出國報告（出國類別：訪問）

德國工業4.0

服務機關：國立清華大學
姓名職稱：王小璠講座教授、張瑞芬特聘教授、
陳寶蓮副教授、黃淑婷助理
派赴國家：德國法蘭克福、漢諾威、柏林
出國期間：2016.8.22-2016.9.2
報告日期：2016.9.20

摘要

德國工業 4.0 是指製造要從市場需求出發，當工廠物聯網後，具有靈活彈性的動態即時生產系統流程，能直接連結消費市場網絡；並讓生產製造與產品設計協同開發，做到降低成本、增加生產效率、提高品質和增加應變能力。

本次參訪德國法蘭克福萊美兩河地區是歐洲經濟活要地區之一，且為自動化工業的重鎮，並有許多創新的中小企業、研究中心等，透過訪問 FRM 投資促進會，了解德國工業產業的動向。並拜訪 Bluefield、ProSTEP 和 IPK 了解業界和研發單位的運作模式，以及拜訪 Leibniz University、TU Berlin 了解學界的觀點。並拜訪 DIN 為德國和世界各國之各項標準奠定一個基礎。

目次

壹、目的

工業 4.0 是一個未來的趨勢，這個趨勢所創造的是一個 ”everything is connected through the internet and things are done automatically”的理想境界。要朝這個理想境界邁進，數位化，自動化，標準化以及系統整合為四個主要執行重點，後兩項將會是台灣廠商及工程研究學者要面臨的主要挑戰。為什麼呢？因為我們擅長單打獨鬥與專注於專業分工，只做自己擅長的「技術」並專研下去，不太習慣跨界合作。

這樣的習慣，會讓我們在工業 4.0 後失去競爭優勢，因為趨勢背後推動的就是一個跨領域的整合，透過前述的四個執行重點，保有專業分工的優點，又同時能讓廠商間無縫接軌。以單獨每一個技術來評論，我們都算強，但湊在一起卻無法創造競爭優勢，因為我們缺乏的正是讓一個系統運作的橋樑系統。要改變這個習慣，學校的老師應該從跨系所實質合作開始，工業與企業管理應該扮演橋樑或系統整合的角色。

貳、過程

此次蒙教育部邁向頂尖大學計畫支助，利用暑假期間於 8/22-9/2，為期 11 天，隨同「先進製造與服務管理」總計畫主持人王小璠教授前往德國與工業 4.0 相關領域之組織和學者進行產學研交流。在此向教育部致謝！

本研究中心代表一行三人並助理一人於 8 月 22 日晚上 9 點至機場，搭乘 11 點的班機飛往德國。於 8 月 23 日上午 7 點半抵達德國法蘭克福機場，提領行李後，先至機場火車櫃台啟用通行票，再搭乘飯店的接駁車至飯店寄存行李。隨後開始訪問行程：

時間：2016 年 8 月 23 日（二）
地點：Stadtallendorf
單位：Mr. and Mrs. Klos 鄉間居家

上午 10 點至法蘭克福火車站，並在火車站內用餐，搭 11 點火車到 Frankfurt 北方約一小時車程的郊區 Stadtallendorf，造訪 Mr. and Mrs. Klos 的鄉間的居家，Stadtallendorf 位於德國格林童話中小紅帽故事的起源地 Alsfeld 附近。

Mr. Timo klos 是網路監控、評估、安全方面的專家，他的公司 Bluefield 是一家相當獨特的網路巨量資料監控評估的(美國)公司，他是德國的代表，我們除了趁旅途到達第一天的空檔探討格林童話的德國鄉間美景，更與 Mr. klos 和他的同事 Stephan 有頗多 mobile telecomm 及網路流量效率等安全議題上的討論。同時更深刻了解德國人崇尚自然低調的鄉間生活，收獲頗多（圖 1）。

時間：2016 年 8 月 24 日（三）09:00-12:00
地點：Frankfurt
單位：德國法蘭克福萊美兩河地區國際投資促進會（FrankfurtRheinMain GmbH）

早上 8 點半至旅館出發，先到 FrankfurtRheinMain GmbH (德國法蘭克福萊美兩河地區國際投資促進會)參訪，瑪麗(Dr. Marita Strubelt)是台灣事務部主任及 Mr. Sascha Peters (IT for Work, Darmstadt 的商業促進組織)都給我們詳細的介紹。他們主要在支援招商事宜、國際企業赴該地區投資、設立公司的相關事務的支援。他們提及約有 25 所大專院校與這類組織下的企業有合作。

法蘭克福萊茵-緬因地區就像是一座航空城，所有的經濟活動是圍繞著法蘭克福機場為核心運作。機場同時掌握貨物與人的移動，但光有機場是不夠的，讓商人想移動至此的動趨力得存在才行。這個趨動力主要來自相對的技術與市場優勢，以及能解決跨國貿易會面臨的問題的基礎建設如招商組織與飯店。其中，法蘭克福區域政府單位設置的這個機構，大大降低了跨國貿易的進入障礙，它能外國公司快速的了解相關的法律規定，媒介潛在的合作對象與提供相關商業服務的機構如律師及地產商等。

根據 FrankfurtRheinMain GmbH 代表說明，法蘭克福地區以汽車，製藥，與化學等工業為主。周邊有多所大學，所以人力資源不乏。對於工業四點零 4.0，他認為重點會放在數位化。很訝異的是，德國工業數位化程度沒想像的高。也就是說，自動化不等於數位化。德國的經濟體是以中小企業為主，即使這些公司已經自動化，他們的數位化程度不高。要走向工業四點零就需要數位化，而這些中小企業主就跟台灣的廠商類似，數位化的成本對他們來說是一個蠻大的負擔，所以推廣上會有阻力，除非讓他們看見這個投資可能帶來的潛在收益。而這個潛在收益，主要會是在競爭優勢來源會是製造客製化與庫存成本的大量降低。也因為有訂單再製作，就可以在製造完直接運送至買家。

目前在 FrankfurtRheinMain 管轄區域的台灣企業也已達 20 多家。Mr. Peters 也介紹 Prof. Metternich (Production Engineering, TU Damstadt) 的 Learning Factory for Agile Manufacturing, Energy Management 及工業 4.0 的構想，並希望我們能建立合作的計劃（圖 2）。

討論結束後已接近中午，搭乘附近飯店的接駁車至機場附近用餐後，下午 2 點與 Pro STEP 的學生會合。

時間：2016 年 8 月 24 日（三）14:00-20:00
地點：Darmstadt
單位：PROSTEP, Inc.

接著前往 ProSTEP, AG 訪問（圖 3）。Dr. Josip Stjepandic (Head of Business Unit in 3D Product Creation) 安排他的學生開車接我們到位於 Darmstadt 的 ProSTEP 總部參訪。他介紹了 Pro STEP iViP Association(有 180 個原始成員)以及 Pro STEP, AG (年營業額超過 3 千萬歐元，有大約 250 位員工) 的技術數位產品及研發重點。

Pro STEP 在汽車設計製造上對產品資料的數位化(Digitalization)著力甚深，藉由產品資訊 container 的結構化，極高效率的建立管理，協同分享，使產品生命週期所有作業能達到高效率、高品質、高可靠度的結果。Pro STEP 可說是工業 4.0 的最關鍵、最基礎的工作，是工業 4.0 成功的關鍵(尤其在複雜產品，如汽車產業、工具機產業 4.0 的實現上) 。

ProSTEP 的主要銷售軟體 3D PDF 是可將一個產品從設計到製作再到回收階段中各項獨立設計軟體，可整合輸出到它的系統軟體上。再依各階段的管理需求運用 3D PD 快速的呈現，並讓原物料供應商能正確了解，該廠商所需要的原物料之規格與設計為何，並同時與採購等管理系統結合，讓成本控制與採購管理更便利與精準。這個軟體其實是邁向工業 4.0 一個重要產品，因為從設計到採購甚至是回收，都可以在這樣一個系統上看到，這對於各階段的管理人來說，是一個很重要的工具。

不過現在這個軟體設計主要應用在汽車製造業，若要用在其他產業，需要在系統上能整合其他產業既有的軟體。資訊與應用系統整合也是 ProSTEP 的強項，正是工業 4.0 所強調的數位化、虛實整合 (digitalization, inter-operability, CPS integration) 的重點工作。

時間：2016 年 8 月 25 日（四）
地點：法蘭克福至漢諾威

結束法蘭克福的訪問，8 月 25 日一早搭乘火車，中午抵達漢諾威，準備隔日的 Leibniz University IRR 中心參訪。當天進行訪問資料整理及閱讀。

時間：2016 年 8 月 26 日（五）
地點：漢諾瓦萊布尼茲大學 Leibniz University
單位：Institute of Risk and Reliability

今天參訪的是在風險與可靠度管理研究所（圖 4、圖 5）。這是一個新改名的所，主要是將 CS 中做 simulation 的人與 civil engineering 中做風險分析的人整合在一起。由 Dr. Michael Beer、Dr. Volker Berkhahn 和 Dr. Matteo Broggi 介紹他們實驗室發展出的風險與可靠度分析軟體。

雖然這個軟體，可以設定各式各樣機率分佈，但對於使用的工程師來說，這個軟體並不能讓他們的分析更省力，因為它並沒針對個別應用內建議值。

時間：2016 年 8 月 27 日（六）、8 月 28 日（日）
地點：漢諾威至柏林

結束漢諾威的訪問，星期六一早搭乘火車，中午抵達漢諾威柏林，準備下週一的參訪。因德國重視休閒、家庭時間，因此週末進行訪問資料整理及閱讀。

時間：2016 年 8 月 29 日（一）10:00-16:00
地點：柏林
單位：柏林工業大學 Technische Universität Berlin （TU Berlin）

