為工單產生頻率與不同補投單比例所造成 CCR 使用率，由表可以得知當 λ=0.198 補投率在 30%時，CCR 的使

用率為 95.55%，λ=0.21 補投率在 20%時，CCR 的使用率為 95.93%，λ=0.22 補投率在 10%時，CCR 的使用率為 95.79%，這三種條件下 CCR 的使用率水準相當，因此本實驗將此三種條件設定為實驗因子。

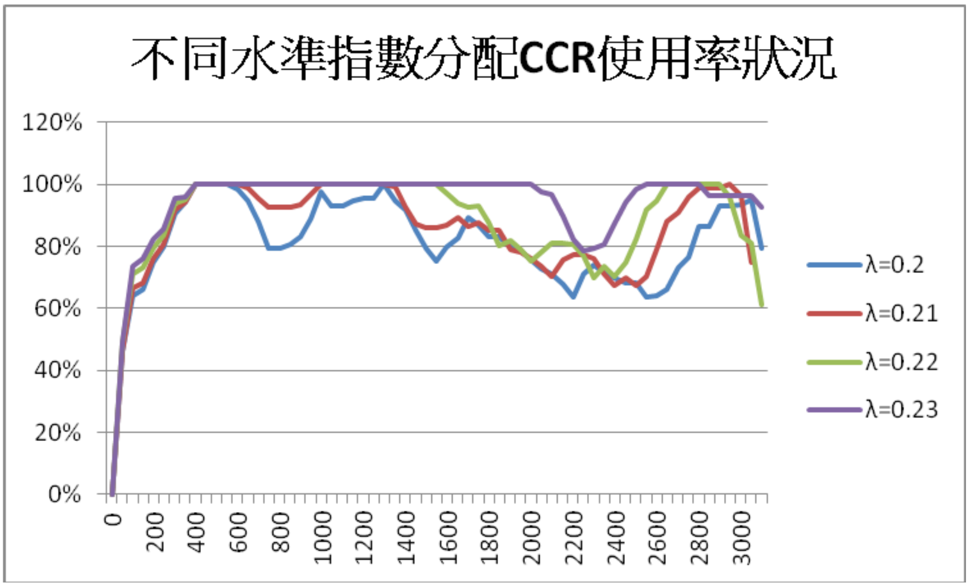


圖 9 工單產生頻率在不同水準指數分配下 CCR 使用率狀況

表三 訂單到達(產生)頻率與不同補投單比例所造成 CCR 使用率

訂單到達頻率	補投單所占比例		
指數分配(λ)	10%	20%	30%
λ=0.198	87.49%	90.50%	**95.55%**
λ=0.21	92.88%	**95.93%**	98.69%
λ=0.22	**95.79%**	98.79%	99.23%

4.1 實驗環境與基本假設

綜合上述整理出實驗環境及基本架設如下：

1. 一共三種產品 A、B、C，每種產品三種規格 A1~A3、B1~B3、C1~C3，工單隨機產生品名。
2. 每張工單需求量為 Normal(80K,5)隨機產生。
3. 需補投量為 Normal(15K,3)隨機產生。
4. 一般補投單回覆交期的設定為各產品平均急件作業流程時間 1.5 倍。
5. DBR 法則補投單回覆交期的設定為 DRUM+Shipping Buffer。
6. 每一機台一次只能針對一批工單作業。
7. 各站針對每工單加工時間固定，如表一。
8. 工單按表二製程順序加工。
9. LED-CM 模擬廠假設無當機及人員異常問題。
10. 3000 天內工單產生間距符合指數分配，當所有工單都完成，實驗即停止。
11. 模擬系統為簡化版 LED-CM 模擬廠。

4.2 績效評估因子

本實驗績效評估因子一共有二個，分別為平均流程時間(MFT)、補投單交期回覆誤差(回覆交期與實際完成時間的差異)，MFT 為產品從投入線上到完成的平均時間，越短代表產線對於 WIP 與產能的控管能力愈佳。而補投單交期回覆誤差目的是要比較何種機制對時交期回覆的準確性較佳，LED-CM 廠在 LED 供應鏈產業中屬中上游，而接單式生產的模式中交期的準確性是相當重要的，因為這會一併影響下游客戶的生產計劃，如果生產節奏太快容易影響雙方的庫存，而節奏太慢又會影響客戶斷線，因此回覆交期的準確性是相當中的，尤其在已經跳票的補投單更是重要。

4.3 實驗結果

圖 10 到圖 12 為模擬實驗結果之比較圖，由圖 10 可以看出補投單優先之 EDD 排程機制與 DBR 排程機制在任何條件下，都能有效地縮短補投單的 MFT，但補投單優先之 EDD 排程機制確會因過於照顧補投單而使一般的 MFT 延長，而 DBR 排程機制，不但能使補投單的 MFT 維持在最短的水準，還能有效的同時縮短一般單的 MFT，在相同的生產系統中當 MFT 愈短意味著線上的 WIP 也越低。

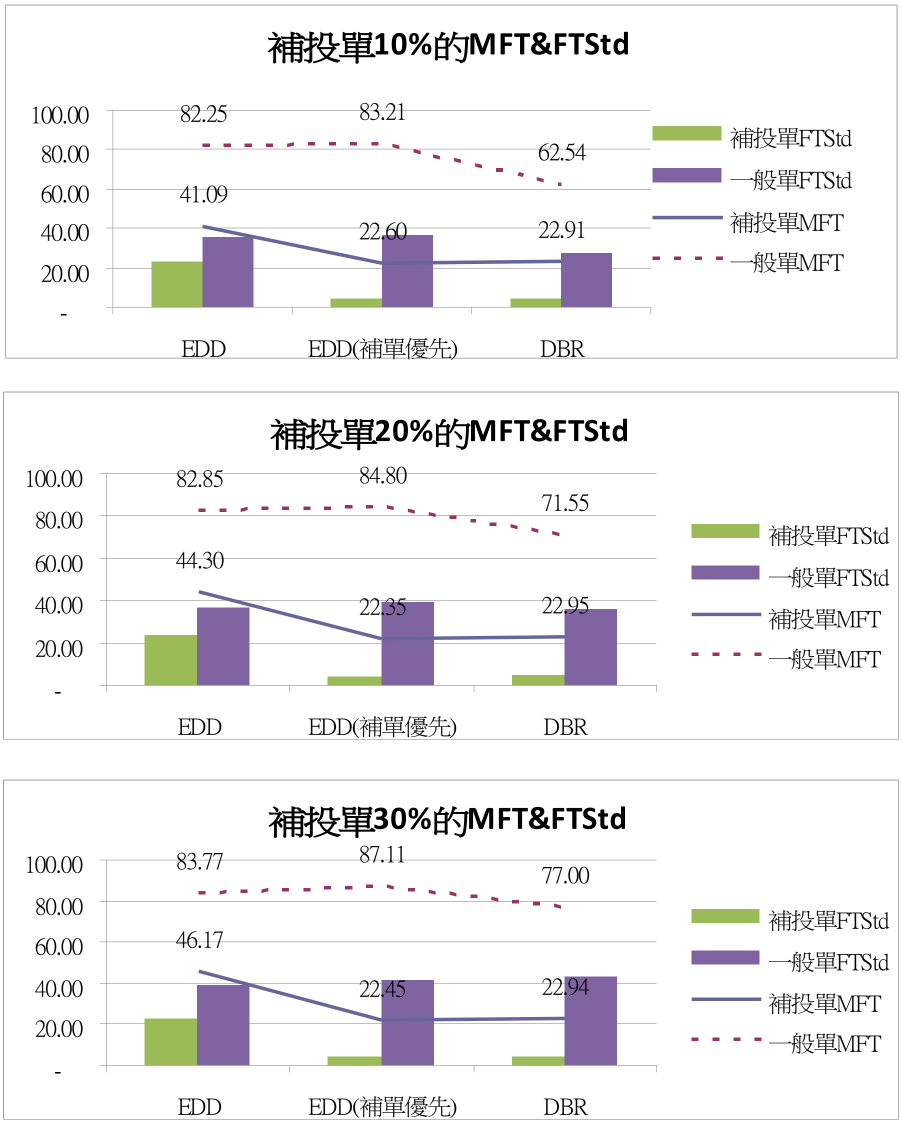
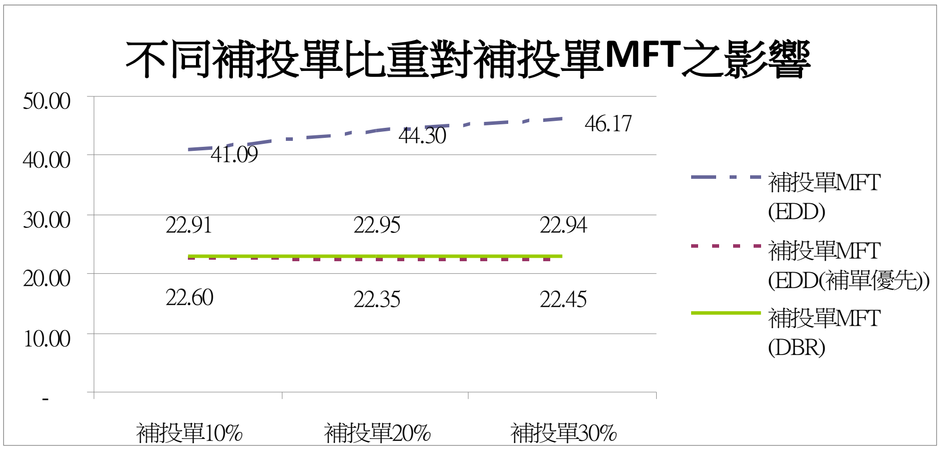


