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2019 International Conference on Industrial Technology Innovation (ICITI, 2019)



"Industry 3.5" as Disruptive Innovation for Intelligent Manufacturing for Emerging Countries and Empirical Studies

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2019/8/27

決策分析研究室 http://DALab.ie.nthu.edu.tw



The Earth is not enough for everyone... Inter- vs Intra-country Gaps

How many Earths do we need if the world's population lived like...

A		RA	AP.							
₩ U.K.	2.9		0				India	0.7	<	
Switzerland	2.9						Brazil	1.8		
E Germany	3.0						China	2.2		
Russia	3.3					<u></u>	Spain	2.3		
South Korea	3.5						Italy	2.6		Ç
🎦 Australia	4.1				(Japan	2.8		
U.S.A.	5.0						France	2.8		

Source: Global Footprint Network National Footprint Accounts 2018



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Alncreasing Gaps



Business Impact

As Goldman Embraces Automation, Even the Masters of the Universe Are Threatened

Software that works on Wall Street is changing how business is done and who profits from it.

by Nanette Byrnes

Feb 7, 2017

At its height back in 2000, the U.S. cash equities trading desk at Goldman Sachs's New York headquarters employed <u>600 traders</u>, buying and selling stock on the orders of the investment bank's large clients. Today there are just two equity traders left.

Automated trading programs have taken over the rest of the work, supported by <u>200 computer engineers</u>. Marty Chavez, the company's deputy chief financial officer and former chief information officer, explained all this to attendees at a <u>symposium</u> on computing's impact on economic activity held by Harvard's Institute for Applied Computational Science last month. Average compensation for staff in equities sales, trading, and research at the 12 largest global investment banks, of which Goldman is one, <u>is \$500,000 in</u> salary and bonus, according to Coalition. Seventy-five percent of Wall Street compensation goes to these highly paid "front office" employees, says Amrit Shahani, head of research at Coalition.

For the highly paid who remain, there is a growing income spread that mirrors the broader economy, says Babson College professor Tom Davenport. "The pay of the average managing director at Goldman will probably get even bigger, as there are fewer lower-level people to share the profits with," he says.





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Industry 4.0



248% ROI (Return on Investment)



Advanced Manufacturing Partnership (AMP), creating high quality jobs and enhance USA global competitiveness.



and enhance \$1 investment USA global competitiveness. In manufacturing



\$2.48 economic activity

Source: Professor Ben Wang of Gatech (2015)



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Industry 2.0 (1-> 10..0?)

The Second Industrial Revolution, also known as the Technological **Revolution**,^[1] was a phase of the larger Industrial Revolution corresponding to the latter half of the 19th century, sometime between 1840/1870 until World War I. It is considered to have begun around the time of the introduction of Bessemer steel in the 1850s and culminated in early factory electrification, mass production and the production line. (Wikipedia)









Taylorism: Scientific Management (Industrial Engineering)

5

Internet of Things in Production: Industrie 4.0

Flexible Production: More Customer orientation



... profitable production for lot size 1

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TECHNOLOGY

The Death of Supply Chain Management

by Allan Lyall, Pierre Mercier, and Stefan Gstettner JUNE 15, 2018



Industry 3.5 Hybrid Strategy between Industry 3.0 and to-be Industry 4.0 via AI, Big Data **Analytics, Computing & Digital Decision as** disruptive innovations to empower smart production and Taiwan manufacturing (Chien, 2014).





T 2 30

透過電子設備 資訊技術,進行 自動化生産

、德國搶著做!台灣製造業不能等

工業 1.0

蒸汽機啟動機械 化生產,撤起第 一次工業革命

這是它們一定要推進的趨勢。」簡禎

因為這影響的不是台積電、聯發科

台達電任一家公司,而是整體台灣

統腳踏車業、鞋廠都上門來向他請益, 3 **茉傅開・因此,當他重回清大教書,一** 家的產業龍頭廠開始來敲門,從最上 电實務上的消息傳出後,他的名號在設 太陽能等,他著聯發科做過供應鏈管理 專體產業延伸到下游硬體代工廠、L 也替廣達做產品設計決策,現在就

无説

避免被上下夾殺

工業 2.0

使用電力作為 大量生產的動

電的例子告訴我們・它們的良事可以 簡禎富將決策分析的理論用到台續 超出同業,靠的不是前段 估算・台積電先進製程良 設備與技術投資、後 巾調機構研 究分析師 的數據分析與預測 心分析師戰受美說 算,才是它們能 鍵・二田院産經 直保持領先的