一早 9 點半前往柏林工業大學訪問，TU Berlin 是一所德國著名的工業大學（圖 6）。它是德國前三大工業大學，且是第一所允許授予工程博士學位(Dr. in Engineering)的大學。

土本工程(全名為 Computer and Civil Engineering)有 12 位 Chair Professors，我們與 Prof. Timo Hartmann 及 Prof. Wolfgang Huhnt 以及他們兩位的博士研究員座談討論 IoT, ICT (尤其 Digital modeling in construction industry)，如何運用 motion sensor 及各類 sensors 做建築物自動量測。如何整合大量數據於大型公共工程等議題上。工業 4.0 的技術可被運用於此領域，且有很大發揮的空間。似乎土木工程領域對 Industry 4.0, Iot, CPS, Service innovation 等概念仍在萌芽期，即使德國土木工程界也才開始從 BIM(Building Information Management)擴散衍生，BIM 在台灣應該是比較類似營建管理 GIS 部門，有很多研究發展及應用的潛力。

當天 Timo 亦安排我們參觀他們頗具特色的“AEG Factory 1912”工業化初期的巨大廠區（圖 7），目前已 Remodel 為 Civil Engineering 的 Lab，但仍保留原建築及代表性設施。充份顯示德國在工業化過程中的 Infrastructure and architectural Development。

下午由 Dr. Michael Kluge 介紹研究項目主要是運用感應器與系統軟體來監控建造過程完成度如 Dry wall 管理。其感應器能感應人的活動與濕度來了解施作牆壁完成度。不過這些感應器並不是針對營建業需求而設計的，離要能真正實際運用還有一段距離。譬如那個濕度感應主要是感應空氣中的濕度，不是牆壁濕度，如何能正確的從空氣濕度轉換到施作牆壁的乾燥度是一個問題。這轉換需要累積相當的實驗資料才能有判斷的基準線。

時間：2016 年 8 月 30 日（二）09:00-13:00
地點：柏林
單位：DIN and international standardization

一早 8 點半前往 DIN 訪問（圖 8、圖 9），1995 年德國聯邦政府與 DIN 正式簽約，使 DIN 成為德國制定國家標準及參與國標準組織的正式代表。DIN 的功能是多元的，它包括所有國家技術標準判定的程序、組織、規範遵循的執行。也包含代表德國參與歐盟及國際標準制定，亦常常擔任主導的角色(如秘書處之類的任務)。

DIN 也提供標準相關技術諮詢，輔導顧問，教育訓練，以及國家及國際標準的各類標的出版。DIN 也參與相關 projects 提供各項領域知識及標準規範。為維持其中立，DIN 財務具有高自主性，同時是一非營利組織“DIN e.V.”。目前 59%收入來自自身服務提供，20%來自產業相關計劃參與的收入，只有 12%來自德國政府的支持，有 9%是 DIN 2,000 多會員(公司、大學、研究機構等)的會費收入。

工業 4.0 的相關標準，尤其工業 4.0 的發展藍圖架構，是由 DIN Digital Technologies 部門負責主導訂定及發展相關標準。最新的工業 4.0 德國標準藍圖(Version 2)剛於今年初發表並由 DIN Digital Technologies 主管 Dr. Stefen Weisgerber 正式提交 EU 歐盟 CEN 標準組織。

此標準藍圖含括了完整的工業 4.0 領域範圍；例如，Industry 4.0 各種參考模式、系統架構、工業 4.0 使用範例、基礎技術、工程發展、資訊及通訊技術、積層製造(3D 列印)及人機介面、人因相關之功能設計。藍圖報告特別對其標準制定程描述。

DIN 有一個小的展示中心（圖 10），將 DIN 制定的相關標準及其在現實生活上的應用很生動地用實物示範。例如，示範電動腳踏車相關標準，紙張 sizes 標準，建築如樓梯尺寸標準等。

時間：2016 年 8 月 31 日（三）09:00-12:30
地點：柏林

單位：Fraunhofer Institute for Production Systems and Design Technology (IPK)

IPK 在德國是一個類似台灣工研院的機構（圖 11、圖 12），但它的運作方式還蠻特別的。IPK 成立於 1986 年，目前有 600 位成員(科學家、研究人員－全職或研究生、及其他中心的服務人員)。IPK 有 10 個主要 Labs，90 個測試區，佔地約 9500 平方米。 IPK 每年科研收入達 3500 萬歐元。它的經費已大多自己籌措，約只 1/4 經費是來自政府的支持。

值得一提的是在 IPK，計劃的內容著重在能快速應用，具商品化價值的研發。它的研究群是以技術類別來區分，每一個研究群是以學校教授主導，這位教授除了研究外，也得同時與產業界連結，進行產學合作。為了讓教授能維持基礎研究與企業合作的平衡，IPK 有設計一套回饋機制，當教授進行太多或太少的產業合作案時，政府回饋到這個研究群的研究經費就會降低。

很多研究計畫與工業 4.0、產品生命週期資料數位化、虛實整合相關。例如，結合 IoT、Sensors、Simulation 及製造廠之應用，將生產系統精進為可快速客製化產品的製造系統。又如數個機場的飛機 MRO 維修作業，可透過虛實整合(CPS)的系統建構，讓 MRO 多元需求能快速地被零件數據庫，自動製作，備料送達等 CPS 所滿足。

這次參訪的研究群與企業在研究一個提醒維修的感應器及 APP，它會感應機器表面的一些力學狀況，若達該維修的時候，它會自動訊號給電腦。這個感應裝置，尺寸不大，而且能用 USP 充電。我們學校工科系老師，其實也有在研發感應器，但其感應器的電源設計問題未決還有對應用方向似乎不太明確，或許可以朝工業 4.0 的方向思考如維修感應通知裝置。

另外，IPK 也展示了智慧機器手臂。機器手臂其實已經在生產鏈上應用很久，但是 IPK 的設計概念是讓這個裝置能多工並自我學習並與其他機器手臂協調分工，讓機器本身不閒置。IPK 建有 Micro Production、Micro-machining 和 Medical manufacturing 等非常具特色的實驗室，並著重在如何精進其工具機台的精密度和生產品質。

時間：2016 年 9 月 1 日（四）、9 月 2 日（五）
地點：柏林

結束德國的訪問，週四早上六點前往機場返台。但原預計 8:45 飛往法蘭克福的班機延遲至 9:50 起飛，抵達法蘭克福已接近 11 點，11:20 華航回台的登機櫃台已關閉，我們無法順利銜接班機。

漢莎航空安排最快回台的班機是晚上 10 點的班機至香港，再由香港返台；因此，最後遲延 14 個小時才於 9 月 2 日晚上 8 點半抵達桃園機場。

參、心得與建議

一、 心得：

- 王小璠教授

（一） 德國以中小企業、高品質產品、嚴謹的製程與不斷的研發見長。此次訪問主要發展工業 4.0 的三個地區(法蘭克福、漢諾威、柏林) 中之五個研發公私立單位。在事前多方的諮詢、規劃、與聯繫下雖不能說已涵蓋相關的工業 4.0 議題，但參訪單位從公部門之政策制定(GmbH, 法蘭克福)、產品規格標準化與執行(DIN, 柏林)、學術科技研發(萊布尼茲大學 IRR; 及柏林工業大學)、至私人企業數位化製程軟體系統(ProSTEP)之應用，我們深切體會產業整體生命週期中達到工業 4.0 的基本要件與其間環環相扣、共同提升產業水準的運作模式。

（二） 台德均以中小企業為發展的基礎。以德國人嚴謹務實的做事態度、自信的研發能力、與整體經濟發展的策略眼光、及相對開放的合作分享精神，我國應更積極的與德國進行具體的合作。尤其工研院已在德國有駐歐辦事處，經營多年，已有相當績效。 應可為進一步促進雙方合作的平台。本研究中心也將思考在最後一年如何與此次訪問的單位建立合作關係，以為下一步之旗艦計畫鋪路。

- 張瑞芬教授

（一） 德國在推動工業 4.0 的規劃與執行上，充分運用大學相關實驗室 (例如柏林工業大學，TU Darmstadt，Leibniz - IRR 等)、研發機構(如 Fraunhofer - IPK 等) 、國家級和區域性政府及公部門(如 FrankfurtRheinMain)、標準組織(如 DIN) ，以及企業 (如 ProSTEP) 的資源與人力投入，有架構有系統的循序漸進，且非常有計畫地與歐盟和國際組織與市場結合，形成一股產業進步的強大力量，在數年間將德國既有的工業優勢，又往上提升。德國在工業發展的歷程中，從工業 1.0 到工業 4.0 從不缺席，不斷積極尋求突破與精進，稱為全球最有實力最具競爭力的工業大國，無庸置疑。的確值得我國產官學研的借鏡與參考。

（二） 德國整體國家建設和國民生活的素質，也值得我們學習。此次有幸造訪三個德國的城市和區域，無論在城市、鄉間，工業區、農業區或商業區，發覺全國的生活水準相當一致，顯現一個進步的國家對整體國人生活的提升非常的用心。德國在二十年間，尤其東西德合併、近期的難民潮等對社會經濟發展上的困境和挑戰，德國都勇於克服承擔，也很值得我們的學習。