圖 10 在不同補投單比重下各法則的 MFT(單位:天)

圖 11 目的是要比較補投單比重對法則的影響，由補投單的角度來看，當補投單增加時，補投單優先之 EDD 排程機制與 DBR 排程機制兩法則皆能有效縮短 MFT 且維持補投單 MFT 於最短的狀態，而 EDD 排程機制確會因補投單數量越多而使 MFT 越長。由一般單的角度來看，EDD 排程機制與補投單

優先之 EDD 排程機制會因補投單數量越多而使 MFT 越長，尤其是補投單優先之 EDD 排程機制，而 DBR 排程機制雖然也會因補投單越多而使 MFT 加長，但比較之下卻是三種機制中能讓一般單 MFT 最短的機制。



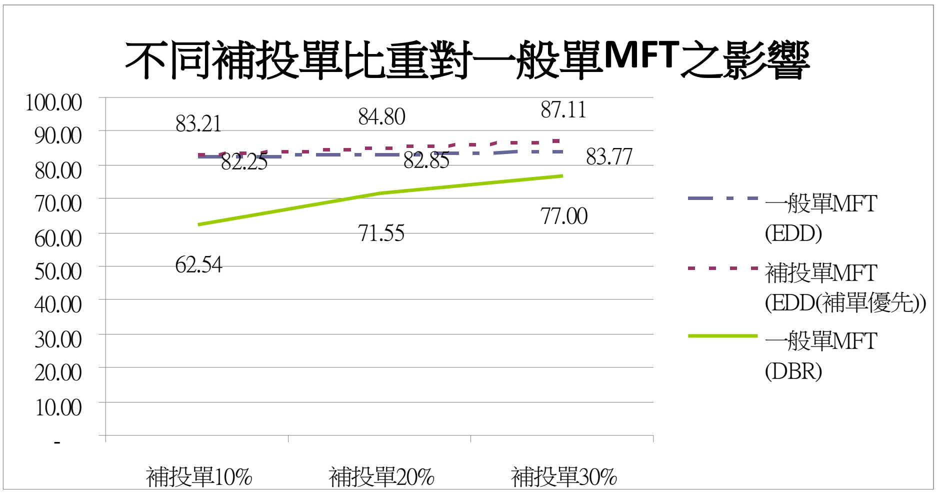


圖 11 比較補投單比重對法則的影響 (單位:天)

圖 12 為補投單回覆交期誤差之比較圖，DBR 排程機制與補投單優先之 EDD 排程機制，針對補投單的回覆交期誤差都在 2 天左右明顯的優於 EDD 排程機制。
這表示如果生產管理者用此兩種機制來回覆補投單之交其，較能有效的掌握補投單的達交狀況。

五、結論

LED 晶粒製造(LED-CM)為 LED 產業中重要的一環，晶粒製造過程由於製程技術的特殊性，容易造成晶粒光電性規格不均勻及良率不穩之問題，一般 LED 晶粒產出符合客戶需求規格的比率約只有 6~8 成左右。因而在接單式生產時，當一張訂單出現產出不足時，生管必須以補投料方式，補投該訂單所缺的不足量。雖然客戶能體諒 LED-CM 製程產出不穩之特性，但會要求補投單必須以急單的趕工方式生產，以減低該訂單產出不足的影響。因此 LED-CM 廠在大量補投單的趕工壓力下，如何確保這些補投單的如期出貨以及如何降低這些補投單對正常單交期的衝擊，即為 LED-CM 廠所面對的挑戰。

本研究提出了一套 DBR 的強化模式以改善 LED-CM 廠所面對的補投單挑戰。這套 DBR 強化模式主要強化了補投單在 DRUM 的合理插單及在投料計畫的立即投料需求。其次本計畫亦設計了模擬實驗以驗證本模式的可行性及效益。實驗結果證明，不論在平均流程時間或補投單交期回覆誤差等績效，

本模式都優於 EDD 及 EDD+補投單優先模式。

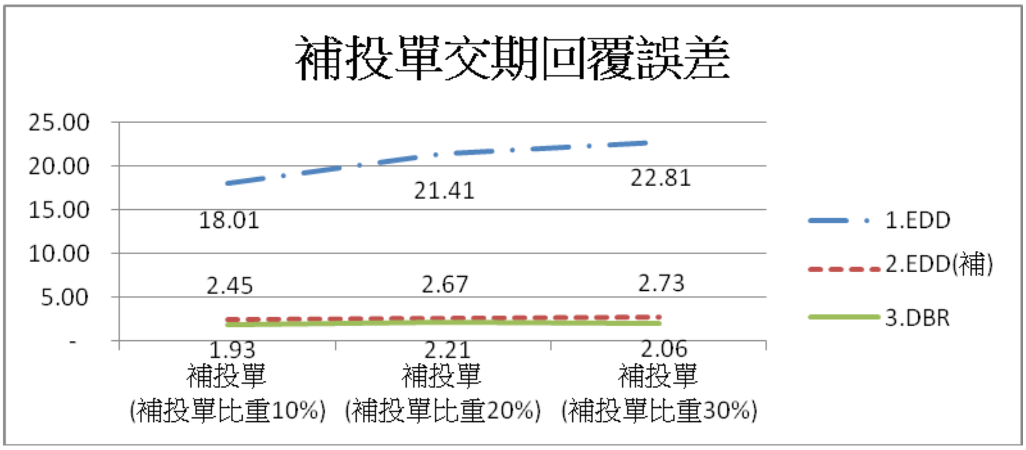


圖 12 補投單回覆交期誤差之比較 (單位:天)

五、結論

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國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■ ☐ 達成目標

☐ 未達成目標（請說明，以 100 字為限）

  ☐ 實驗失敗

  ☐ 因故實驗中斷

  ☐ 其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論■文：☐已發表 ☐未發表之文稿 ☐撰寫中 ☐無

專利：☐已獲得 ☐申請中 ☐無

技轉：☐已技轉 ☐洽談中 ☐無

其他：（以 100 字為限）

1. **Horng-Huei Wu**, Ming - Feng Li and Cheng-Hsin Yeh, 2013, "A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant," *Advanced Materials Research Vols*. 694-697, pp 3434-3440.
2. **Horng-Huei Wu**, Ming-Feng Li and Tzu-Fang Hsu, 2013, "An order fulfillment model for the LED chip manufacturing plant, "*Advanced Materials Research*, Vols. 694-697, pp 3446-3452.
3. **Horng-Huei Wu**, Hung-Hsuan Wu, and Ming - Feng Li, 2013, "A Study of the Shifting MO Model for an Insufficient Output of the LED Die Manufacturing Plant, " *Global Business & International Management Conference Journal*, Vol.6, No.2, pp.46-55.

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）

(1) 對於學術研究、國家發展及其他應用方面之貢獻：

- 建立 DBR 於 LED 晶粒製造廠之研究模式。
- 建立應用 TOC/DBR 在 LED 晶粒製造廠之模式。
- 將研究結果提供給國內工廠有意導入 TOC/DBR 方法之業界作為參考。

(2) 發表本計畫之成果於國內外研討會與國際期刊(SCI)，提供給學術界與業界參考。

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：102 年 4 月 1 日

計畫編號	NSC 101－2221－E－216－016-		
計畫名稱	限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究		
報告人姓名	葉承鑫	服務機構及職稱	中華大學工業管理學系 碩士班研究生
會議時間	102/3/30~3/31	會議地點	Dalian, China
會議名稱	(中文)2013 年製造科學與工程國際研討會 (英文) 2013 The International Conference on Manufacturing Science and Engineering		
發表論文題目	(中文) LED 晶粒製造廠產出合工單量不足時的補投單模式之探討 (英文) A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant		

1、 參加會議經過

2013 The International Conference on Manufacturing Science and Engineering was held in Dalian, China. The conference served as important forum for the exchange of ideas and information to promote understanding and cooperation among the Industrial Engineering and System Management.

In the conference, I published a paper entitled “A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant”. In addition, some other topics about management and engineering were all impressed me very much.

2、 與會心得

The international conference provided good opportunities for exchanging information and ideas among scholars in relative research fields. And I feel great for that I can also know other countries student's research.