戦備料、産能規畫・求取最大利益 只要花錢買機台就可以做,可是台號 全世界的製造業,很多人都以

eindustrialization)」,要把高階製造搬回美國去 · 一葉的競爭力 國推動「工業四・〇」・將高度自動化與數據分析 過去這幾年,美國政府積極喊出「再工業化

2014, 11/24 / 84

技術導入徳國工業・往「無人工廠」的目標發展

「勢力、大量生産的低階製造,又被中國搶走,台灣 箸眼於提升自家製造業的競爭力。 美國、德國把製造業價值最高的這塊拿走,便 簡禎富認為,這是台灣所有製造業者不

重塑華人大未來

用過去管理經驗,先從部分自動化做起

迴避的課題

- 什麼?」

ro製造業一定要升級,要用大數據的思惟來想事情, 找們自己攻擊敵人的武器卻是弓箭與矛。所以,台 **發展大數據,就如同我們把精良武器都賣到海外**. 、台灣過去總被稱為製造大國、軟體小國・如果

式・提出 像美國、德國做到全自動化・可不可以用混合的方 「度想・「我們不能停在工業三・〇・短期内又無法 未具備足夠能力・發展工業四 一個工業三・五?」簡禎富直言・台灣製造 〇的全自動智慧

近升台灣製造業的競爭力・因為這一戰・台灣已沒 廠・但我們可以利用過去的管理經驗與智慧・先 分自動化做起,再搭配數據分析的力量,從根本

做械所分析師黃仲宏口中聽到,「大數據絶對是開啟 造業往智慧化、自動化發展的一大關鍵。」 相較於歐美製造業都在升級,簡顧富從另外一種

同樣的說法,也在對智慧工廠研究甚深的工研院

增加我們的產業競爭力。」 工研院巨資中心主任余孝

迎向轉型

實觀案例

簡禎富建議:台灣應獨創工業3.5

Cover Story

工業 4.0

透過機器人與大數 陳·達到生產少量

樣,兼具環保, 能在都市進行製



台企新五四運動,《工業 作者簡禎富:德先生是 3.5》 公司治理和決策;賽先生是科 學管理與分析!





ndustry 3.5

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Industry 3.5 for Taiwan & **Emerging Countries**

工業35

10 Fin



Kevin Plank: "Time for disruptive innovation for labor-intensive shoe making that is dominated by Asian countries..."



Under Armor Lighthouse is groundbreaking new design and manufacturing hub to push the boundaries of what's possible via pioneering the best practices, efficiencies, and methods that will help us make products faster and better...

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UA LIGHTHOUSE MANUFACTURING & DESIGN LEADERSHIP CENTER



11



Robot for shoe making via EMS such as Flex (Flextronics)



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Not easy to replace human :)

Flex and Nike terminate business relationship

Flex and Nike has mutually agreed to wind-down the footwear manufacturing operations in Guadalajara by the end of the year.

"Regarding NIKE, we have worked hard with NIKE to make our footwear operation in Mexico technically and commercially successful. In recent weeks, however, it became clear that we are unable to reach a commercial and viable solution with NIKE and have mutually agreed to wind down our NIKE footwear manufacturing operation in Guadalajara by December 31, 2018. We are finalizing the terms and details of the wind-down and we are striving to retain many of our affected employees and to repurpose our facility", states Christopher E. Collier, CFO at Flex Ltd. in an analyst call.

In connection with the closing of the operation, the EMS-provider recognised USD 30 million of exit costs primarily related to its estimated impairment of fixed assets. Additional costs as the wind-down is completed may be incurred.

"I would say that we are disappointed where we sit right now. I think as we step back, NIKE was extremely unique in differentiating and I think that it was an important feature that we went after and we are just being very thoughtful at this stage in terms of where we sit. And since we can't get to a commercial agreement where our shareholders can have a sustainable return, we decided to exit", Collier continues.