- 陳寶蓮教授

（一） FrankfurtRheinMain GmbH 必須能挖掘出製造廠商，並使其能直接接觸到新客戶或是能跳過中間人直接面對既有客戶，才能吸引企業數位化，加入工業 4.0 的場域。

（二） 3D PDF 的軟體若能整合其他產業既有的軟體，會成為建立系統性運用，以及最佳化管理的重要工具。

（三） 德國學界也嗅到工業 4.0 的未來需求之一是在土木工程上領域，要能針對該領域的主要風險來源做預測並能事先警示，如地震災害與使用維護。

- 黃淑婷助理

（一） 法蘭克福城市發展定位清楚，以便利的交通樞紐、發達的金融產業為基礎，且 FrankfurtRheinMain GmbH 非常積極，致力吸引、引進各國企業進駐，降低企業進入障礙，非常值得借鏡。

（二） Fraunhofer IPK 成立宗旨是匯集各機構的專業知識和經驗，全面研究和提供可行解決方案。其研究成果與產業連結非常密切不失焦，能直接應用、解決市場問題，非常值得工研院取法。

二、 建議：

- 王小璠教授

（一） 此次以工業 4.0 為參訪主軸的行程與本中心發展的方向極為吻合。自上學期規畫至終於成行，實經過相當的折衝與困難。主要本中心(本國)因過去較缺與德國的聯繫。但以工業 4.0 為首的德國卻是本中心極力想了解，借鏡與建立合作關係的國家。尤其期望在一次的行程中能將重要的研發單位都能含蓋，所以在時程與人員的協調上面臨相當困難。此次雖有工研院駐歐辦事處(ITRI)的幫助，但僅限柏林地區，其他大區只有毛遂自薦。因此難免有遺珠之憾。

（二） 建議政府能增加歐洲駐點單位，或加強現有單位之功能與權限。不僅要瞭解駐地國的經貿技術發展，也要了解台灣即時的科技政策。兩相配合方能有效幫助雙方之合作。

（三） 此次相當遺憾的是本中心五計劃主持人最終僅本人成行。策略管理組由陳寶蓮教授代表，綠價值鏈計畫之張瑞芬教授因為本人退休後之替代主持人，故邀請參加。建議未來在如此難得的參訪行程中，各主持人均能積極參與，取法其他先進研發單位作法，以提升自己的研發能量。

- 陳寶蓮教授

（一） 工業 4.0 的一個重點是供應鏈上各階段間的介面要能溝通，所以標準的制定極其重要。台灣的政府或廠商若能積極參與這些標準制度協會，即使不能影響標準制定方向，但至少能提早知道標準未來走向，及早布局或因應。

（二） 我們學校的工科系與電機系目前有個別在做感應器以及有毒氣體分析的老師，但還沒朝土木工程應用上發展。這樣一套系統，雖然還在非常初步發展階段，但卻是營建業邁向工業 4.0 一個必須的概念，因為它有潛力讓營建過程及其管理更趨數位化與自動化，大幅降低營建管理成本。這對現今人力難尋的土木營建業，尤其重要。

- 黃淑婷助理

（一） DIN 在制定國際各項標準具有深厚影響力，若能加深聯繫合作，定能強化各類產業競爭力。

（二） 德國教職體系特殊，非教授人力比例高，對於教授在推展其研究與教學上十分有利；在大學人力配置上，可以調整改變，減緩教授的行政負擔。

肆、附錄

一、攜回資料

（一） FrankfurtRheinMain 介紹說明簡報（P15-16）

（二） FrankfurtRheinMain 合作企業介紹簡報（P17-20）

（三） DIN 介紹說明簡報（P21-23）

（四） DIN 工業 4.0 說明簡報（P24-27）

（五） IPK 工業 4.0 說明簡報（P28-35）

二、活動照片

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>圖 1、拜訪 Mr. and Mrs. Klos 鄉間居家</td><td>圖 2、與 FrankfurtRheinMain GmbH 合影</td></tr>
<tr><td> 
</td><td>  </td></tr>
<tr><td>圖 3、與 PROSTEP 合影</td><td>圖 4、與 IRR 討論</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>圖 5、與 IRR 合影</td><td>圖 6、拜訪 TU Berlin</td></tr>
</table>

	
圖 7、參訪 TU Berlin 的廠區(實驗室)	圖 8、與 DIN 討論
	
圖 9、與 DIN 合影	圖 10、參觀 DIN 展示區
	
圖 11、參訪 IPK 實驗室	圖 12、與 IPK 合影

Become a part of it ...

FrankfurtRheinMain welcomes the
Delegation of AMSMRC
National Tsing Hua University

FrankfurtRheinMain GmbH
International Marketing of the Region
August 24th, 2016

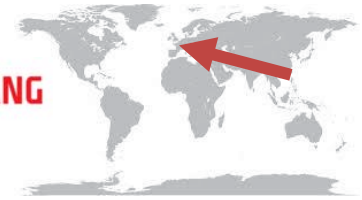
1

From Taiwan to FrankfurtRheinMain….- Samples

AAEON an ASUS company

D-Link Building Networks for People

greatlink



SANYANG

SEYI

EVA AIR 長榮航空

Portwell

4

Our organisation

- Inward investment agency
- Promote the region internationally
- Attract foreign companies to the region
- Multilingual, internationally experienced team
- Government funded
- Representative offices: India, China, USA

2

Source: Fraport AG

FrankfurtRheinMain
Well connected!

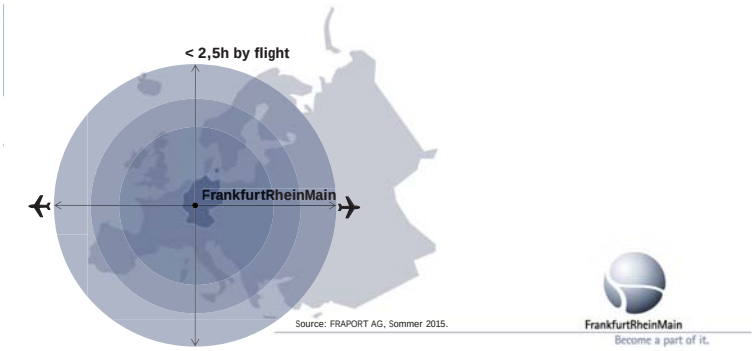
- Leading European airport hub
- Unrivaled cut-off times for overnight delivery
- Highly efficient inter-connectivity between Autobahn, air-, water- and railways
- A wide variety of logistic providers
- 240 cargo-only flights per week to 84 destinations (Europe´s most important cargo hub)

5

FrankfurtRheinMain

- Population: 5.6 million
- Workforce: 3.0 million
- Forest area: 37%
- 35 million consumers in a 200 km radius
- ~9% of all products Made in Germany are manufactured in FrankfurtRheinMain

3



Source: FRAPORT AG, Sommer 2015.

Frankfurt International Airport (Examples)	
Paris	1,25h (101 flights/week)
Prague	1,15h (54 flights/week)
Warsaw	1,40h (48 flights/week)
London	1,50h (168 flights/week)
Rom	1,75h (56 flights/week)
Helsinki	2,50h (37 flights/week)
Madrid	2,50h (70 flights/week)
Moscow	3,00h (75 flights/week)

Fast inter-German/EU fast-train-connections	
Munich	ca. 3h
Hamburg	ca. 3.5h
Berlin	ca. 3,5h
Brussels	ca. 3h
Paris	ca. 4h

6

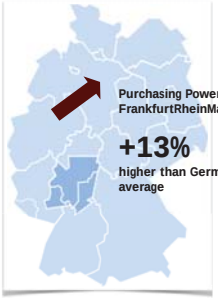
automechanika · IAA · FRANKFURTER BUCHMESSE · light+building · techtextil · ambiente

FrankfurtRheinMain
Become a part of it.

„Shop window“ to the world

- Messe Frankfurt: >40 trade fairs, >1,4 million visitors and >40,000 exhibitors in the city of Frankfurt p.a.
- Short distances to hotels, airport, trains
- Convention region: from state-of-the-art congress centers to magnificent historical buildings & villas

7



Source: mb-research, 2016

Purchasing Power/Capita/Year 2015

Frankfurt	€ 25.168
Berlin	€ 20.303
Hamburg	€ 24.331
Stuttgart	€ 24.919

FrankfurtRheinMain
Become a part of it.

A strong local market

- Excellent conditions for consumer goods/retailing industry and their suppliers
- Consumers 5,6 mill. (within 60km), 35 mill. (200km), 500 mill. (2,5h flight)
- Dense network of outstanding business services (multi-lingual/multi-cultural)

8

Brothers Grimm memorial in the city of Hanau – birthplace of German fairy tales. Stadt Hanau, 2014.

FrankfurtRheinMain
Become a part of it.

A remarkable talent pool

- 25 universities (>200,00 students)
- >100 Bac/Master programs in foreign languages
- 6 Max Planck-, 3 Fraunhofer- and 4 Leibniz Institutes
- Over 70 other research centres
- 76 clusters/networks
- … and skills from established industries!

9

Schloss Vollrads, one of the world's oldest Wine Estates.

FrankfurtRheinMain
Become a part of it.

Quality of life? Absolutely!

- An efficient and modern infrastructure
- Countless & diverse recreational and leisure facilities
- Over 200 museums, about 200 galleries, the nation's leading opera house in Frankfurt
- „Real“ fairytale landscape of castles, vineyards and villages

10

Our Services

FrankfurtRheinMain
Become a part of it.