3、 考察參觀活動(無是項活動者省略)

no

4、 建議

no

5、 攜回資料名稱及內容

Conference Program: 2013 The International Conference on Manufacturing Science and Engineering

6、 其他

A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant

Horng-Huei Wu[1, a], Ming - Feng Li[2, b] and Cheng-Hsin Yeh[3, c]

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Key Words: Material re-issue strategy, Expediting model, Rescheduling, Unstable production output, LED chip manufacturing

Abstract. The LED chip manufacturing (LED-CM) is an important process in the LED supply chain. The make-to-order production strategy is a general production model for the LED-CM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-CM plants, the effective order fulfillment is low and variety. Under the severely competitive pressure, the production planner will thus confront the issue of material re-issued for an insufficient output of an MO. The purpose of this effort is to meet the required due-date of this MO and to reduce the unnecessary inventory of by-product chips. Therefore, a study of the material (EPI) re-issued MO model for an insufficient output of the LED chip manufacturing plant is proposed in this paper. Three material re-issued models are proposed and detailed discussed first. A real-life LED-CM case is then utilized to demonstrate and evaluate the application and effectiveness of these models. A simulation model is also designed to complete the further experiment.

Introduction

The major processes of the LED industry compose of four parts: material substrate, upstream, midstream and downstream[1]. Substrate is an important material to produce the Epitaxy wafer (EPI). Two substrate materials are Sapphire substrate and Silicon substrate. The manufacturing process of LED Chip Manufacturing (LED-CM) plant is in the midstream. The production process of a LED-CM plant not only complex but also unstable, and the quality of the LED chips will determine the function of the subsequent applications. Therefore, the LED-CM plants are important in the LED supply chain and the focus of this paper.

The make-to-order production strategy is a general production model for the LED-CM plants to satisfy the variety requirement of their customers. However, the special features of the unstable production output and a product composed of the chips of different feasible Bins exist in the LED-CM plant. The production planner will confront the issue of effective inventory control and exact due-date performance under the severely competitive pressure. An order fulfillment model was therefore presented by Wu *et al.*[2]. Therefore a re-issued model for order fulfillment is further proposed in this paper to improve the due-date performance of the LED-CM plants.

The specificity and order fulfillment issues of the LED-CM plants are first discussed in the second section. The material re-issued models are then presented in the third section. A real-life LED-CM case is also utilized to demonstrate and evaluate the application and effectiveness of the proposed models.

The Order Fulfillment Issues in the LED-CM Plant

Basically, the input material of LED-CM plant is EPI and the final products are LED chips. The manufacturing process of LED-CM can be divided into two parts, i.e., frontend process and backend process. The major purpose of the frontend process is to manufacture the electrical function into EPI. And the functions of the backend process are chip probing, cut and break, sort (by different bins) and package. An EPI can be cut or broken into several or several ten thousands LED chips depending on its size. Although the specifications of the LED chip are several, such as structure, size, electrical functions, voltage or customized requirements etc., the major specification is the electrical functions, i.e., lightness and wavelength. And these two functions are only utilized as the product specification of the order in the following discuss. The notations utilized in this paper are as follows:

I: The types of the product specification.

i: The index of a product specification, i =1,2,,I.

ll_i: The lower bound light grade of product specification i , i =1,2,,I.

lu_i: The upper bound light grade of product specification i ,i =1,2,,I.

J: The maximum range of light grade.

j: The index of light grade for a Bin, j=1,2..J.

b_j: The chip inventory in the Bin indexed with the j^{th} grade light and k^{th} wave band, j=1,2..J.

r_i: The required quantity of an order of the product specification i, i=1,2..I.

g_i: The gross required quantity of an order of the product specification i, i=1,2..I.

p_{ij}: The planning output distribution of the Bin indexed with the j^{th} grade light, i=1,2,..I, j =1,2,,J.

q_i: The issued quantity for product specification i, i=1,2,..I.

e_{ij}: The actual output of the Bins for the order product specification i, j =1,2,,J.

t_i: The total production output probability of the feasible Bins for a product specification i, i=1,2,..I.

The Feasible Bins for a Product Specification. The major product specifications compose of lightness and wavelength. For example, for the yellow light, the wavelength is between 584nm and 594nm and lightness is between 100mcd and 300mcd. Therefore, besides the color of the LED chips, the specification of order must further define clearly the range of wavelength and lightness. For example, if users want more yellow and light LED chips, their specifications of wavelength will be between 586nm and 588nm and lightness between 200mcd and 250mcd. However, for the yellow LED chips, the wavelength of another user requirement will be between 588nm and 590nm and lightness between 150mcd and 200mcd.

In the LED-CM plant, a user product specification is then transferred to be feasible Bins[1-3]. A Bin is defined by the light grade and waveband. However, waveband is ignored in this paper to reduce the complexity of Bin. The detailed Bins descriptions please refer Wu *et al*[2]. The lightness of a color LED chip is divided into several light grades (i.e., J grades) depending on the requirements of users. For example, the yellow lightness is between 100mcd and 300mcd and is divided into 6 grades as shown in Table 1. Therefore, the feasible Bins for an order with product specification i are defined in Eq. 1.

$$FB_i = \{b_j, ll_i \leqq j \leqq lu_i\},\ i=1,2,..I \quad (1)$$

The shipment chips of an order are then based on the chips of these feasible Bins. For example, the specifications of an order are yellow LED chips and lightness is between 80mcd and 160mcd. Because the quality of Bins must narrow than the specification of order, the feasible Bins for this order are light grade 2~3 (i.e., ll_i=2 and lu_i=3), as shown the shadow boxes in Table 1. Therefore, the inventory chips of these feasible Bins for a product specification are as shown in Eq. 2.

$$v_i = \sum_{j=ll_i}^{lu_i} b_j \text{ , } i=1,2, ..I \quad (2)$$

Table 1. An example of Bin definition for yellow LED chips.

Light Grade *j* Lightness [mcd]	Bin #					Current Date: 10/19
	1	2	3	4	5	6
	50~100	100~150	150~200	200~250	250~300	300~350
Chips in Bin [×K grains] b_j	100	5	5	20	5	50

If the inventory chips of these feasible Bins are sufficient for this order, the shipment of this order is fulfilled by these inventory chips. Otherwise, a production plan or MO of the 1st product specification will be issued to produce for this order.

Production Output Distribution of Bins. Because the status of process stable or not in the frontend process will determine the electrical distribution of those several thousand chips in an EPI, the electrical functions of the production output of chips in an EPI will be gradient distribution. In other words, the electrical function of each chip in an EPI is different. Therefore, these chips with non-identical electrical function are classified into different Bins. Basically, the different Bins distributions will be determined by the different process parameter or EPI. Therefore, the different product specification identifications are provided by the R&D or engineering department to get the optimal Bins distributions, as shown the example in Table 1. The total production output probability of these feasible Bins for a product specification *i* is thus as shown in Eq. 3.

$$t_i = \sum_{j=ll_i}^{lu_i} p_{ij} \text{ , } i=1,2, ..I \quad (3)$$

When the inventory chips in the feasible Bins are insufficient for an order, a production plan or MO of a feasible product specification is required. The gross required quantity of an order i is first determined by Eq. 4.

$$g_i = r_i - v_i \text{ , } i=1,2,..I \quad (4)$$

Then the production quantity of chips for this order is determined by the g_i and t_i, as shown in Eq. 5.

$$q_i = \frac{g_i}{t_i} \text{ , } i=1,2,..I \quad (5)$$

Hit Target of a MO. Because the status of process stable or not in the frontend process will determine the electrical distribution of those several thousand chips in an EPI, the actual distribution of the production output of chips in an EPI will not be same as the planned. The Hit Target (HT) for a MO is the ratio of the production output chips which are in the feasible Bins. If the ratio is greater than the value of t_i, a higher HT is performed for this MO. For example, the lightness specifications of two MOs are both 150~200mcd.

Therefore, if the HT of a MO is greater than the planed level, this order can be delivered on time. However, the planner will get too much excess chips in the Bins. On the contrary, if the HT of a MO is less than the planed level, a shortage will occur for this MO. An expediting replenishment plan must be switched on by the planner to catch the requirement of this MO[4]. The determination of an expediting replenishment is by the remaining time before the due-date of the order of product specification *i*. The first alternative is to re-create a MO and re-issue it to replenish the shortage quantity. And, the second alternative is to select a shifting MO from the WIP to replenish the shortage quantity. The this paper studies the material re-issued models for the first alternative. Although the order release field has been a popular topics in the literature[5-9], the re-issued model is little studied. The purpose of this paper is therefore to present the material re-issued models for an insufficient output of a MO in the LED-CM plant.

Material Re-issued Models for LED-CM Plants

Three material re-issued models are proposed in this section. The first model is to issue the shortage quantity only (SQO). The second model is to issue the shortage quantity and loss buffer. (SQLB). The third model is to consider the global WIP inventory status after the probing process. The re-issued quantity depends on the global shortage quantity(GSQ).