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Industry 3.5 aims to empower human being as "Iron Man"



WPG Holdings is the world No.1 Semiconductor Distributor and the largest electronics distributor



Human empowered by AI

human replaced by robots and AI

Digital Transformation : Industry 3.5 as alternantive strategy





^{大聯大控股執行長 葉福海} 面對新變革 一起共享共好 把市場做大

大數據、物聯網的出現,使得運作近百年的商業流程,將在5年內全面「顛倒」,過往大量製造銷售、壓低成本、擔佔市占率的紅海手段已面臨考驗。在 面臨變革的重要時刻,大聯大領頭,邀請產業建立共識、攜手打群架,建築智 慧供應鏈平台的生態圈,一起贏市場,把市場做大。

撰文者 商周數位 2017-09-07 瀏覽數:2049

▲ 讃 94 分字



^{清華講座教授 簡禎富} 善用台灣優勢 鋼鐵人迎戰機械人

工業4.0驅動各國製造戰略競合,台灣製造業如何乘勢而起?清華講座教授簡禎富 提醒,台灣必須升級轉型,但無法一步到位,工業3.5的混合策略是先當銅鐵人, 善用台灣人的管理智慧和產業利基,並整合新科技的應用,搶先卡位。

撰文者 商周數位 2017-09-27 瀏覽數:1849

✔ 讃 216 分字







wpg



Industry 3.5 is better for Emerging Countries







SAP "indirect access"

- Indirect access is a term used to define the situation where a SAP customer is liable for additional license fees when third party applications access data held in SAP.
- If a customer fails to purchase licenses for users accessing a SAP system indirectly through a third party or custom interface, such as software-as-a-service (SaaS) application. For example, a third-party or custom mobile app for tracking goods and updating SAP records accordingly would be deemed indirect access.
- February 2017: SAP wins court case against Diageo that is ordered to pay £54,503,578 in licensing fees after its sales staff were running Salesforce applications on top of SAP data.
- SAP seeks \$600 million in compensation for unlicensed use from the Belgian brewing giant Anheuser-Busch InBev that was also settled in June 2017
- May 2017: SAP responds to Diageo indirect licensing case with "modern pricing" approach
- October 2017: SAP launches Licensing Transparency Centre responding to continued confusion from customers regarding indirect access...

Source: https://www.computerworlduk.com/it-vendors/sap-indirect-access-explained-3671760/

Industry 4.0: Algorithmicized "production chess" within cyber-physical systems



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IFFE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINFERING

A Novel Route Selection and Resource Allocation Approach to Improve the Efficiency of Manual Material Handling System in 200-mm Wafer Fabs for Industry 3.5 Chen-Fu Chien, Member, IEEE, Che-Wei Chou, and Hui-Chun Yu

Abstract—Motivated by realistic needs to enhance the productivity for 200-mm wafer fabs, this paper aims to propose a novel approach for manual material handling system (MMHS) to mimic functionalities of the automated material handling system in the advanced fabs without intensive capital investment to deliver the wafer lots manually and systematically. In particular, a mathematical model is developed to optimize the routing plan with two objectives that minimize the total traveling distance in all routes or minimize the number of manpower needed in all routes. Furthermore, a route planning approach is proposed to utilize the routes that reduce the technican traveling distance and transportation time for implementation. Also, a manpower loading index was developed for evaluating the number of needed technicians in the proposed MMIS. To estimate the validity of the proposed MMHS, we developed a simulation environment based on empirical data with different transportation requirement scenarios for comparison. The results have shown practical viability of the proposed approach.

Note to Practitioners—As advanced manufacturing strategies such as Industry 4.0 are proposed for smart production, 200-mm wafer fabs cannot be equipped with fully automation facilities such as the automated material handling system to enhance overall productivity. To address the needs in real settings, a disruptive innovation manual material handling system vas developed, on the basis of existing 200-mm fab facility, to organize the technicians to mimic the setting of a virtual material handling system manually to enhance productivity. Indeed, the developed solution has been implemented in this case company, in which the results have validated the proposed approach that can be a hybrid between the existing Industry 3.0 and to-be Industry 4.0.

Index Terms—Fab economics, Industry 3.5, manpower allo-ation, manual material handling system (MMHS), productivity, oute planning.

I. INTRODUCTION

SEMICONDUCTOR fabrication facilities (fabs) are the most capital-intensive and complex manufacturing plants that consists of lengthy re-entrant processes including cleanthat consists of lengthy re-entant processes including clean-ing, oxidation, deposition, metallization, lithography, etching, ion implantation, photoresist strip, inspection, and measure-ment [1]. The wafers pass through approximately several hundred processing steps for wafer fabrication, in which opera-tional efficiency and productivity enhancement via maximizing the themschwart and initial which minimize mean internathe throughput and yield, while minimizing cycle time, and