We offer free advice for international investors to get started.


A personalized facilitation service


Access to international tax and labour law experts


Arrangement of tailor-made scouting visits


Assistance with work/residence permit applications


Site identification across the entire region


Sector and industry insights


Access to industry and business networks


You are welcome …

11

Digitisation in Frankfurt Rhein Main – Enabled through Cooperations

Frankfurt, August 24th 2016

Sascha A. Peters
Managing Director IT FOR WORK e.V.

What we mean by digitisation

Impact on our economy

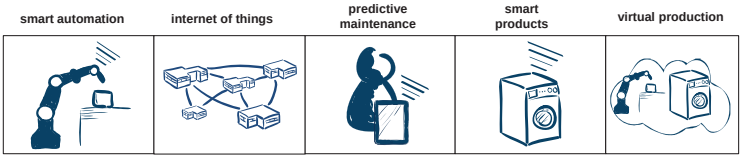
Agenda

1. What we mean by digitisation
2. Science & research in the FRM region
3. Economical strengths of the FRM region
4. The role of clusters
5. Success stories

What we mean by digitisation

Needs

- Technical needs



- Strategic needs

adapted business processes ⟷ flexible business structures ⟷ new business models

What we mean by Digitisation

Science & Research in the FRM Region

Science & Research in FRM

Overview

- 10 universities and research institutes
- over 50,000 students
- leading region in Europe for industrial and cyber security

www.forschungsfinder-hessen.de, Hessen Trade & Invest

Economical Strengths of the FRM Region

Science & Research in FRM

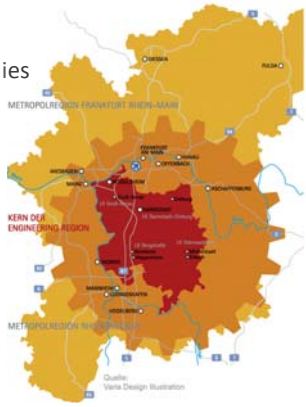
Relevant institutes and activities

- **Technical University Darmstadt**
  Mittelstand 4.0 – Competence Center
  „Effiziente Fabrik 4.0“ – „Industry 4.0“ model factory
- **University of Applied Sciences Darmstadt**
  Mittelstand 4.0 – Agentur
  Competence Center for Applied Sensor Systems
- **Frankfurt University of Applied Sciences**
  Realisation of an „Industry 4.0“ model application

Economical strengths in FRM

Facts & figures

- 70,000 industrial and trade companies
- growth domestic product (GDP): 36 billion euros/year



Science & Research in FRM

Relevant institutes and activities

- **Fraunhofer SIT (cybersecurity)**
  IUNO: National research project for cybersecurity in Industry 4.0 applications
- **Fraunhofer IGD (virtual reality)**
  FabLab: Digital manufacturing and virtual protoyping
- **Fraunhofer LBF (durability and reliability)**
  Additive manufacturing and smart services

Economical strengths in FRM

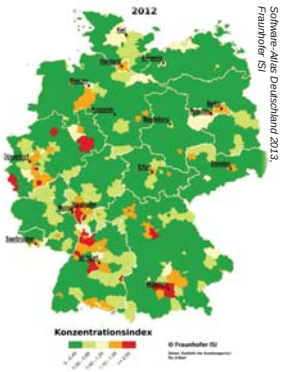
Strong in :

- information and communication technology
- automotive/mobility
- chemicals/pharmaceuticals
- automation and production
- logistics
- environment/energy

Economical strengths in FRM

IT competencies in FRM

- 7.600 IT companies
- 70.000 employees in the IT Sector
- 18 bill. EUR GDP per year
- >30% global market share for enterprise software



Concentration index: Ratio between the percentage of software and IT service sector with respect to total employment in a region and the same percentage in Germany as a whole.

Clusters

How we work

- events that combine information transfer and networking
- matchmaking on demand
- expert groups
- professional training for particular sector-related topics
- support in recruiting
- Support for public funding as to R&D projects
- … and other!

The Role of Clusters

Clusters

What we aim at doing

- **showing expertise** – offering a plattform to present the competencies of our members
- **supporting cooperation** – identifying potential innovations in order to promote technology transfer
- **enabling Growth** – providing information and services to push interaction with partners along supply chain

Success Stories

Success stories

Industry 4.0 projects in FRM region – enabled by clusters

MyFoam.net
Individuelle Schaumstoffeinlagen

CYPIFLEX
Industrie 4.0 im Mittelstand

KonM4.0 | MEHRWERT DURCH DIGITALISIERUNG

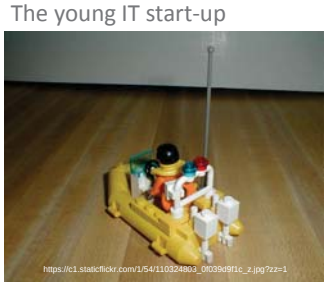
Success stories

IT FOR WORK Wir vernetzen.

„MyFoam.net“ – an example of successful cooperation

Wetropa
The medium-sized company

Bright Solutions
The young IT start-up



Success stories

IT FOR WORK Wir vernetzen.

CYPIFLEX – necessary competencies and project partners

- medium-sized manufacturing company / use case
- system architecture and processes
- intralogistics and automation
- procedure model and research
- project management and transfer of knowledge to medium-sized companies within the region

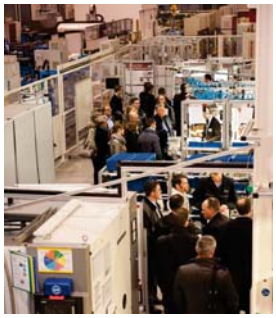
SANNER
axxessio
software
ECKELMANN
Datenverarbeitung in der Konstruktion
IT FOR WORK IHK

Success stories

IT FOR WORK Wir vernetzen.

KonM 4.0 Conference – added value through digitisation

KonM4.0 | MEHRWERT DURCH DIGITALISIERUNG



To sum up:

IT FOR WORK Wir vernetzen.

… Clusters are an enabler of the the digital transformation!

IT FOR WORK Wir vernetzen.

Questions?

Visit of a Delegation from the National Tsing Hua University, Taiwan

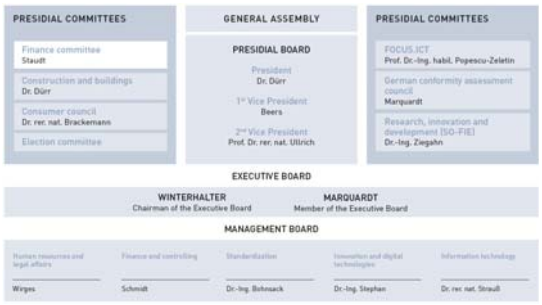
Welcome to DIN
German Institute for Standardization

Maria Albert
Project Manager International Cooperation

Berlin, 2016-08-30

As of: July 2016

Organization of DIN e. V.

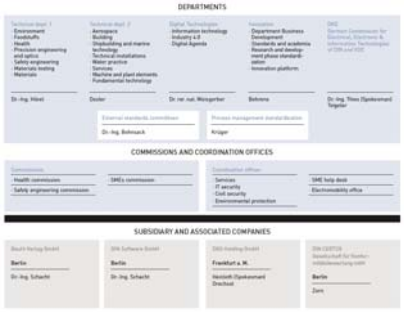


DIN e. V.

- Registered non-profit association supported by the private sector
- Based in Berlin since 1917
- Primary task:
  to develop market-oriented standards and specifications that
  - promote global trade and innovations,
  - assure efficiency and quality,
  - help protect environment and society

As of: January 2016

Departments and Commissions
Subsidiary and associated companies

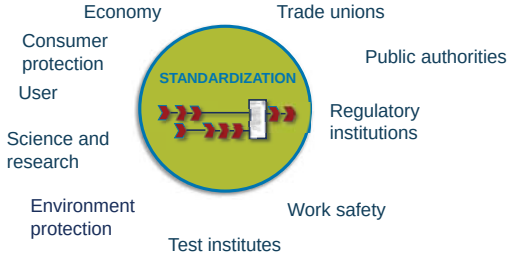


Standardization Agreement

- Public-private partnership between DIN and the German Federal Republic
- Agreement signed in 1975
- Recognizes DIN as the sole national standards body for Germany, representing German interests in European and international standards organizations

Standardization in joint responsibility

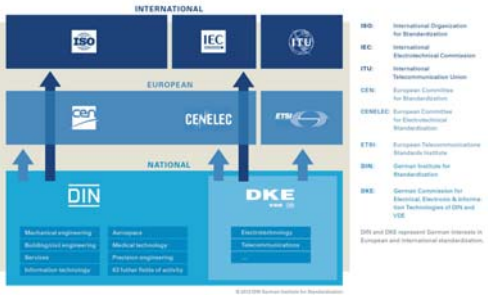
Democratic legitimation of standardization depends on the involvement of all stakeholders



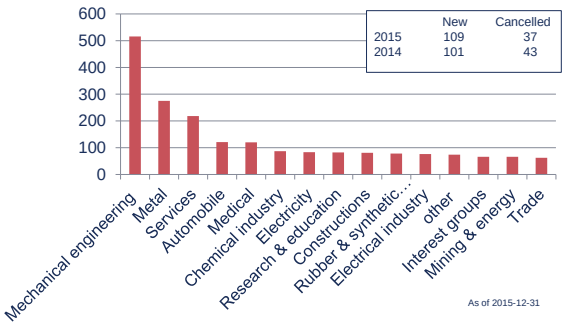
DIN's objectives and mission

- Involvement of all stakeholders, regardless of their economic strength or foreign language skills
- Promotion of free trade through active involvement in international and European standards work
- National adoption of international standards
- Uniform and consistent standards
- Avoiding duplication in standards work
- Compliance with legislation
- Active role in consensus-building