SQO Model. Let si is the shortage quantity of the order of product specification *i*. Then si is as:

$$s_i = r_i - \sum_{j=ll_i}^{lu_i} e_{ij} \quad (6)$$

Then, the inventory chips of the feasible Bins for this product specification must be reviewed again. And si is revised as:

$$s_i = \max\left\{0, s_i - \sum_{j=ll_i}^{lu_i} b_j\right\} \quad (7)$$

Therefore, if s_i is greater than zero, the re-issued quantity (rq_i) of SQO model is as :

$$rq_i = \frac{s_i}{t_i} \quad (8)$$

SQLB Model. The loss buffer (*L*) is considered in the SQLB model to confirm the enough output of the re-issued quantity. Basically, the loss buffer is the average loss ratio in which the HT is lower than ti in the last some periods. Therefore, if s_i is greater than zero by utilizing (7), the re-issued quantity (rq_i) of SQLB model is as:

$$rq_i = \frac{s_i \times (1 + L)}{t_i} \quad (9)$$

GSQ Model. The global WIP inventory status after the probing process is considered in the GSQ model. The global shortage quantity(*gsi*) is equal to the required quantity minus the output of the orders with the same product specification and in the process after probing. Let wi is the current process of the order of the product specification i, i=1,2..I. The gs_i is then as shown in Eq. 10.

$$gs_i = \sum_{i \in \{i|w_i \neq probing\ \ process\}} (r_i - \sum_{j=ll_i}^{lu_i} e_{ij}) \tag{10}$$

The re-issued quantity depends on the global shortage quantity(gsi). If if gs_i is greater than zero, the re-issued quantity (rq_i) of GSQ model is as :

$$rq_i = \frac{gs_i}{t_i} \tag{11}$$

A Case of a LED-CM Plant

A LED-CM plant located in the Hsinchu Science Park of Taiwan is utilized to illustrate the above models. The lightness specification is only considered. The lightness is further divided into six specifications, i.e., A~F. as shown in Table 2. The range of light grades and production output distribution are also shown in Table 2. The normal or hot run cycle times (CT) for different process are shown in Table 3. Suppose today is 10/19 and there are 28 lots in production. Table 4 shows the information of these lots. Lot # 001~009 have completed the Probing process and the HT is known. The HT of other lots are still unknown. For example, the HT quantity of lot #1 is 263K and greater than the required quantity 250K. Therefore, this lot can be delivered on time. However, lot #9 met some troubles. The HT quantity of lot #1 is only 867K and less than the required quantity 1000K. Therefore a re-issued lot is required as soon as possible. Based on the proposed re-issued models, the re-issued lot is shown in follows respectively.

SQO Model. Because si is 133K and the inventory chips of the feasible Bins for this product specification are 25K, $s_i = \max(0, 133K - 25K) = 108K$. Therefore, by utilizing (8), the re-issued quantity $rq_i = 108K / 0.6 = 180K$. That is an expediting lot # 009-1 is issued and its quantity is 108K and duedate is 11/6. Therefore, the lot #9 is split into two lots. The first lot is still # 009 but its quantity is revised to be 892K. The second lot is #009-1 and its quantity is 108K and duedate is 11/6.

SQLB Model. The si is same as SQO model. Suppose the loss buffer (i.e., L) is equal to 20% by past experience. Therefore, by utilizing (9), the re-issued quantity $rq_i = 108K \times (1 + 0.2) / 0.6 = 216K$. That is an expediting lot # 009-1 is issued and its quantity is 108K and duedate is 11/6. Therefore, the lot #9 is split into two lots. The first lot is still # 009 but its quantity is revised to be 892K. The second lot is #009-1 and its quantity is 108K and duedate is 11/6.

Table 2. An example of product specifications and their output distribution.

ID of product specification [i]	Light grade [j]	Feasible EPI	Output distribution of Bin						Total production output probability [t_i]
			1	2	3	4	5	6	
A	2~3	X	15%	30%	30%	15%	5%		60.00%
B	3~4	Y	5%	15%	30%	30%	15%	5%	60.00%
C	4~5	Z		5%	15%	30%	30%	15%	60.00%
D	2~4	X	15%	30%	30%	15%	5%		75.00%

E	3~5	Y	5%	15%	30%	30%	15%	5%	75.00%
F	4~6	Z		5%	15%	30%	30%	15%	75.00%

Table 3. The cycle time for the different process of LED-CM plant.

[days]	Front process	Cut	Probing	Sorter	QC	Die Count
Standard CT	15	2	1.5	3	1	2.5
Hot Run CT	10.50	1.40	1.05	2.10	0.70	1.75

Table 4. Lot information in production.

Current Date: 10/19 Unit: × K grains

Lot #	Hot Run [Y/N]	Prod. Spec.	Required Qty	Issued Qty	Issued date	DueDate	Current process	Remaining Days [Std]	Remaining Days[Hot run]	DueDate [Hot Run]	Output probability [ti]	HT	Qty of HT
001	N	B	250	417	9/27	10/22	Die Count	3	2	10/21	60.00%	63.00%	263
002	N	E	400	533	9/27	10/22	Die Count	3	2	10/21	75.00%	75.00%	400
003	N	C	300	500	9/27	10/22	Die Count	3	2	10/21	60.00%	62.00%	310
004	N	A	500	833	9/28	10/23	QC	4	3	10/22	60.00%	65.00%	542
005	N	B	1200	2000	9/29	10/24	Sorter	5	4	10/23	60.00%	61.00%	1220
006	N	C	700	1167	9/29	10/24	Sorter	5	4	10/23	60.00%	66.00%	770
007	N	A	300	500	10/1	10/26	Probing	7	5	10/24	60.00%	64.00%	320
008	N	D	100	133	10/1	10/26	Probing	7	5	10/24	75.00%	79.00%	105
009	N	C	1000	1667	10/1	10/26	Probing	7	5	10/24	60.00%	52.00%	867
010	N	A	500	833	10/3	10/28	Cut	9	6	10/25	60.00%		
011	N	B	500	833	10/3	10/28	Cut	9	6	10/25	60.00%		
012	N	E	600	800	10/5	10/30	Front process	11	8	10/27	75.00%		
013	N	C	100	167	10/5	10/30	Front process	11	8	10/27	60.00%		
014	N	F	500	667	10/7	11/1	Front process	13	9	10/28	75.00%		
015	N	E	100	133	10/7	11/1	Front process	13	9	10/28	75.00%		
016	N	F	200	267	10/7	11/1	Front process	13	9	10/28	75.00%		
017	N	B	700	1167	10/7	11/1	Front process	13	9	10/28	60.00%		
018	N	A	800	1333	10/13	11/7	Front process	19	13	11/1	60.00%		
019	N	C	600	1000	10/13	11/7	Front process	19	13	11/1	60.00%		
020	N	D	1000	1333	10/13	11/7	Front process	19	13	11/1	75.00%		
021	N	B	200	333	10/15	11/9	Front process	21	15	11/3	60.00%		
022	N	B	300	500	10/15	11/9	Front process	21	15	11/3	60.00%		
023	N	E	2000	2667	10/15	11/9	Front process	21	15	11/3	75.00%		
024	N	D	100	133	10/18	11/12	Front process	24	17	11/5	75.00%		
025	N	A	500	833	10/18	11/12	Front process	24	17	11/5	60.00%		
026	N	C	200	333	10/18	11/12	Front process	24	17	11/5	60.00%		
027	N	F	700	933	10/18	11/12	Front process	24	17	11/5	75.00%		
028	Y	C	130	217	10/19	11/13	Front process	25	18	11/6	60.00%		

GSQModel. Based on the information shown in Table 4, the lots which are product specification C and has processed by Probing process are lot # 003, 006 and 009. Therefore, by utilizing (9), $gs_i = (300K + 700K + 1000K) - (310K + 770K + 867K) = 53K$. Then, utilizing (10), $rq_i = 53K / 0.6 = 88K$. That is an expediting lot # 009-1 is issued and its quantity is 53K and duedate is 11/6. Therefore, the lot #9 is split into two lots. The first lot is still # 009 but its quantity is revised to be 947K. The second lot is #009-1 and its quantity is 53K and duedate is 11/6.

Simulation and Experiments

In order further to compare the performance of these three re-issued models, the simulation experiments are designed. The environments of experiment are as follows:

(1) Six processes, i.e., frontend, cut, probing, sorter, QC, and Die count etc. and their CT are as shown in Table 3.
(2) Seven product specifications, i.e., A~G etc. and their production output distributions are shown in Table 2.
(3) The production specification of arriving order depends on uniform distribution.
(4) The required quantity of an arriving order depends on normal distribution and its mean is 600K grains and standard deviation is 100K grains.
(5) The materials of all arriving orders are issued first come first in but limited by 2000K grains per day.
(6) The materials are successively issued until 100 days and this experiment ends when all orders are completed.
(7) The ratio of HT depends on the production output probability in Table 2 but its mean is changed by normal distribution.