critical for maintaining competitive advantages [2], [3]. Automation in modern fabs enables efficient material han dling between resources to reduce cycle time and manufacturing cost [4]. In particular, the advanced 300-mm fabs rely on automated material handling system (AMHS) to manage the wafer transportation in fabs [5], [6]. Furthermore, Germany has proposed a manufacturing strategy, Industry 4.0 [7], for smart factory via cyber-physical systems and decentralized decisions within a smart and networked platform. However, most existing 200-mm fabs that find it difficult or cost effective to install AMHS employ technicians maneuvering the trolleys for moving the wafer lots [8]. Motivated by realistic needs to empower 200-mm wafer

fabs, this paper aims to propose a disruptive innovation via manual material handling system (MMHS) that mimics the AMHS functionalities by technicians and reduces the trolley accidents effectively. However, since the technicians n decide by themselves the wafer lots and the correspond transportation route, some lots may be delayed causing cycle time increase, while serious trolley accidents happen causing

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Industry 3.5

Smart Fab of Industry 3.5





Circuit Probe (CP) test for wafer to identify "Known Good Dies"



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Optimizing multi-variate analytics

8.371 58.373 56.375 56.377 56.379 56	381
Speed:	
47	
47 45 51 53 55 57 59 61 83	6,5
Jpperbound of Position	
56.371	
56.371	
Upperbound of Speed	
4.7	
Lowerbound of Speed	
1-	



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A model-based, goal-based "intelligent agents" can perceive environment and take actions to maximize its chance of success at some goal.





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Al for defect detection in precision forming industry (1/2)

- Step 1 : AOI image collection and Image preprocessing
- Step 2 : Image labeling







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CASE (FIELD)

The TSMC Way: Meeting Customer Needs at Taiwan Semiconductor Manufacturing Co.

by Willy Shih, 節禎富, Chintay Shih, Jack Chang Source: Harvabool 23 pages. Publication date: Aug 13, 2009. Prod. #: 610003-PDF-ENG

When L.G. Tu receives an emergency order, he is confronted with a range of production scheduling choices, each of which has unique costs and trade-offs. The case was designed to help students understand job-shop style production and the impact of disruptions and reactive scheduling. Students use two of Taiwan Semiconductor Manufacturing Company's mainstream processes as a vehicle for analysis. The case describes a real situation in which upper management accepts an emergency order. By working through the impact on the production system, students should develop a feel for how shifting demand in a large factory that is structured as a job shop alters the demands on, and utilization rates of expensive capital equipment in a complex way. As bottlenecks shift, students can explore several alternatives, each with different costs and trade-offs. Students may also reflect on the true cost of providing the extraordinary service, and whether management properly takes the impact on operations into account when it makes customer commitments.

To maximize their effectiveness, color cases should be printed in color.





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2. What I Learned Building the Apple Store

Taiwan manufacturing experience to empower Indonesia Industries

Industry 3.5

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https://www.aims.org.tw/industry3.5

觀點

15 星期四

簡禎富:工業3.5才是台灣製造的機遇和戰 懇請不吝賜教!!!

名人講堂

簡禎富

隨著物聯網(IoT)、大數據、機器人和人工智慧(AI)的發展,產業轉型升級的工業革命已經在進 行中,越來越多工作機會因為自動化和智能化而消失,年輕人和弱勢族群更不容易找到好的 工作。世界各國均提出自己的製造戰略,換言之,發展工業4.0提升製造的國際競爭力以搶救 失業和經濟是德國的國家戰略。為了因應未來個人化、少量多樣的市場需求,工業4.0、大數 據和虛實整合系統只是「工具目標」,聰明生產和彈性決策才是根本目標。台灣應該認真做 SWOT分析,思考適合台灣的製造戰略。

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作在行理論」曾被用來形容國際分 工,日本不做的給台灣做, 台灣不做的給大陸和東南亞做一然 以前外移的工作拿回去做:德國工 國家和亞洲拿回製造、德國、日本依 據工業基礎和產業結構轉型需求,發 的基礎·因此工業4.0應運而生。德 物戰調蒐集和分析所有生產過程相關 (cyber physical system)整合價值鍵 的所有生產區塊;其三是支持「大量 設? 图人他生產」(mass personalization)