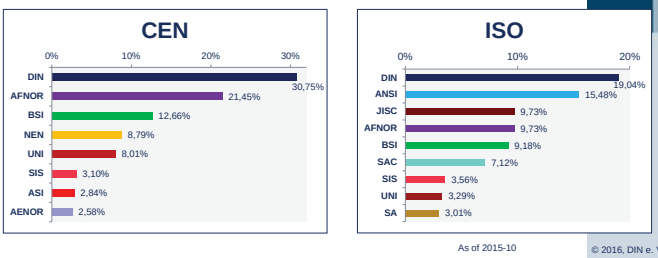
DIN represents German interests in international standards work



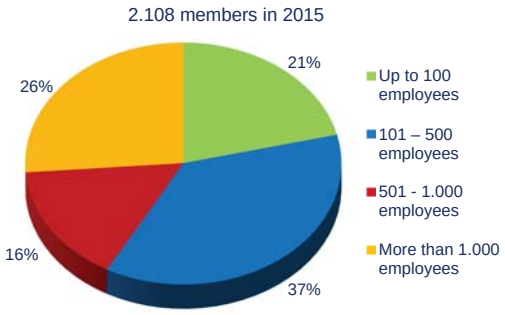
DIN-Members



European and international TC/SC secretariats



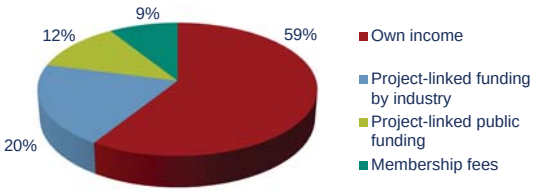
Members by company size



DIN – the figures

	2015	2014
DIN Standards (total)	33.877	33.856
External experts	32.199	31.366
Members of DIN	2.108	2.036
DIN employees	413	411
DIN Standards published	2.028	1.801
Draft DIN Standards	4.471	4.333
Standards committees/commissions	70/3	72/3
Working committees	3.534	3.600

DIN group: Breakdown of revenue sources 2015



Thank you for your attention!

Any questions?

Maria Albert
DIN e. V.
Phone: +49 30 2601 2301
Email: maria.albert@din.de

Legal aspects of standardization

- Anyone can use DIN standards.
  → Their application is voluntary (recommendation).
- Standards are only legally binding if they are part of a contractual agreement between parties, or if referred to in laws or regulations.
- Standards reflect the state of the art and are thus helpful in liability cases.

Standardization – an instrument of deregulation

- Standards help relieve the State of its responsibility for drawing up detailed technical requirements.
- At national level: National laws lay down the legal framework and set protection targets, while consensus-based standards describe in detail the means of achieving those targets.
- Standards reflect the state of the art because they are regularly reviewed by experts (at DIN every five years) to adjust for new developments.
- Thus, technical regulation is delegated to those most suited: experts from industry and other stakeholder groups.

Industry 4.0

August 30th 2016, Berlin
Filiz Elmas

Industry 4.0 – Eight Fields of Action

- **standardization and reference architecture**
- control of complex systems
- nationwide broadband infrastructure
- safety and security
- organization and formation of labour
- education
- legal framework
- resource efficiency

Source: Forschungsunion, acatech 2013

Industry 4.0

- Industry 4.0 – definition, fields of action and challenges
- Standardization activities on
  - National level
  - International level
- Conclusion

Industry 4.0 – Challenges

Manufacturing
Automation Technology
Logistics
System Architecture & Reference Model
Process Control Technology
Data Model
Characteristics
Ontology
Standardization needs Industry 4.0
Human-Machine-Interface
ICT
Cloud Computing
Big Data
Functional Safety
Piracy of Products
Maintenance
IT-Security

Definition

Industry 4.0/Smart Manufacturing is:

- Characterized by convergence of advanced manufacturing capabilities, digital technologies and internet of things (IoT);
- Integration of customers and business partners in business and value-added processes;
- The collaboration of human beings, embedded systems, fully or partly autonomous machines, and systems of systems.

It leads to:

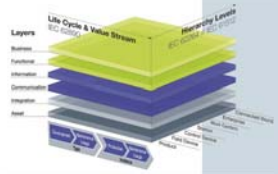
- The individualization (up to batch size 1 in mass production) of products, services and processes;
- The networking of systems, which results in highly complex structures and cyber physical systems (CPS);
- New forms of value creation, business models and subsequent services;
- Evolution of safety, security, organization, processes and work design;
- An impact on human productivity and innovation cycles.

Source: ISO/SAG Industry 4.0/Smart Manufacturing

Source: BMWi, press release from 2015-03-16

DIN SPEC 91345 – reference architecture model

- RAMI4.0 is a reference architecture model for semantic technologies and their benefits for automation and its associated technologies.
- One of the fundamental ideas on RAMI4.0 is the grouping and description of highly diverse aspects in a common model.
- RAMI4.0 permits step by step migration from the world of today to that of I4.0, and the definition of application domains with special stipulations and requirements.
- DIN SPEC 91345 on RAMI4.0 published in April 2016



Standardization Council Industrie 4.0

- Coordinates and initiates standardization activities in areas of Industry 4.0 nationally and internationally
- Bundles work involving the cooperation of German bodies and organizations in all sectors
- Ensures consistent standards development
- Supports industry actors as well as researchers in their work
- Involves all stakeholders and other developers of technical rules to include the widest range of German stakeholders as possible in this important work
- Defines the need for new projects and organizes their implementation at international level

Holistic Approach

DIN/DKE Steering Committee Industry 4.0

- Standardization Roadmap Industry 4.0
- Radio
- Standardization Process
- Use Cases

DIN

Coordination Office IT Security (KITS)

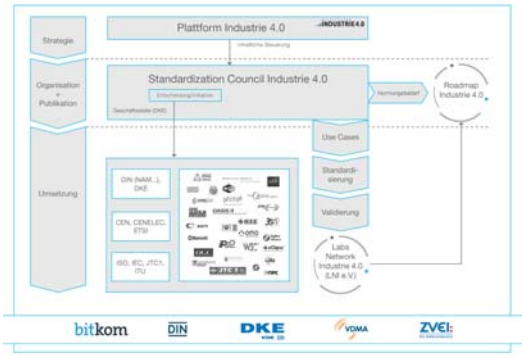
- Coordination and consulting of stakeholders and standardization committees
- Analysis of national and European legal requirements
- Conferences

Standardization Roadmap IT-Security

Standardization Roadmaps

- Innovative topics such as Industry 4.0 or smart cities involve the integration of many systems
- These topics are presenting standardization with new challenges
- Today, strategic discussions require a broader view rather than focusing on one standards committee

Standardization Council Industrie 4.0



Why? – Standardization roadmap…

- Is a central source of information for standards bodies, companies, associations, research institutes and governmental bodies
- Serves as a guide for actors in all sectors and supports industry actors as well as researchers in their work on complex subjects
- Bundles the interests of all actors and helps to increase the market acceptance of their new technologies
- Gives new ideas on how to implement ideas
- Ensures consistent standards development

How?

- DIN and DKE organize and coordinate the development of standardization roadmaps
- All relevant stakeholders and where necessary other developers of technical rules are included in the development process
- Experts from both the public and private sectors are responsible for drawing up the standardization roadmaps
- Under the leadership of DIN and DKE, the roadmaps are continually revised and published

 13

Subject areas and requirements

- Standardization requirements for Industry 4.0
- Reference models
- Use Cases
- Fundamentals
- Non-functional properties
- Development and engineering
- Communication
- Additive Manufacturing
- Human beings in Industry 4.0
- Standardization process

 16

What? – Standardization roadmap…

- Is a "living" document and reflects the current situation
- Summarizes ongoing activities and the work results of these activities
- Gives an overview of all relevant stakeholders
- Gives a comprehensive overview of the current status of standardization
- Lists existing standards and specifications
- Outlines the need for further standardization and gives recommendations for action

New version available for download: www.din.de/go/industry-4-0

 14

Standardization Activities – Overview

Germany	Europe	International
DIN-Standards Committees (e.g. NATG, NIA, NAErg, NAM etc.) DIN/DKE-Steering Committee Industry 4.0 DKE-Standards Committees Platform Industry 4.0 under direction of BMWi/BMBF Industrial Data Space under direction of FhG VDI-GMA ZVEI BITKOM VDMA	CEN/TC 310 „Advanced Automation technologies and their applications“ CEN/TC 319 „Maintenance“ CEN/TC 438 „Additive Manufacturing“ oneM2M - Standards for M2M and the Internet of Things	ISO/TC 10 „Technical Product documentation“ ISO/TC 184 „Automation systems and integration“ ISO/TC 261 „Additive manufacturing“ **ISO/SAG „Industry 4.0 – Smart Manufacturing“** IEC/TC 3 „Information structures and elements“ IEC/TC 8 „Systems aspects for electrical energy supply“ IEC/TC 65 „Industrial-process measurement, control, automation“ IEC/SC 3D „Product properties, classes and their identification“ ISO/IEC JTC1 „Information technology“ IEC/SG 8 „Industry 4.0 – Smart Manufacturing“