Two indexes are utilized to evaluate the performance of different re-issued model. The first index is the rate of re-issued requirement (RRR). The RRR is the total re-issued lots divided by total issued lots. The higher RRR the worse the model is. The second index is the inventory level in the Bins (ILB). The higher ILB the worse the model is.

Some results of the simulation are shown in the follows:

(1) The GSQ model can get the lower RRR and the SQO model gets the higher RRR, as shown in Fig. 1 and Table 5.

(2) The ILB is lowest for GSQ model in all Bins but the highest for the SQO, as shown in Fig. 2 and Table 6.

(3) The inventory of by-product, i.e., Bin 1 and 6, are higher than the inventory of other Bins for all re-issued model, as shown in Fig. 2. However, the SQO model gets the highest inventory level of by-product.

(4) Although the ILB of SQLB model is lower than that of the SQO model in most Bins, the ILB in Bin #2 and #3 of SQLB model is much more than that of SQO model, as shown in Table 6.

Based on the preliminary simulation study, the GSO model gets better performance in both indexes, on the contrary, the performances of the SQO model are worse in neither indexes. Although the SQO model is simple and popular application, the GSO model is recommended to improve the order fulfillment performance and inventory in the LED-CM plant.

Conclusions

The LED chip manufacturing (LED-CM) is an important process in the LED supply chain. The make-to-order production strategy is a general production model for the LED-CM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-CM plants, the effective order fulfillment is low and variety. Under the severely competitive pressure, the production planner will thus confront the issue of material re-issued for an insufficient output of an MO. The purpose of this effort is to meet the required due-date of this MO and to reduce the unnecessary inventory of by-product chips. Therefore, a study of the material (EPI) re-issued model for an insufficient output of the LED chip manufacturing plant is proposed in this paper. Three material re-issued models, i.e., SQO, SQLB and GSQ etc, are proposed and detailed discussed first. A real-life LED-CM case is then utilized to demonstrate and evaluate the application and effectiveness of these models. A simulation model is designed to complete the further experiment. Based on the simulation study, although the SQO model is simple and popular application, the GSO model is recommended to improve the order fulfillment performance and by-product inventory in the LED-CM plant.

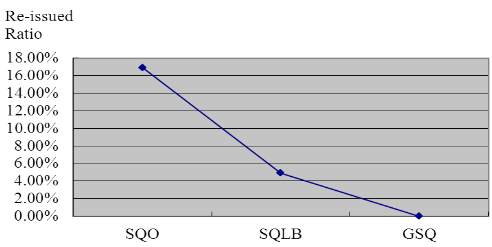

Fig. 1 The inventory level of Bins for different re-issued models.

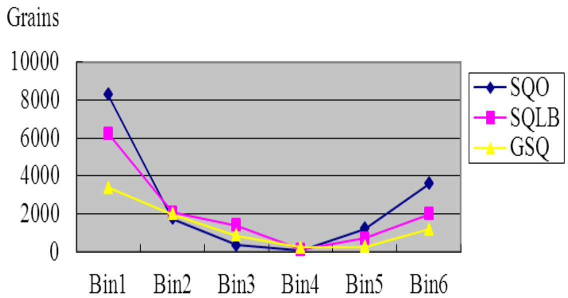

Fig. 2 The re-issued ratio required for different re-issued models.

Table 5. The inventory level of Bins for different re-issued models.

Inventory in Bins	Bin #

Grains [bj]	1	2	3	4	5	6
SQO	8266.15	1766.6	370.35	108.8	1218.05	3599.05
SQLB	6222.25	2087.35	1407.25	120.7	729.35	2006.85
GSQ	3382.25	2003.75	860.2	254	288.15	1207.6

Table 6. The re-issued ratio required for different re-issued models.

Re-issued Models	Re-issued Ratio	Issued Lots	Re-issued Lots
SQO	16.93%	384	65
SQLB	4.92%	386	19
GSQ	0.00%	389	0

Acknowledgements

The authors would like to thank the National Science Council of the Republic of China, Taiwan for partially supporting this research under Contract No. NSC 101-2221-E-216-016-.

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國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：102 年 8 月 1 日

計畫編號	NSC 101－2221－E－216－016-		
計畫名稱	限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究		
報告人姓名	吳鴻輝	服務機構及職稱	中華大學企業管理學系 教授
會議時間	102/7/1~7/3	會議地點	New York Institute of Technology -Vancouver Campus
會議名稱	(中文)2013 年全球商業與國際管理研討會 (英文) 2013 Global Business & International Management Conference		
發表論文題目	(中文) LED 晶粒製造廠產出合工單量不足時的轉移製令模式之探討 (英文)A Study of the shifting MO Model for an insufficient Output of the LED Die Manufacturing Plant		

一、參加會議經過

本研討會開始時間於 2013 年 7/1-7/3, 總共有四種不同的議題, 分別為服務與金融、行銷、科技與經濟、教育與管理。本人於科技與經濟此議題中發表研討會題目「A Study of the shifting MO Model for an insufficient Output of the LED Die Manufacturing Plant LED (晶粒製造廠產出合工單量不足時的轉移製令模式之探討)」。研討會於 7/1 至會議單位完成註冊手續，而 7/2 下午一點抵達會場，並於一點四十分進行研討會分享，直到三點二十分此議題之會議才告一段落，期間互相與與會來賓交流，相當愉快並且感受到來賓們對於學術的熱愛。7/3 則是體驗當地文化的一天，於當地進行教學參觀之活動。

二、與會心得

參與 2013 年的全球商業與國際管理研討會，有機會認識來自各國不同學術領域的同學以及教授，各各皆是該領域之專家，對於所發表的文章，給予不同的觀點與建議，為本次參加學術研討會中的最大收穫。

三、考察參觀活動(無是項活動者略)

無

四、建議

無

五、攜回資料名稱及內容

Global Business & International Management Conference Journal 一本

六、其他

A Study of the Shifting MO Model for an Insufficient Output of the LED Die Manufacturing Plant

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Hung-Hsuan Wu, Student of Kwantlen Polytechnic University, Canada
Ming-Feng Li, Graduate Student of Chung Hua University, Taiwan

ABSTRACT

The LED die manufacturing (LED-DM) is an important process in the LED supply chain. The make-to-order production is a general model for the LED-DM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-DM plants, the effective order fulfillment is low and variety. Under the severely competitive pressure, the production planner will thus confront the issue of an insufficient output of a manufacturing order (MO). Two strategies that are material re-issued and shifting other MOs are generally utilized. Especially, the shifting MO strategy is required when the manufacturing lead-time is not enough or due-date is tight. Therefore, a study of the shifting MO model for an insufficient output of the LED-DM plant is proposed in this paper. The feasible shifting MOs are first screened by some requirements in this model. Then three priority rules are proposed and detailed discussed. A real-life LED-DM case is then utilized to demonstrate and evaluate the application and effectiveness of this model. A simulation and experiment model is further designed to compare the performance of these rules. Based on the simulation study, the LDD rule is recommended to improve the order fulfillment performance and by-product inventory in the LED-DM plant.

Keywords: *Shifting manufacturing order (MO) strategy, Expediting model, Rescheduling, Unstable production output, LED die manufacturing*

INTRODUCTION

The major processes of the LED industry compose of four parts: material substrate, upstream, midstream and downstream (Wu & Li, 2011). Substrate is an important material to produce the Epitaxy wafer (EPI). Two substrate materials are Sapphire substrate and Silicon substrate. The manufacturing process of LED Die Manufacturing (LED-DM) plant is in the midstream. The production process of a LED-DM plant not only complex but also unstable, and the quality of the LED dies will determine the function of the subsequent applications (Chang *et al.*, 2012, Scholand & Dillon, 2012). Therefore, the LED-DM plants are important in the LED supply chain and the focus of this paper.

The make-to-order production strategy is a general production model for the LED-DM plants to satisfy the variety requirement of their customers. However, the special features of the unstable production output and a product composed of the dies of different feasible Bins exist-in the LED-DM plant. The production planner will confront the issue of effective inventory control and exact due-date performance under the severely competitive pressure. An order fulfillment model was therefore presented by Wu *et al.* (2013a). However, an insufficient output MO (IOM) is unavoid due to the unstable production process in the LED plant. A shortage will occur for an IOM because its production output is less than the planed requirement this MO. An expediting replenishment plan must be switched on by the planner to catch the insufficient requirement of this MO (Aytug *et al.*, 2005). Two alternatives are generally utilized for the expediting replenishment plan. The first alternative 1 is to re-create a MO and re-issue it to replenish the shortage quantity. And the second alternative is to select a shifting MO from the WIP to replenish the shortage quantity. The determination of the expediting replenishment alternative is by the remaining time before the due-date of the IOM. If the remaining time is still enough, the alternative to re-issue a new MO is prefered. Otherwise, the alternative to select a feasible shifting MO from the WIP is required. The purpose of this paper is to propose the models to select a shifting MO from the WIP for order fulfillment to improve the due-date performance of the LED-DM plants.