務中;要達成預算執行率而短期能交 出的KPI,可能部分是以前就有的成 商。因為虛實整合系統每年都升級 構,而不是網絡和虛實整合的決策流 果。預算往往吸引各方來搶食,有 改版,而且是根據使用的數量來收 程,公司也沒有發展讀當的系統和工 而,現在這個分工模式已被打破,隨 時甚至劣幣遂良幣。真正在研發深 著機器人和智慧製造系統的生產力和 耕的公司不一定會去或爭取到政府 比較利益,日本等先進國家可以把 補助,這樣折騰反而對產業生態系 統有失衡的影響,健全企業投資經營 ¥4.0的戰略目標之一就是要從新興 環境和簡化法令規章,讓產業生態和 市場機制去汰弱留強,空出空間讓滿 足未來需求的新創企業種苗得以成 要機器人和自動化系統已經有幾十年 長,或許比普遍施肥更好。台灣資源 有限·更不能遍地開花,卻無人種樹 國工業4.0的醫學有三:其一是藉由 給後人乘涼。就像每個縣市都放煙 火、辦燈會等小確幸活動,但有幾個 的大數據:其二是發展網宇虛實系統 縣市延續長期的應政整圖,認真處 理下水道和共同管溝等看不到的建

總著產業價值鏈因為工業革命而 端、網際網路、物聯網歐測溫)等資 買工業4.0的設備和大數據的軟硬體

費,不付錢就不能使用,於是每年台 具讓這些人可以彈性決策。 灣廠商的收入不管有沒有賺錢都要先 付一大筆給系統商,若台廠只能使用 授權的製造平台,將變成別人製造系 血汗司機一樣。這不是台灣應該走的 路

建設性對抗有助提升競爭力

低成本為主的競爭優勢正快速喪失 4.0當特效藥,靠大躍進的運動就一 中。台灣基礎工業能力和研發或許 不如人,先進設備部仰賴進口,但這 些困境都無法短期改變,必須長期嚴 新的發展,日益強化對上下 系統,但是台,實很多公司卻未必能夠

付職大的金額給製造系統軟硬體廠 策的權力,公司仍停留在官僚層級架 統只會加速貧富差距和社會不安,

另一方面,台灣大多數的公司還 統的殖民地,就像自己買車去靠行的 能真正發揮形而上的智慧製造和彈性 **言**之,公司能夠用數據和分析來做為 多環環相扣的問題有待解決,不同公 台灣以跟隨式創新,快速量產,降 部顧問就可以解決,也不可能把工業 步到位

以台積電為例,張忠謀十幾年前 積電成為「流體組織」提升組織效 率,鼓勵跨部門溝通要建設性對抗 和能力,也就是另闢蹊徑,先在既有 structive confrontation) · 讓真理愈 的製造系統環境下 · 達成或局部朝工 續富口述 · 記者莊衍松整理)

台廠可收割過渡期利益

德國工業4.0的階段目標是2025 沒有準備好面對工業4.0的革命,執 年:「中國製造2025」也是希望在 的不是工業4.0的軟硬體設備,而是 2025年從製造大國變成製造強國; 美國雖然總統改選,但推動再工業化 決策能力的組織運作和公司治理。換 和製造回流美國的壓力只會更強。台 景應該要有自己的製造戰略和生存 決策依據嗎?台灣不同產業領域有很 智慧,把握目前產業結構轉換的空 檔·善用僅存的相對競爭優勢和台灣 司也有各自的基本功要课,不是靠外 製造管理的軟實力。我並不反對台灣 產業升級轉型往工業4.0邁進,但大 多數公司可能無法一步到位。其實大 面,在每個利基產業發展工業3.5的 多數公司只是工業4.0系統和設備的 大數據分析和聰明生產解決方案,提 使用者。既然如此,何不等到相關系 就親自講授推動企業轉型,讓台 統設備更成熟再導入?當務之急還是 先發展能夠善用智慧製造系統的人才

大丽景的大數據分析

等重大政策和預算會帶動產業熱潮 雖然潮起潮茲,但科技進步和產業革 命仍將繼續前進,台灣小國眾民如何 自處?許多人都在找「藍海」,我說 為只要市場大、利潤高、一定會吸引 跨國強權競逐,最後必然淪為微利競 爭的紅海·

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我曾提出「藍湖策略」(Blue Lakes Strategy) · 一方面 · 透過台 廠的彈性和勤奮更點近不同客戶需 求,將藍海市場碎形化成更多的藍湖 甚至藍池塘,維持每一個利基市場甚 至個人化市場的高利潤,但因為總市 場不夠大到吸引大企業進入;另一方 高未來工業4.0的企業的進入成本和 競爭鬥檻,一言以蔽之、製造大數譯 和工業3.5是台灣製造的機遇和「進 可攻, 退可守」的戰略。(本文由關





Thank you very much for your kind attentions!!!

Q&A



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