 17

Contents of Standardization roadmap Industrie 4.0

- Introduction
  - Objectives of Industry 4.0
  - Challenges for technology and standardization
  - Aspects of implementation
  - General information about standards and specifications
- Objectives of the Standardization Roadmap
- Current environment
  - Cooperation between standardization committees
  - Cooperation at international level
  - DIN/DKE Steering Group Industry 4.0, Platform Industry 4.0 etc.
- Subject areas and requirements (10 subsections, see next slide)
  - Initial situation
  - Areas of application
  - Recommendations
- Relevant standards and specifications and further information

 15

ISO Initiative on Industry 4.0/Smart Manufacturing

- Strategic Advisory Group on Industry 4.0 is established:
  - To provide a definition of Industry 4.0/Smart manufacturing and give an overview on available standards, use cases and current work related to Industry 4.0/Smart manufacturing
  - To identify possible gaps where additional standards are needed
  - To make recommendations on actions to be taken by TMB
  - To monitor other national, regional and international activities and suggest cooperation mechanisms with partner organizations, especially with IEC and ITU-T

 18

ISO Initiative on Industry 4.0/Smart Manufacturing

- Secretariat: ISO Central Secretariat
- Chairman: Nominated by DIN (Germany)
- Membership: Industry representatives nominated by the following ISO members: DIN (Germany), AFNOR (France), ANSI (USA), NEN (Netherlands), SNV (Switzerland), JISC (Japan), SAC (China), SA (Australia) and BSI (UK) plus an industry representative from JTC 1/WG 10 Internet of Things, as well as IEC and ITU-T representatives
- Term: Final report to be provided by the September 2016

 19

Conclusion

- Comprehensive, integrated work on standardization topics is needed, ongoing activities have to be bundled
- All relevant companies (especially the SMEs), organizations and consortia have to be involved in the standardization work
- Close coordination between standardization bodies and fora and consortia will lead to an effective support of the vision of Industry 4.0 through standardization

 22

Sino-German Standardisation Sub-Working Group on Intelligent Manufacturing/Industrie 4.0

- SINO – German Standardization Cooperation Commission – Agreement signed –
  - Long-term involvement on both sides
  - Define the scope of the UAG I 4.0
    - Reference Architecture
    - Uses Cases
    - Standardization Landscape
    - Coordination of activities in international standardization organizations
    - ICT Security/Safety
    - Others to be defined

 20

Thank you for your attention!

Any questions?

Ms. Filiz Elmas
E-Mail: filiz.elmas@din.de
Phone: +49 30 2601-2464
Webpage: www.din.de/go/industry40
Twitter: DIN_Innovation

Liaison with Industrial Internet Consortium

- IIC and DIN have agreed on formal cooperation in the field of standardization related to Industry 4.0
- A Memorandum of Understanding was signed last summer in Berlin
- The objective of this agreement is to coordinate the activities of DIN and the Industrial Internet Consortium in support of standardization efforts in areas impacting Industry 4.0
- IIC was founded in 2014 by AT&T, Cisco, GE, IBM and Intel and is currently boasting over 180 members, including small and large technology innovators, vertical market leaders, researchers, universities and governments

 21

» National Tsing Hua University Taiwan«
August 31st 2016

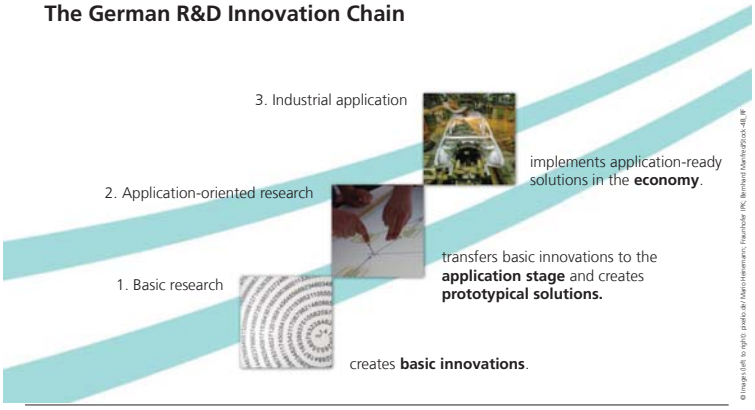
Fraunhofer
Fraunhofer IPK
Industrie 4.0

Prof. Dr. h. c. Dr.-Ing. Eckart Uhlmann
Director
Institute for Machine Tools and Factory Management IWF, TU Berlin
Director
Fraunhofer Institute for Production Systems and Design Technology IPK
Advisory Dean
School of Mechanical Engineering Tongji-University, Shanghai

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The German R&D Innovation Chain



Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Agenda

- **The Fraunhofer Model:**
  Application-oriented research supporting industries and governments
- **PTZ Berlin:**
  Cooperation for scientific investigation from basic research up to the application state
- **Industrie 4.0:**
  Research, industrial applications, business models

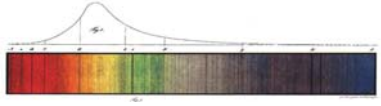
Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

From Idea to Practice : Who stands wherefore?

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Joseph von Fraunhofer (1787 – 1826)

- **Researcher**
  Discovery of "Fraunhofer Lines" in the sun spectrum
- **Inventor**
  New methods of lens processing
- **Entrepreneur**
  Head of royal glass factory

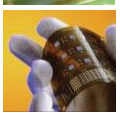


Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The Research Profile of Fraunhofer

Institutes undertaking related research are organized in Fraunhofer Groups:

- Information and Communication Technology
- Life Sciences
- Microelectronics
- Light & Surfaces
- Production
- Materials and Components
- Defense and Security



Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The Fraunhofer-Gesellschaft – Europe's Largest Organization for Applied Research

Headquarters in Munich

- Founded in 1949 in Munich
- 67 institutes and research units in Germany
- More than 24,000 employees
- Annual budget is about € 2 billion, partly public founded

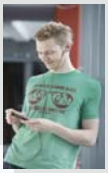
Representative offices, research units, and subsidiaries worldwide

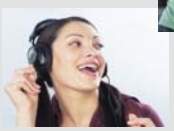
Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

International Rewards and Prizes Audio and Multimedia

Fraunhofer IIS





German Future Prize 2000

licence fees about 80 million euro per year!

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The Fraunhofer-Gesellschaft in Germany

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Intellectual Property Rights of Fraunhofer

	2009	2010	2011	2012	2013 (preliminary)
Active Patents	5235	5457	5657	6103	6407
Inventions reported p.a.	691	694	671	696	733
Invention disclosures p.a.	563	520	500	499	603

2012: Fraunhofer was
Nr. 15 of the most active **patent applicants** and
Nr. 12 of the most active **trade mark applicants**
at the German Patent and Trade Mark Office

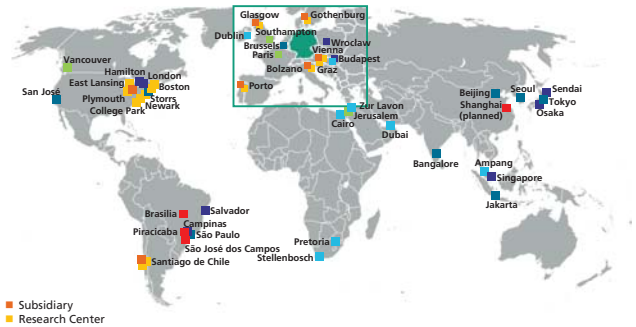
2013: Fraunhofer was
Nr. 45 of the most active **patent applicants**
at the European Patent and Trade Mark Office

2013: *according to international media and information firm Thomson Reuters,*
Fraunhofer is one of the **»Top 100 Global Innovators«**
(only 3 German companies made it into TOP 100)

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Fraunhofer Worldwide



- Subsidiary
- Research Center
- Project Center
- ICON / Scientific Cooperation
- Representative / Marketing Office
- Senior Advisor
- IPK Subsidiary / Research Center

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The Most Active Patent Applicants 2012

Applicant	Patent Apps.*	HQ
1. Robert Bosch GmbH	3972	D
2. Daimler AG	1991	D
3. Siemens AG	1921	D
4. Schaeffler Technologies GmbH & Co. KG	1854	D
5. GM Global Technology Operations LLC	1565	US
6. Bayerische Motorenwerke AG	829	D
7. Volkswagen AG	805	D
8. Audi AG	787	D
9. ZF Friedrichshafen AG	740	D
10. BSH Bosch und Siemens Hausgeräte GmbH	719	D
11. Hyundai Motor Company	533	KR
12. Ford Global Technologies LLC	504	US
13. Continental Automotive GmbH	435	D
14. DENSO Corporation	428	JP
15. Fraunhofer-Gesellschaft	**424**	**D**

Quelle: Deutsches Patent- und Markenamt, Stand August 2013
Die 50 aktivsten Patentanmelder beim Deutschen Patent- und Markenamt (Anzahl eingereichter DPMA-Direkt-anmeldungen im Jahr 2012)

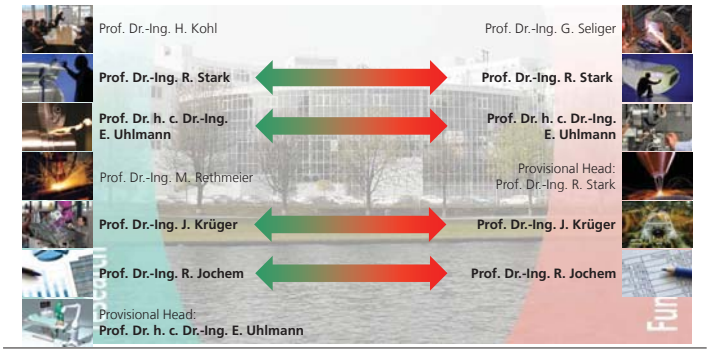
Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