The specificity and order fulfillment issues of the LED-DM plants are first discussed in the second section. The models of the selection shifting MO are then presented in the third section. A real-life LED-DM case is also utilized to demonstrate and evaluate the application and effectiveness of the proposed models.

ORDER FULFILLMENT ISSUES IN THE LED-DM PLANT

Although the order fulfillment process is generally in a make-to-order plant(Croxton, 2003, Kawtummachai & Hop, 2005, Parameshwaran *et al.* 2011), this process in the LED-DM plant possesses some special characteristic and features. Basically, the input material of LED-DM plant is EPI and the final products are LED dies. The manufacturing process of LED-DM can be divided into two parts, i.e., frontend process and backend process. The major purpose of the frontend process is to manufacture the electrical function into EPI. And the functions of the backend process are die probing, cut and break, sort (by different bins) and package. An EPI can be cut or broken into several or several ten thousands LED dies depending on its size. Although the specifications of the LED die are several, such as structure, size, electrical functions, voltage or customized requirements etc., the major specification is the electrical functions, i.e., lightness and wavelength. And these two functions are only utilized as the product specification of the MO in the following discuss. The notations utilized in this paper are as follows:

K: the total number of MOs in the WIP.

k: the index of a MO, k=1,2..K.

F: the index of an IOM, $F \in \{1,2,..K\}$

I: The types of the product specification.

i: The index of a product specification, i =1,2,,I.

ll_i: The lower bound light grade of product specification i , i =1,2,,I.

lu_i: The upper bound light grade of product specification i ,i =1,2,,I.

J: The maximum range of light grade.

j: The index of light grade for a Bin, j=1,2..J.

b_j: The die inventory in the Bin indexed with the jth grade light，j=1,2..J.

v_i: The total inventory of the feasible bins for product specification i，i =1,2,,I.

M:The number of major work stations in the LED-DM plant.

C_m: The standard cycle time required in the mth work station, m=1,2,..M.

H_m: The hot run cycle time required in the mth work station, m=1,2,..M.

m_k: The work station where the k^{th} MO is processed , k=1,2,..K.

d_k: The required due-date of the k^{th} MO, k=1,2..K.

r_k: The required quantity of the k^{th} MO, k=1,2..K.

g_k: The gross required quantity of the k^{th} MO, k=1,2..K.

q_k: The issued quantity of the k^{th} MO, k=1,2,..K.
s_k: The specification of the k^{th} MO, k=1,2..K.
p_{ij}: The planned probability output of the jth bin for a product specification i, i=1,2,..I, j =1,2,,J.
e_{ij}: The actual probability output of the jth bin for a product specification i, i=1,2,..I, j =1,2,,J.
t_i: The total planned probability output of the feasible bins for a product specification i, i=1,2,..I.
a_i: The total actual probability output of the feasible bins for a product specification i, i=1,2,..I.
Tnow: Current date.

The Feasible Bins for a Product Specification

The major product specifications compose of lightness and wavelength. For example, for the yellow light, the wavelength is between 584nm and 594nm and lightness is between 100mcd and 300mcd. Therefore, besides the color of the LED dies, the specification of order must further define clearly the range of wavelength and lightness. For example, if users want more yellow and light LED dies, their specifications of wavelength will be between 586nm and 588nm and lightness between 200mcd and 250mcd. However, for the yellow LED dies, the wavelength of another user requirement will be between 588nm and 590nm and lightness between 150mcd and 200mcd.

In the LED-DM plant, a user product specification is then transferred to be feasible Bins. A Bin is defined by the light grade and waveband. However, waveband is ignored in this paper to reduce the complexity of Bin. The detailed Bins descriptions please refer Wu *et al*.(2013a). The lightness of a color LED die is divided into several light grades (i.e., J grades) depending on the requirements of users. For example, the yellow lightness is between 100mcd and 300mcd and is divided into 6 grades as shown in Table 1. Therefore, the feasible Bins for a product specification i are defined as Eq.(1).

$$FB_i = \{b_j, ll_i \leq j \leq lu_i\},\ i=1,2,..I \quad (1)$$

The shipment dies of an order are then based on the dies of these feasible Bins. For example, the specifications of an order are yellow LED dies and its lightness is between 80mcd and 160mcd. Because the quality of Bins must narrow than the specification of order, the feasible Bins for this order are light grade 2~3 (i.e., ll_i=2 and lu_i=3), as shown the shadow boxes in Table 1. Therefore, the inventory dies of these feasible Bins for a product specification are as Eq.(2).

$$v_i = \sum_{j=ll_i}^{lu_i} b_j,\ i=1,2,..I \quad (2)$$

If the inventory dies of these feasible Bins are sufficient for this order, the shipment of this order is fulfilled by these inventory dies. Otherwise, a production plan or MO of the 1[st] product specification will be issued to produce for this order.

Table 1: An Example of Bin Definition for Yellow LED dies

	Bin #				Current Date: 10/19	
Light Grade j	1	2	3	4	5	6
Lightness [mcd]	50~100	100~150	150~200	200~250	250~300	300~350
Chips in Bin [×K grains] b_j	100	5	5	20	5	50

Production Output Distribution of Bins

Because the status of process stable or not in the frontend process will determine the electrical distribution of those several thousand dies in an EPI, the electrical functions of the production output of dies in an EPI will be gradient distribution, as shown in Figure 2. In other words, the electrical function of each die in an EPI is different. Therefore, these dies with non-identical electrical function are classified into different Bins. Basically, the different Bins distributions will be determined by the different process parameter or EPI. Therefore, the different product specification identifications are provided by the R&D or engineering department to get the optimal Bins distributions, as shown the example in Table 1. The total planned probability output of these feasible bins for a product specification i is thus as Eq. (3).

$$t_i = \sum_{j=ll_i}^{lu_i} p_{ij} \text{ , } i=1,2,..I \tag{3}$$

When the inventory dies in the feasible Bins are insufficient for an order, a production plan or MO of a feasible product specification is required. The gross required quantity of a MO k is first determined by Eq. (4)

$$g_k = r_k - v_k \text{ , } k=1,2,..K \tag{4}$$

Then the production quantity of dies for this MO is determined by the g_k and t_{s_k} , that is $\frac{g_k}{t_{s_k}}$.

Finally, the issued quantity of wafers for a MO k is as Eq.(5)

$$q_k = \frac{g_k}{t_{s_k}} \text{ , } k=1,2,..K \tag{5}$$

Hit Target of a MO

Because the status of process stable or not in the frontend process will determine the electrical distribution of those several thousand dies in an EPI, the actual distribution of the production output of dies in an EPI will not be same as the planned. The total actual probability output of these feasible bins for a product specification i is the sum of actual probability output (e_{ij},)of each feasible bin, as shown as Eq. (6).

$$a_i = \sum_{j=ll_i}^{lu_i} e_{ij} \text{ , } i=1,2,..I \tag{6}$$

The Hit Target (HT) for a MO is therefore the total actual probability output of these feasible bins or the ratio of the actual production output dies which are in the feasible Bins. If the ratio is greater than the value of t_i, a higher HT is performed for this MO. The difference of the actual output and planned output for a MO k is as shown in Eq.(7).

$$l_k = (t_{s_k} - a_{s_k}) \times q_k \tag{7}$$

Therefore, if $l_k > 0$, i.e., the HT of this MO k is greater than the planed, the planner will get too much excess dies. However, if $l_k < 0$, i.e., the HT of this MO k is less than the planed, an IOM will occur. For an IOM, an expediting replenishment plan must be switched on by the planner to catch the requirement of this MO. Two alternatives are generally utilized for the expediting replenishment plan:

Alternative 1: *The planner will re-create a MO and re-issue it to replenish the shortage quantity.*

Alternative 2: *The planner will select a shifting MO from the WIP to replenish the shortage quantity.*

The determination of an expediting replenishment alternative is by the remaining time (i.e., due date – Tnow) before the due-date of the IOM. If the remaining time is still enough, the alternative to re-issue a new MO is prefered(Wu *et al.*, 2013b). Otherwise, the alternative to select a shifting MO from the WIP is required. The purpose of this paper is to propose the models to select a shifting MO from the WIP for the second alternative to improve the due-date performance of order fulfillment of the LED-DM plants.

MODEL FOR THE SELECTION OF OPTIMAL SHIFTING MO

Two major processes are required for the selection of the optimal shifting MO model. The first process is the evaluatation of the feasible shifting MOs from the WIP. The second process is the determination of the first priority shifting MO from these feasible shifting MOs.

