Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 63 (2017) 219 – 223

www.elsevier.com/locate/procedia

The 50th CIRP Conference on Manufacturing Systems

The Implementation of Cloud Platform for Injection Molding Process

Wen-Ren Jong*, Shia-Chung Chen, Shih-Ming Wang, Su-Houn Liu, Hsiu-Li Liao, Yu-Hung Ting, Han-Ting Chen

Department of Mechanical Engineering, Chung Yuan Christian University, Chung Li District, Taoyuan City 32023, Taiwan
* Corresponding author. Tel.: +886(3) 2654318; fax: +886(3) 2654399. *E-mail address:* wenren@cycu.edu.tw

Abstract

Injection molding of plastic has been the important process for mass production. However, due to the diversified complications of mold design with mold manufacturing, and the coupling effects of plastic with molding machine, it is quite difficult to consistently molding the products with higher quality and precision. This research proposes the implementation of a cloud platform. It can not only digitize the information of mold design, mold manufacturing and molding practice, but also interchange the data with these stages automatically. Moreover, it brings up a possible methodology to accumulate the interdisciplinary knowledge and expertise for molding quality and precision.

Peer-review under responsibility of the scientific committee of The 50th CIRP Conference on Manufacturing Systems

Keywords: Cloud Platform; Cloud Application; Mold Design Navigating System; Mold Manufacturing; Injection Molding; Industry 4.0;

1. Introduction

Injection molding of plastic has been the important process for mass production. As long as the mold is properly made, each cycle of molding process only takes about a couple of seconds to tens of seconds. Especially for most products, the quality is consistent and the yield is high. Moreover, with the improvement of material, CNC machining, and molding machines, the expectation for quality and precise molding produces is getting higher.

However, due to the diversified complications of mold design with mold manufacturing, and the coupling effects of plastic with molding machine, it is quite difficult to consistently molding the products with higher quality and precision. Even with the high-end commercial software and hardware, the seamless integration of mold design, mold manufacturing and molding process needs innovative thinking.

With conventional approach, due to the lacking of interdisciplinary expertise, the mold design, mold manufacturing and molding process are usually executed separately. However, due the needs for consistent high-precision products, the realization of design-for-manufacturing and design-for-molding must be implemented. In present day most of these cross-domain information needed to be manually passed back and forth several times, and this will reduce the efficiency and might lose or miss-understand some important data during each cycle. In other words, the interdisciplinary knowledge and expertise of the whole design, manufacturing and molding process must be built, executed, and accumulated.

The mold-design navigating system, smart machining system, and molding navigating system has been elaborated for many years [1-6]. As shown in Figure 1, these systems have the capabilities of physical, operational, and information technologies; namely, they have somehow reached the level 3 in ISA-95 architecture [7]. With these sound foundations, this research is aimed to build a cloud platform to treasure data and information from these systems; hopefully, the cross-linked knowledge and expertise can be further formulated to elevated the injection molding process to level 4 of ISA-95.

Peer-review under responsibility of the scientific committee of The 50th CIRP Conference on Manufacturing Systems
doi:10.1016/j.procir.2017.03.117

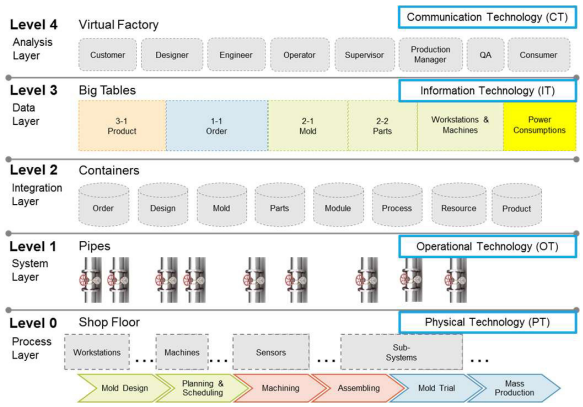


Fig. 1. ISA-95 architecture for an injection mold smart factory.

2. Scope and Implementation

With the implementation of cloud platform, it will be possible to keep, couple and reuse the individual and interdisciplinary data/information. Since the research team has dedicated in these stages (mold design, mold manufacturing, and molding process) for many years, the collection of data and generation of information for individual stage shouldn't be a problem. However, these data/information should be acquired and generated in the cloud platform automatically, as such they can be interchanged and synthesized just-in-time to formulate the unprecedented knowledge and expertise. As such, the quality and precision of machining component and molding product can be guaranteed and thereafter elevated.

2.1. Scope of Platform

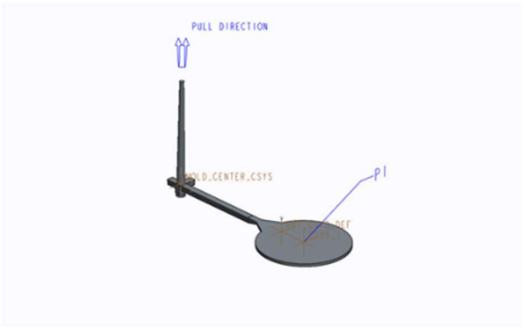
As show in Figure 2, a disk mold is used concatenate the mold design, CNC machining, and molding practice. Even though the design, machining, and molding data are collected through individual stage, the data should be firstly related together. Secondly, the transmitting of data should be done automatically without adding any extra burden to the operation. Thirdly, the data should be able to communicate in both directions between individual stage and cloud platform, as such the dialog among stages will always go through cloud platform with developed applications.

2.2. Interchange of Data and Information

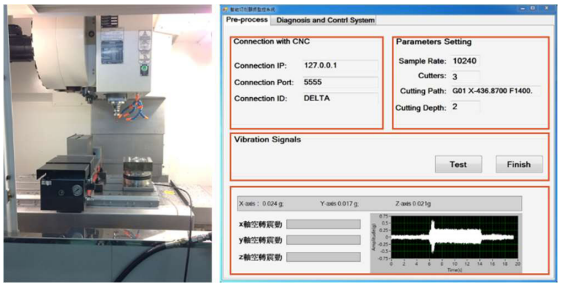
Considering the factors of readability and flexibility, the data exchange uses the open-standard file format (JavaScript Object Notation, JSON). Figure 3 shows the four different samples of JSON file in this study. In addition, since the web service is software system designed to support interoperable machine-to-machine interaction over a network, the different web services are established to provide the communications between stages and cloud platform. All the uploaded data will be stored in the database of cloud platform for further visualization and analysis. The access to the data is allowed by all registered agents with corresponding authorities in the cloud platform.

2.3. Realization of Platform

The cloud platform is currently built on Node.js (Meteor) which is designed to optimize the throughput, scalability and real-time of web applications. Besides, the NoSQL (not only SQL) database system (MongoDB) is used store all heterogeneous data from all three stages for further big-data and real-time web applications. The cloud platform structure implemented in this study is illustrated in Figure 4. Pre-defined event-triggered applications were implemented as well as the self-issued identification of the systems or agents, such as the design system, or the machines.



(a) Mold design



(b) CNC machining

(c) Mold trial

Fig. 2. A disk-shaped mold data inter-communication between lifecycle stages.