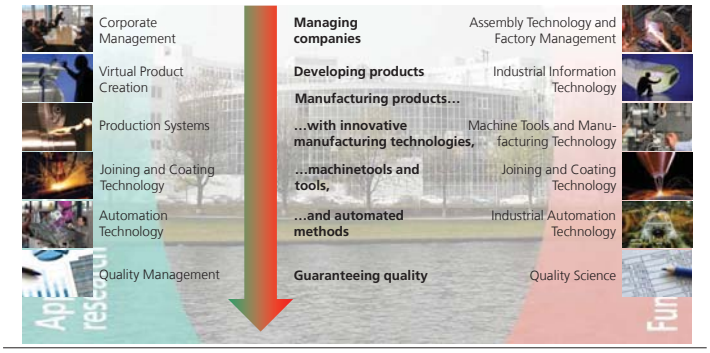
IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

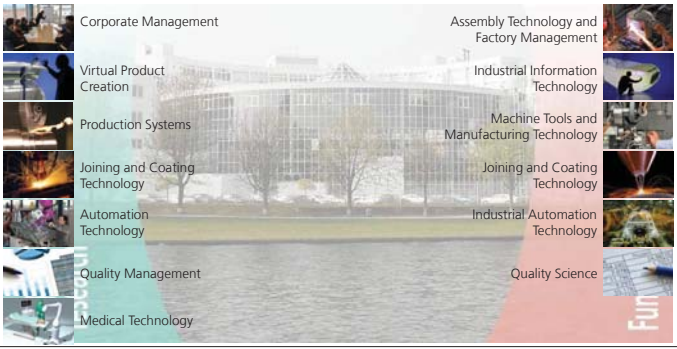


Agenda

- **The Fraunhofer Model:**
  Application-oriented research supporting industries and governments
- **PTZ Berlin:**
  Cooperation for scientific investigation from basic research up to the application state
- **Industrie 4.0:**
  Research, industrial applications, business models



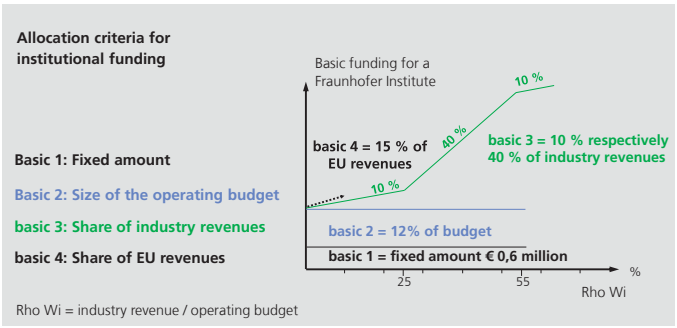




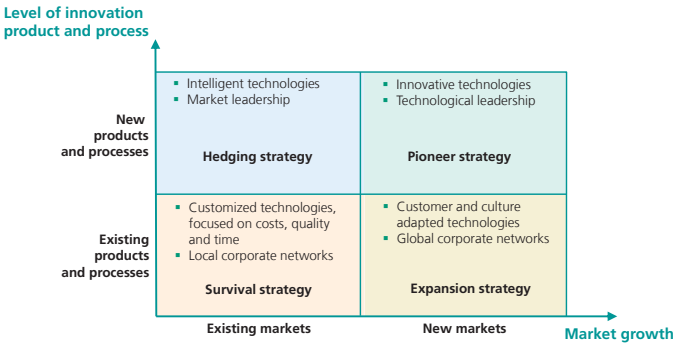
Production Technology Center
Facts and Figures
(2015)

- 1986 IWF and IPK move into PTZ
- > 600 employees (scientists, service and students)
- More than 90 test areas and 10 special laboratories on about 9 500 m²
- Budget of 35 million Euros in 2015
- Spin-offs and start-ups by 12 % of former staff members

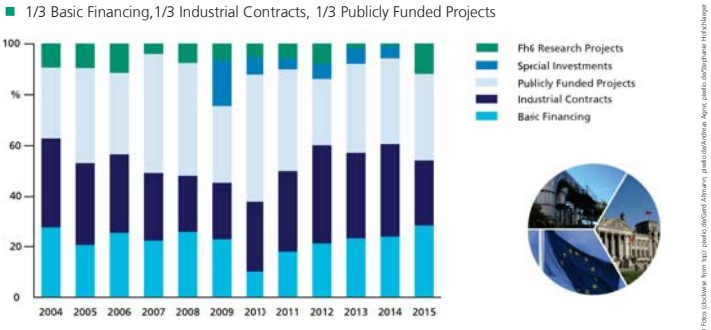
Allocation of Institutional Funding



Strategic Variants in the Product-Market Matrix



Funding of Fraunhofer IPK

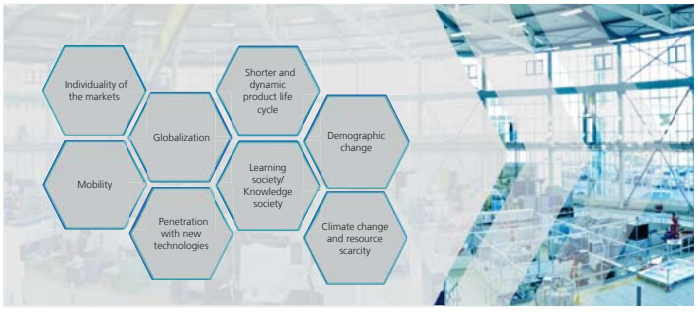


Our Portfolio: Research along the process chain of manufacturing companies

Corporate Management

The **Corporate Management** division works together with customers to design transparent, efficient and sustainable business and management processes, harmonize information and communication technology and in-house know-how to ensure a leading competitive edge. Its two specialist departments »**Business Excellence Methods**« and »**Business Process and Factory Management**« develop innovative ideas for management, planning, controlling and production processes. Methods include analysis and evaluation instruments such as **benchmarking** and **knowledge management**.

Megatrends Determine the Future



Our Portfolio: Research along the process chain of manufacturing companies

Virtual Product Creation

In the **Virtual Product Creation** division we realize the vision of a fully digitized product creation process. The two specialist departments »**Information and Process Control**« and »**Model-based Engineering**« support industrial companies and public institutions in their quest for ever-higher standards of excellence in their solutions. The portfolio of consultancy and development services ranges from independent technology surveys and optimization of digital applications to **optimization of information standards and IT integration architectures**.

Our Portfolio: Research along the process chain of manufacturing companies
Production Systems

Overarching aim of the **Production Systems** division is to engineer **application-specific modular and systems solutions** that ensure significant long-term improvements in the competitiveness of our customers. It focuses on the development, fabrication and adaption of **production and manufacturing technologies**, and on the **engineering and control techniques** needed in the creation of innovative products. The specialist departments »**Manufacturing Technologies**«, »**Microproduction Technologies**« and »**Production Machines and Systems Management**« develop **novel machines** and processing strategies, optimize existing production facilities and engineer **forward-looking concepts for tools**.

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Our Portfolio: Research along the process chain of manufacturing companies
Quality Management

Quality of products and services has become a vital element of competitive strategy. Given the ever rising complexity of processes in product creation, manufacturing and distribution, an **effective quality management** (QM) is now of the essence for quality assurance and on-going quality improvement. Efficient QM strategies and methods have to pay close attention to development and production and have to consider such areas as **production planning, acquisitions, and maintenance, repair and overhaul (MRO), as well as sales and customer service**. Our Quality Management division develops innovative concepts, methods and organizational approaches for the consistent **integrated evaluation and design of quality processes and QM systems**.

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Our Portfolio: Research along the process chain of manufacturing companies
Joining and Coating Technology

New materials call for new approaches in joining technology. The **Joining and Coating** division works in close collaboration with the BAM Federal Institute for Materials Research and Testing to develop new techniques for **materials which thus far have proven largely resistant to processing**. Our work is focused on engineering the requirements-specific joining and coating of **cutting-edge materials** and combinations of materials, on raising the quality and reliability of joints and coatings. **Simulation** of welding processes, distortion and residual stress facilitates the rapid introduction of cost-effective, energy-efficient techniques in industry, while also ensuring optimization of existing processes and components.

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Agenda

- **The Fraunhofer Model:**
  Application-oriented research supporting industries and governments
- **PTZ Berlin:**
  Cooperation for scientific investigation from basic research up to the application state
- **Industrie 4.0:**
  Research, industrial applications, business models

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

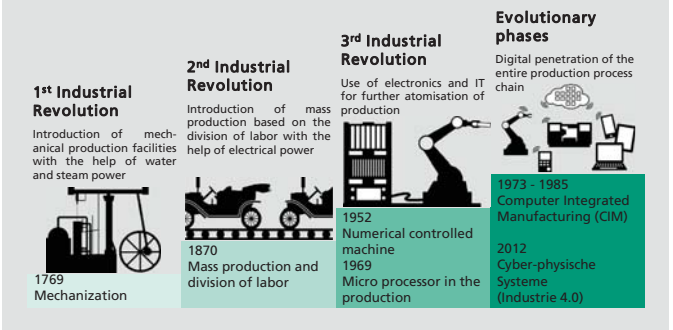
Our Portfolio: Research along the process chain of manufacturing companies
Automation Technology

The **Automation Technology** division develops technologies and systems which combine **innovative robotics** and **control and security concepts** with **methods of machine vision**. The aim is to raise **process efficiency** through integration and combination of these key automation components. One example of such an approach is machining processes with **new control technology** and **integrated human-machine collaboration** which enable industrial robots to flexibly and cost-effectively perform production stages previously performed by conventional machines. Another aim is to use innovative methods and automation concepts from the world of production engineering to pave the way for new applications and business sectors in the fields of **security technology** and human-machine interaction.