The Evaluation of the Feasible MOs from WIP

Three criteria are required to filter the feasible MOs from WIP. That is, for a feasible shifting MO k, k=1,2..K and $k \neq F$, for an IOM F , the following three criteria or equations must be satified.

(1) Based on the same EPI, the feasible bins of the specifications of the shifting MO k must be overlapped with that of the IOM. Let OB be the overlapped bins of MO k and IOM F, as shown in Eq. (8).

$$OB_k = FB_{s_k} \cap FB_{s_F} \tag{8}$$

Therefore, the first criterion is that $OB_k \neq \phi$.

(2) The quantity of the overlapped bins of the shifting MO must be greater than the shortage quantity of the IOM. That is, the second criterion is that Eq. (9) must be satified.

$$\sum_{j \in OB_k} p_{kj} > l_k \tag{9}$$

(3) The due date for this shifting MO is late enough to re-create a new MO and re-issue it. Otherwise this shifting MO will be late itself. Therefore, the third criterion is that Eq. (10) must be satified.

$$d_k > Tnow + \sum_{j=1}^{M} H_j \tag{10}$$

The feasible shifting MOs can be filtered through the above three creteria. Then the second process for the selection of the optimal shifting MO model is to determine the priority shifting MO After ree material re-issued models are proposed in th from these feasibe shifting MOs.

The Determination of the First Priority Shifting MO

Three priority rules for the selection of the optimal shifting MO model, i.e., Earliest due date MO first (EDD), Latest due date MO first (LDD) and Smallest required quantity MO first (SRQ) etc., are proposed and detailed discussed in the following. Let FM be the set of the feasible shifting MOs for an IOM F and S is the selected shifting MO.

(1) Earliest due date MO first (EDD): The optimal shifting MO is determined by the Eq. (11).

$$S = \min_k \{d_k \mid k \in FM\} \tag{11}$$

(2) Latest due date MO first (LDD) : The optimal shifting MO is determined by the Eq. (12).

$$S = \max_k \{d_k \mid k \in FM\} \tag{12}$$

(3) Smallest required quantity MO first (SRQ) : The optimal shifting MO is determined by the Eq. (13).

$$S = \min_k \{r_k \mid k \in FM\} \tag{13}$$

A CASE OF A LED-DM PLANT

A LED-DM plant located in the Hsinchu Science Park of Taiwan is utilized to illustrate the above models. The lightness specification is only considered in this case study. Six product specifications, i.e., A~F, are considered as shown in Table 2. The range of light grades and production output distribution for each product specification are also shown in Table 2. The normal or hot run cycle time (CT) for different station are shown in Table 3. Suppose today is 10/19 and there are 28 MOs (lots) in production. Table 4 shows the information of these MOs. MO #001~009 have completed the Probing process and the HT is then known. The HT of other MOs are still unknown. For example, the HT quantity of MO #001 is 263K and greater than the required quantity 250K. Therefore, this MO can be delivered on time. However, MO #009 met some troubles. Its HT quantity is only 867K and less than the required quantity 1000K. Therefore MO #009 is an IOM and an expediting replenishment plan is required as soon as possible. Considering the due date requirement, the remaining time for the MO #009 is not enough to re-issue a new MO. Therefore, the selection of a shifting MO from the WIP is an inevitable alternative to delivery the MO #009 on time. The required process to select a feasible shifting MO from the WIP is shown in follows respectively.

Table 2: An Example of Product Specifications and Their Output Distribution.

ID of product specification [i]	Light grade [j]	Feasible EPI	Output distribution of Bin						Total production output probability [t_i]
			1	2	3	4	5	6	
A	2~3	X	15%	30%	30%	15%	5%		60.00%
B	3~4	Y	5%	15%	30%	30%	15%	5%	60.00%
C	4~5	Z		5%	15%	30%	30%	15%	60.00%
D	2~4	X	15%	30%	30%	15%	5%		75.00%
E	3~5	Y	5%	15%	30%	30%	15%	5%	75.00%
F	4~6	Z		5%	15%	30%	30%	15%	75.00%

Table 3: The Cycle Time for the Different Station of a LED-CM Plant. Unit:Days

Station	Front process	Cut	Probing	Sorter	QC	Die Count
Standard CT	16	2	1.5	1.5	1	2.5
Hot Run CT	11.50	1.40	1.05	1.10	0.70	1.75

The Evaluation of the Feasible MOs from WIP

Step 1: The EPI and specification of MO #009 (i.e., IOM) is Z and C respectively. The feasible shifting MOs are #013, #014, #016, #019, #026, #027 and #028 which can satisfy the first criterion, i.e., $OB_k \neq \phi$.

Step 2: The Quantity of HT of these feasible shifting MOs are 100, 400, 160, 600, 199, 559 and 130 respectively. Therefore based on the criterion Eq.(7), The feasible shifting MOs are #014, #016, #019, #026 and #027.

Step 3: The hot run CT requires 18 days at least as shown in Table 3. Therefore, if the due date a MO is not late than 11/5, it will be late if its MO is re-create and re-issue today (10/19). Therefore, based on the Eq. (8), the feasible shifting MOs are then #019, #026 and #027.

The Determination of the First Priority Shifting MO

The determination of the priority for the feasible shifiting MOs is dependent on the utilization of priority rules, i.e., EDD, LDD and SRQ.

(1) EDD rule: Because the due date of the three feasible shifting MOs, i.e., # 019, #026 and #027, are 11/7, 11/12 and 11/13, respectively, the selected shifting MO for the IOM #009 is then the MO #019.

(2) LDD rule: Because the due date of the three feasible shifting MOs are 11/7, 11/12 and 11/13, respectively, the selected shifting MO for the IOM #009 is then the MO #027.

(3) SRQ rule: Because the required quantity of the three feasible shifting MOs are 600K, 200K and 700K, respectively, the selected shifting MO for the IOM #009 is then the MO #026.

Table 4: Lot Information in Production

Current Date: 10/19

Unit: × K grains

MO #	Hot Run [Y/N]	Prod. Spec.	Required Qty	Issued Qty	Issued date	DueDate	Current Station	Remaining Days [Std]	Remaining Days[Hot run]	DueDate [Hot Run]	Output probability [ri]	HT	Qty of HT
001	N	B	250	417	9/27	10/22	Die Count	3	2	10/21	60.00%	63.00%	263
002	N	E	400	533	9/27	10/22	Die Count	3	2	10/21	75.00%	75.00%	400
003	N	C	300	500	9/27	10/22	Die Count	3	2	10/21	60.00%	62.00%	310
004	N	A	500	833	9/28	10/23	QC	4	3	10/22	60.00%	65.00%	542
005	N	B	1200	2000	9/29	10/24	Sorter	5	4	10/23	60.00%	61.00%	1220
006	N	C	700	1167	9/29	10/24	Sorter	5	4	10/23	60.00%	66.00%	770
007	N	A	300	500	10/1	10/26	Probing	7	5	10/24	60.00%	64.00%	320
008	N	D	100	133	10/1	10/26	Probing	7	5	10/24	75.00%	79.00%	105
009	N	C	1000	1667	10/1	10/26	Probing	7	5	10/24	60.00%	52.00%	867
010	N	A	500	833	10/3	10/28	Cut	9	6	10/25	60.00%		
011	N	B	500	833	10/3	10/28	Cut	9	6	10/25	60.00%		
012	N	E	600	800	10/5	10/30	Front process	11	8	10/27	75.00%		
013	N	C	100	167	10/5	10/30	Front process	11	8	10/27	60.00%		
014	N	F	500	667	10/7	11/1	Front process	13	9	10/28	75.00%		
015	N	E	100	133	10/7	11/1	Front process	13	9	10/28	75.00%		
016	N	F	200	267	10/7	11/1	Front process	13	9	10/28	75.00%		
017	N	B	700	1167	10/7	11/1	Front process	13	9	10/28	60.00%		
018	N	A	800	1333	10/13	11/7	Front process	19	13	11/1	60.00%		
019	N	C	600	1000	10/13	11/7	Front process	19	13	11/1	60.00%		
020	N	D	1000	1333	10/13	11/7	Front process	19	13	11/1	75.00%		
021	N	B	200	333	10/15	11/9	Front process	21	15	11/3	60.00%		
022	N	B	300	500	10/15	11/9	Front process	21	15	11/3	60.00%		
023	N	E	2000	2667	10/15	11/9	Front process	21	15	11/3	75.00%		
024	N	D	100	133	10/18	11/12	Front process	24	17	11/5	75.00%		
025	N	A	500	833	10/18	11/12	Front process	24	17	11/5	60.00%		
026	N	C	200	333	10/18	11/12	Front process	24	17	11/5	60.00%		
027	N	F	700	933	10/18	11/12	Front process	24	17	11/5	75.00%		
028	Y	C	130	217	10/19	11/13	Front process	25	18	11/6	60.00%		

SIMULATION AND EXPERIMENTS

In order further to compare the performance of these three priority rules, the simulation experiments are designed. The environments of experiment are as follows:

(1) Six processes, i.e., frontend, cut, probing, sorter, QC, and Die count etc., and their CT are as shown in Table 3.

(2) Seven product specifications, i.e., A~G etc. and their production output distributions are shown in Table 2.

(3) The production specification of arriving order depends on uniform distribution.

(4) The required quantity of an arriving order depends on normal distribution and its mean is 600K grains and standard deviation is 100K grains.

(5) The materials of all arriving orders are issued first come first in but limited by 2000K grains per day.

(6) The materials are successively issued until 100 days and this experiment ends when all orders are completed.

(7) The ratio of HT depends on the production output probability in Table 2 but its mean is changed by normal distribution.

Three indexes are utilized to evaluate the performance of these priority rules. The first index is the ratio of requiring at least two shifting MOs (RRS), i.e., RRS=the number of MOs that require at least two shifting MOs ÷ the total MOs. The higher RRS the worse the rule is. The second index is the inventory level in the Bins (ILB). The higher ILB the worse the model is. And the final index is the average cycle time (ACT). The higer ACT the worse the rule is.

Some results of the simulation are shown in the follows:

(1) For RRS, the performance of LDD rule is the best one. The EDD rule and SRQ rule gets the higher RRR and more 20% than that of LDD rule, as shown in Table 5.

(2) For ACT, the performance of SRQ rule is the worst one. The performances of both of EDD rule and LDD rule are better and almost alike, as shown in Table 6.

(3) The inventory of by-product, i.e., Bin #1 and #6, are higher than the inventory of other Bins for all priority rules, as shown in Table 7. However, the EDD rule gets the highest inventory level of by-product. And the performance of LDD rule and SRQ rule have no significant difference.

Based on the preliminary simulation study, the LDD rule gets better performance in all indexes. On the contrary, the performances of the SRQ rule are worse in neither indexes. Therefore, the LDD rule is recommended to improve the order fulfillment performance and inventory in the LED-DM plant.

Table 5: The Ratio of MOs Which Requires at Least Twice Shifting MOs (RRS)

	RSS
EDD rule	12.14%
SRQ rule	12.47%
LDD rule	10.10%

Table 6: Average Cycle Times (ACT) for Different Priority Rules

	ACT (days)
EDD rule	32.63
SRQ rule	33.489
LDD rule	32.267

Table 7: The Inventory Level in the Bins for Different Priority Rules

Die pieces (x K)	G1	G2	G3	G4	G5	G6	Total
EDD rule	8055.05	1682.05	168.05	113	784.8	3751.55	14554.5
SRQ rule	6943.75	1711.4	1260.8	130.9	234.6	1767.65	12049.1
LDD rule	8487.15	998.2	739.3	223.25	649.05	1267.45	12364.4

CONCLUSIONS

The LED die manufacturing (LED-DM) is an important process in the LED supply chain. The make-to-order production strategy is a general production model for the LED-DM plants to satisfy the variety requirement of their customers. Because the unstable production output of the LED-DM plants, the effective order fulfillment is low and variety. Under the severely competitive pressure, the production planner will thus confront the issue of expediting replenishment for an insufficient output of an MO. Two strategies, i.e., material re-issued and shifting other MOs, are generally utilized. Especially, the shifting MO strategy is required when the manufacturing lead-time is not enough or due-date is tight. The purpose of this effort is to meet the required due-date of this MO and to reduce the unnecessary inventory of by-product dies.

Therefore, a study of the shifting MO model for an insufficient output of the LED die manufacturing plant is proposed in this paper. The feasible MOs are first screened by some requirements in this model. Then three priority rules for this model, i.e., Earliest due date MO first (EDD), Latest due date MO first (LDD) and Smallest required quantity MO first (SRQ) etc., are proposed and detailed discussed. A real-life LED-DM case is then utilized to demonstrate and evaluate the application and effectiveness of this model. A simulation and experiment model is further designed to compare the performance of these rules. Based on the simulation study, the LDD model is recommended to improve the order fulfillment performance and by-product inventory in the LED-DM plant.

ACKNOWLEDGEMENT

The authors would like to thank the National Science Council of the Republic of China, Taiwan for partially supporting this research under Contract No. NSC 101-2221-E-216-016-.

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國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：102 年 4 月 1 日

計畫編號
NSC 101
2221
E
216
016-

計畫名稱
限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究

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會議

時間

102/3/30~3/31

會議
地點

Dalian, China

會議

名稱

(中文)2013 年製造科學與工程國際研討會

(英文) 2013 The International Conference on Manufacturing Science and Engineering

發表
論文
題目

(中文) LED 晶粒製造廠產出合工單量不足時的補投單模式之探討

(英文) A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant

1、 參加會議經過

2013 The International Conference on Manufacturing Science and Engineering was held in Dalian, China. The conference served as important forum for the exchange of ideas and information to promote understanding and cooperation among the Industrial Engineering and System Management.

In the conference, I published a paper entitled “A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant”. In addition, some other topics about management and engineering were all impressed me very much.

2、 與會心得

The international conference provided good opportunities for exchanging information and ideas among scholars in relative research fields. And I feel great for that I can also know other countries student's research.

3、 考察參觀活動(無是項活動者省略)

no

4、 建議

no

5、 攜回資料名稱及內容

Conference Program: 2013 The International Conference on Manufacturing Science and Engineering

6、 其他

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：102 年 8 月 1 日

計畫編號
NSC 101
2221
E
216
016-

計畫名稱
限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究

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會議

時間

102/7/1~7/3

會議
地點

New York Institute of Technology -Vancouver Campus

會議

名稱

(中文)2013 年全球商業與國際管理研討會

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論文
題目

(中文) LED 晶粒製造廠產出合工單量不足時的轉移製令模式之探討

(英文)A Study of the shifting MO Model for an insufficient Output of the LED Die Manufacturing Plant

一、參加會議經過

本研討會開始時間於 2013 年 7/1-7/3，總共有四種不同的議題，分別為服務與金融、行銷、科技與 經濟、教育與管理。本人於科技與經濟此議題中發表研討會題目「A Study of the shifting MO Model for an insufficient Output of the LED Die Manufacturing Plant LED (晶粒製造廠產出合工單量不足時的轉移製令模式之探討)」。研討會於 7/1 至會議單位完成註冊手續，而 7/2 下午一點抵達會場,並於一點四十分進行研討會分享，直到三點二十分此議題之會議才告一段落，期間互相與與會來賓交流，相當愉快並且感受到來賓們對於學術的熱愛。7/3 則是體驗當地文化的一天，於當地進行教學參觀之活動。

二、與會心得

參與 2013 年的全球商業與國際管理研討會，有機會認識來自各國不同學術領域的同學以及教授，各各皆是該領域之專家，對於所發表的文章，給予不同的觀點與建議，為本次參加學術研討會中的最大收穫。

三、考察參觀活動(無是項活動者略)

無

四、建議

無

五、攜回資料名稱及內容

Global Business & International Management Conference Journal 一本

六、其他

無研發成果推廣資料

101 年度專題研究計畫研究成果彙整表

計畫主持人：吳鴻輝			計畫編號：101-2221-E-216-016-				
計畫名稱：限制驅導式排程技術(DBR)於 LED 晶粒製造廠應用之強化模式研究(I)							
成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	2	2	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	3	3	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	1. Horng-Huei Wu, Ming - Feng Li and Cheng-Hsin Yeh, 2013, ’A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant,’ Advanced Materials Research Vols. 694-697, pp 3434-3440. 2. Horng-Huei Wu, Ming-Feng Li and Tzu-Fang Hsu, 2013, ’An order fulfillment model for the LED chip manufacturing plant, ’Advanced Materials Research, Vols. 694-697, pp 3446-3452. 3. Horng-Huei Wu, Hung-Hsuan Wu, and Ming - Feng Li, 2013, ’A Study of the Shifting MO Model for an Insufficient Output of the LED Die Manufacturing Plant,’ Global Business & International Management Conference Journal, Vol.6, No.2, pp.46-55.

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

　　□實驗失敗

　　□因故實驗中斷

　　□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：（以 100 字為限）

1.
2013, ’ A Study of the Material Re-issued Models for an Insufficient Output of the LED Chip Manufacturing Plant,’

2.
2013, ’ An order fulfillment model for the LED chip manufacturing plant’’

3.
2013, ’ A Study of the Shifting MO Model for an Insufficient Output of the LED Die Manufacturing Plant’’

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

（1）對於學術研究、國家發展及其他應用方面之貢獻：

- 建立 DBR 於 LED 晶粒製造廠之研究模式。
- 建立應用 TOC/DBR 在 LED 晶粒製造廠之模式。
- 將研究結果提供給國內工廠有意導入 TOC/DBR 方法之業界作為參考。

（2）發表本計畫之成果於國內外研討會與國際期刊(SCI)，提供給學術界與業界參考。