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Digital integrated, intelligent production
Industry 4.0 – The 4th Industrial Revolution?

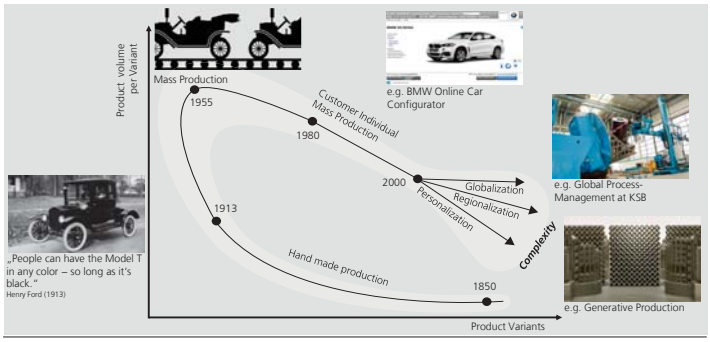


Quelle: In Anlehnung an BITKOM, VDMA, ZVEI: Plattform Industrie 4.0; Fotos: © Fraunhofer IPK

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Increasing Complexity leads to new Value Chains



Based on: The Global Manufacturing Revolution, Reference: Ford, beefeaxxtd.net, bmw.de, dw.de

Industry 4.0 projects at the Production Technology Center Berlin

Self-organized production

intelligent facilities, components, work pieces, decentralised, cooperative controlling und organisation, adaption to changes in the production environment

European and German Programs

EU Level

Horizon 2020
Aim: Generation of growth and jobs through research and innovation
Focus: Leading role of industry in manufacturing, processing and ICT
Subsidies: about 7 Mrd. € for the topic area
Term: 2014 – 2020

Federal Level

Hightech Strategy – BMBF Future Project Industrie 4.0
Aim: Germany as pioneer regarding the solution of global challenges
Focus: Production research, ICT research: „Intelligent Interconnection in Production"
Subsidies: 46,1 Mio. €
Number of Projects: 63 projects
Term: 2011 – 2017

AUTONOMIK for Industrie 4.0 – BMWI
Aim: Interlocking ICT with industrial production to exploit innovation potentials and accelerate the development of innovative products
Focus: Legislation, IT security, Future of Work, Standardization
Subsidies: 39,1 Mio. €
Number of Projects: 14 Projects
Term: 2014 – 2017

Based on: BMBF: Zukunftsprojekt Industrie 4.0 (2014), BMWi: Autonomik für Industrie 4.0 (2012), European Commission: Horizont 2020 in Bits - das europäische Forschungsrahmenprogramm (2014)

Industry 4.0 projects at the Production Technology Center Berlin

Intelligence and "Internet of Things" during production

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung


Barcode


RFID Transponder


eGrains

Today: **Product identification**
- Readable data media
- Identification of products, workpieces

Tomorrow: **Product memory**
- Reading and writing of information
- Traceability and documentation in production

Day after tomorrow: **Product intelligence**
- Information processing in radio sensor nodes
- Work pieces bring processing information
- Objects communicate, cooperate, decide
- Decentralized Intelligence through agents
- Flexibility because of product-driven manufacturing

Industrie 4.0 projects running in 2016

Crowd Production	950.000 €
JUMP4.0	660.000 €
IWEPRO	790.000 €
AMELI4.0	570.000 €
iLaP - Networked systems and equipment	2.000.000 €
Leistungszentrum Digital Networking	1.400.000 €
Adaptive learning and support system - Augmented Reality	120.000 €
pICASSO	420.000 €
MetamoFAB	420.000 €
E³ Assistance systems for the assembly	1.000.000 €
VIB-SHP - Virtual Commissioning / Smart Hybrid Prototyping	750.000 €
RetroNet - Retrofitting	620.000 €
Agent-3D	1.200.000 €
Testlab and Testware IoT	400.000 €
	11.300.000 €

IWEPRO – Intelligent Self-organized Shop-Floor Production

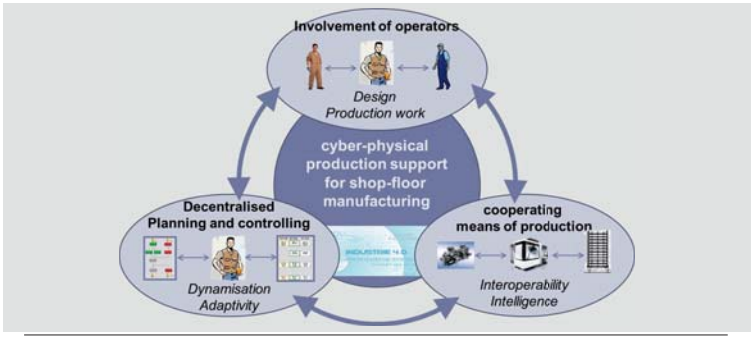
Federal Ministry of Education and Research

Decentralized production control

Combining the planning and control level

Examining the interactions
Developing technical solutions for cyber-physical production support

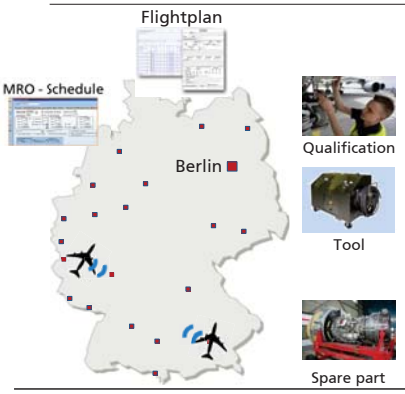
Intelligent Self-organized Shop-Floor Production



Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

The future starts today: application of direct communication of systems for the maintenance and repair of aircrafts



Qualification

Tool

Spare part

- simplification of Planning
- faster reactions to unpredicted events
- C and D Checks may be integrated in daily maintenance
- anticipated increase of the availability > 3%

Patent: FB 1104-01DE, FB 1104-02US

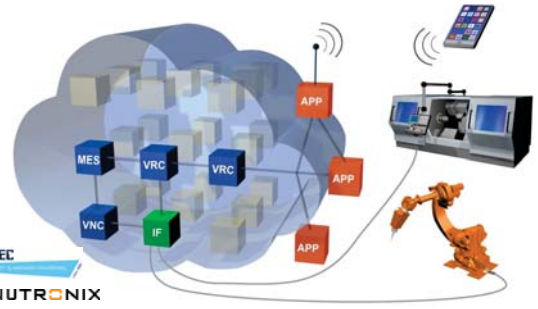
Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

41

Industry 4.0 projects at the Production Technology Centre Berlin

Industrial cloud-based controlling platform for a production with cyber-physical systems

- Scalable controlling platform
- Additional/ subsequent functional modules (app-concept)
- IT-methods for backup, redundancy, centralized updates



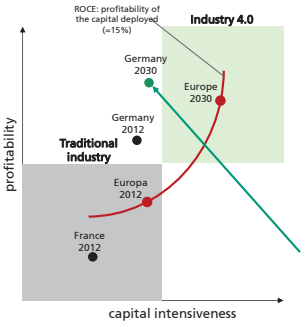
HOMAG GROUP
BOSCH
REIS ROBOTICS
SOTEC
LINUTRONIX

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

39

Impacts of Industry 4.0 to the business location Germany



Roland Berger: Industry 4.0 requires higher investments

- Risks in connection with the implementation of modern IT systems are already no longer representable for medium-sized businesses (Computerwoche 11/2012: „Handelsunternehmen fährt ERP Einführung an die Wand")
- Even after successful implementation investment costs are to high for SME while the ROI is to low– the more integrated the IT, the larger the expenses for interfaces and maintenance.

Industry 4.0 solutions of the Fraunhofer IPK lead to:

- Lower capital intensiveness
  SMI friendly solutions
  (e.g.: Industry 4.0 straight from the case)
- Better data- und failure security
  (Industrial Cloud)
- **»Industrie 4.0 aus dem Berliner Koffer / out of the Berlin box…«**

Source: Roland Berger - Think Act Studie

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

42

INDUSTRY COCKPIT

Opening the way to customized processes and products

© Fraunhofer IPK / Nicole Oertwig

© Fraunhofer

Fraunhofer IPK

31.08.2016

… solutions »aus dem Berliner Koffer / out of the berlin box« for:

Logistics

(e-) Mobility

SME

Aerospace Industry

Automotive Industry

Energy

Fraunhofer IPK
INSTITUTE PRODUCTION SYSTEMS AND DESIGN TECHNOLOGY

IWF
INSTITUTE MACHINE TOOLS AND FACTORY MANAGEMENT TECHNISCHE UNIVERSITÄT BERLIN

Thank you very much
for your attention

Fraunhofer IPK
INSTITUTE
PRODUCTION SYSTEMS AND
DESIGN TECHNOLOGY

INSTITUTE MACHINE TOOLS
AND FACTORY MANAGEMENT
TECHNISCHE UNIVERSITÄT BERLIN